CIRCADIAN PERIODICITIES OF SELECTED SOCIAL AND MOTOR BEHAVIORS IN TWO-YEAR-OLD CHILDREN: AN ETHOLOGICAL INVESTIGATION

by

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The problem investigated in this study was the relationship between the frequencies and durations of selected behavioral categories in a group of two-year-old children and time of day. Specifically, the question asked was, do two-year-olds' behaviors change in a free play setting in a nursery school as a function of time of day? It was hypothesized that there would be no group differences in either frequency or duration of behavior at different times of the day in similar preschool settings.

The question was investigated by means of ethological, observational techniques, utilizing videotape technology in the data collection process. The subjects observed were eight two-year-old children concurrently enrolled in a morning nursery school program at Centenary United Methodist Church and an afternoon nursery school program in the Department of Child Development and Family Relations at the University of North Carolina at Greensboro. There were two major time groups, morning and afternoon, and two afternoon time sub-groups, early afternoon (1-2 p. m.) and late afternoon (3-4 p. m.). The subjects were all of the middle socio-economic structure.

The subjects were taped in the first part of the school year to provide the researcher with both an indication of the most frequently occurring behaviors of that age group and experience in viewing and transcribing behaviors from videotape. The data collection process took place during a four-week period in November and December, 1975. During that period, each of the

eight children was taped twice in each setting, one-half hour per tape, while he/she was engaged in free play activities. A total of two hours of observations per child was obtained.

Ten social and motor behavioral categories were initially chosen for inclusion in the study. However, upon completion of the data transcribing process it was noted that four of the categories occurred extremely infrequently and they were dropped from the statistical analysis procedures. The final categories, whose definitions were from Blurton-Jones (1972a), Leach (1972), and McGrew, (1972a), were as follows: 1) immobile; 2) automanipulate; 3) manipulate; 4) take; 5) digit suck; and 6) smile.

The two-day scores per preschool setting of each child were summed for each behavioral category. The statistical analysis consisted of:

1) Comparison of the percent of change of frequencies of behaviors between groups across time by means of six t-tests.
2) Direct comparison of those behavioral frequencies which reached significance in the initial t-test procedures.
3) Comparison of the durations of behaviors between groups across time by means of six separate one-way analyses of variance.
4) Comparison of the morning and afternoon frequencies of behaviors between the afternoon sub-groups by means of twelve separate t-tests.

The results of the analyses revealed one significant difference in frequency of behavior at the different times, afternoon versus morning ($p < .01$): automanipulate. No other significant differences were noted

with respect to either frequencies or durations of behaviors in the group across time, including the durations of automanipulate.

It was noted that no real differences in the behavioral patterns of the children in the study were indicated as a function of time of day. It was seen that the children were consistent across time and across centers with respect to the frequency and duration of the chosen behavioral categories. Conclusions were in the form of questions which dealt with the seemingly inconclusive results. They dealt with such topics as what factors accounted for the consistency of circadian rhythmicities indicated by this study, the specificity and applicability of the selected ethogram, the meaning of periodicity in preschoolers, and the relationship between physiological development and behavioral rhythmicity. More extensive and diverse developmental rhythmicity studies were recommended.

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CHAPTER I

INTRODUCTION

As human beings have become more sophisticated in the use, measurement, and maintenance of time, their relationship with the temporal dimension has changed accordingly. Crude measurements of time have given way to highly sensitive clocks which can measure the movement of the earth in space to within fractions of a second. Also, man's means of transportation have improved to the point that he is now able to outspeed the rotation of the earth and to place himself in a different spatio-temporal relationship with the environment, a phenomenon colloquially termed "jet-lag". It has been discovered, however, that moving rapidly from one time zone to another has more long-term ramifications than a superficial, relational change because the body's physiological functioning is altered by such a move (Elliott et al., 1972). Space travel has an even greater effect (Rummel, 1966).

Periodicities in behaviors of the non-human animal and plant worlds have long been the subjects of inquiry by scientists interested in unraveling the seeming anomalies of such behaviors. It is only recently, in the past two centuries, that man has recognized periodicities in his own species and made some attempts at understanding them (Kleitman, 1963; Sollberger, 1965). The relativity theory postulated by Einstein, which describes the fourth dimension of time within which the first three dimensions unfold, lends support to such studies (Halberg et al., 1973). Research on sleep behavior, which has discerned different phases of sleep which follow a cyclic pattern, add

further credibility to the notion of behavioral, biological periodicities in the human species, and establish periodicity as a field of study in behavioral and biological research (Kleitman, 1963).

Researchers have examined the physiological etiologies of cyclic behaviors in terms of glandular and hormonal secretions, and their ramifications with respect to cell and organismic functioning, and biosocial development (Aschoff, 1965; Axelrod, 1974; Brownstein & Axelrod, 1974; Chapple, 1970; Halberg, 1960; Halberg et al., 1973; Hellbrugge, 1960; Kleitman, 1963; Luce, 1971; Ostberg, 1973). The effects of disruption of individual cyclic functioning have been described as well (Anders & Chalemian, 1974; David et al., 1973; Felton & Patterson, 1971; Kripke et al., 1971; Lund, 1974; Morgan et al., 1974; Patkai, 1970; Taub & Berger, 1974). Researchers have also focused on performance and behavioral variabilities as a function of time (Barton & Cattell, 1974; Gooddy, 1969; Halberg et al., 1973; Kleitman, 1970; Lavie, 1974; Lavie et al., 1974; Mackenberg et al., 1974; Musumeci & Misiak, 1974; Samis, 1968; Wade et al., 1973). Finally, and most significantly with respect to this study, the characteristics and development of periodicities of behavior in neonates, infants and young children have been the subjects of other studies (Anders & Chalemian, 1974; Birns et al., 1965a; Birns et al., 1965b; Escalona, 1965; Halberg et al., 1973; Hellbrugge, 1960; Kahn et al., 1973; Kleitman, 1963; McGrew, 1972(a); Parmelee, 1961; Parmelee et al., 1961; Sollberger, 1965; Wade et al., 1973).

Problem

The present study was designed to observe and record potential social and motor behavioral periodicities of eight two-year-old preschoolers who attended the Two-year Program of the Nursery School in the Department of Child Development and Family Relations of the School of Home Economics at the University of North Carolina at Greensboro, and the Two-year Weekday Program at Centenary United Methodist Church, both located in Greensboro, N. C. The children observed in the study attended both preschool programs which met at different times of the day, and for the most part, different days of the week. The group was chosen so that circadian behavioral fluctuations might have been observed without the confounding variables involved in other sampling techniques such as matched sampling. An attempt was made to discern and describe regular behavioral patterns in the same individuals at different times of the day during a four-week period.

The problem considered in this study was modeled after the ethological observational studies of three- and four-year-old nursery school children conducted by McGrew (1972a). He and his co-workers noted the periodicities in motor and social behaviors of children in two nursery-school settings over a period of four months. Definite periodicities in both the motor and social skills areas were found by McGrew. As in that study, videotape methodology was utilized in the data collection process, incorporating the precautions which need to be considered in the use of that medium. (cf. Hutt & Hutt, 1970; McGrew, 1972a)

Justification for the Study

Since a dearth of information existed with respect to behavioral rhythmicities in two-year-old children, an ethological study design was deemed most appropriate for elicitation of baseline data in that area. An objective behavioral description of the cyclic characteristics of two-year-olds gleaned from such a study was seen as the first of several steps in developing measurements of the "rhythmic and nonrhythmic" children postulated by Luce (1971), and delineating the entrainment process in early rhythmic development.

Questions and Hypothesis

The basic question of the study was: are there significant differences in the occurrence of ten selected behaviors in a group of two-year-old children attending two preschool programs which meet at different times of the day? This seemingly simple question represented an initial attempt at describing the formation of behavioral rhythmicities, and at indicating the characteristics of same, at a point in development between the arhythmic neonate and infant and the synchronized four- and five-year-old child. More specifically, a clarification was attempted of the age-related phenomenon of the development of periodicity in behavior in human children, which has been postulated to occur sometime in the child's third year of life (Luce, 1971).

It need be noted, however, that this study represents only the initial phase of a series of research endeavors aimed at establishing the full

developmental etiologies and characteristics of circadian rhythmicities in human children. The present study had as its focus the recording of frequencies and durations of selected behaviors of two-year-olds in similar preschool settings at different times of the day. This descriptive study was seen as the precursor to, and foundation for, experimental biotelemetry, and environmentally-controlled research efforts aimed at developing a full understanding of the development of rhythmicity, or lack thereof, in early childhood.

The null hypothesis was assumed in this study because of the general absence of data with respect to the behavioral patterns of two-year-olds (Blurton-Jones, 1972a), and the seeming immaturity of those organ systems of the human body which pattern rhythmicities in children of that age (Luce, 1971). A directional hypothesis was deemed inappropriate given those considerations. On the basis of prior research efforts in the area of periodicities in the behavior of young children (McGrew, 1972a), no behavioral differences were expected to occur as a function of time of day. A rejection level of p less than or equal to .01 was assumed. (cf. McGrew, 1972a)

Implications of the Study

The focus area of the study has implications for preschool administrators and teachers, child development experts, parents, and circadian rhythm researchers. Administrators and teachers in programs for young children may glean some understanding of the predictability-unpredictability of young

children's behavior as a function of time of day. For example, if aggressive, antagonistic behaviors either increase or decrease according to the time of day, programs might consider those tendencies in their scheduling for the benefit of all concerned. If children have better experiences in group situations at different times of the day, that would be a possible key consideration in both the administration and characteristics of preschool programs.

Child development personnel are concerned with normative behavioral patterns of children at different ages and stages of development, among other factors (Ausubel & Sullivan, 1970). The temporal variable may prove to be critical in developing a full understanding of the potential behaviors of the preschool child. More specifically, characteristics deemed appropriate for a given age group by previous research may in fact be found to be descriptions of behaviors common to a particular time of day. For example, young children may be more social in the morning, while research might be conducted in the afternoon which would find a preponderance of aggressive, non-social behaviors. It is the purpose of this study to support incorporation of rhythmicities research into the field of child development. Research geared toward determining normative behavioral patterns of different ages and stages of development may need to include not only the age of the child, but also the time of day at which the study was conducted.

A source of controversy for parents in terms of optimal child-rearing practices has been whether they should institute a strict temporal regimen,

feeding the child at regular intervals and establishing constant sleep-awake patterning; or whether they should adopt a child-determined regimen, feeding at the demand of the child and allowing the child to determine sleep and activity periods. Also, although adults may recognize that their functioning capabilities fluctuate according to the time of day, children have not been systematically studied with resepct to the time-of-day variable. Parents know through experience when their children become irrascible, distractable, and the like, but do not know enough about the development of behavioral periodicities, for the most part, to optimally structure the home environment to help the child adapt to the endogenously-determined, inherent rhythmicities of his body, and the exogenously-determined, social rhythmicities of his general environment. Nap times, night-sleep times, activity patterning, and feeding periods must all be included in the development of an optimal environment for the patterning of rhythmicities in young children.

Literature reviews in the field of circadian rhythm research have been only marginally concerned with the behavioral consequences of the development of periodicities in the young child. Most studies of rhythmicities in children have dealt with sleep patternings and/or physiological functioning. There is a seeming quantum leap from the irregular behavioral patterns of the neonate and infant to the highly developed rhythmicities of the human adult which may continue even in conditions of isolation. A clear understanding of the development of rhythmicity in children during the postulated critical

period of rhythmic patterning, i.e., two to three years of age (Kleitman, 1963; Luce, 1971), is indicated.

This study was designed to provide an initial baseline from which other research efforts aimed at providing the aforementioned information may be evolved. Thus it is hoped that this effort represents a modest contribution to child development and periodicity researchers, other professionals in both fields, and, perhaps ultimately, parents.

Limitations of the Study

Time-sampling of behaviors across different periods of the day in preschool settings for two-year-olds placed limitations on the number of subjects who could be adequately observed. There is ample precedent for small population studies in the ethological literature (c.f. Blurton-Jones, 1972; McGrew, 1972a), even though the generalizability of the data was thus constrained. That restriction was mediated by the innate, species-wide nature of the phenomenon observed. The phenomenon of rhythmicity development in young children was assumed to be a universally-similar process (Luce, 1971), so that a larger sample size would have only added more data to the pool rather than more verity and/or clarity to the study at hand.

A further problem to be acknowledged is that the study population may be seen as a self-selected group in that the participating parents have chosen not only involvement in one preschool program for their two-year-olds, which is in itself still somewhat uncommon (Blurton-Jones, 1972a), but also

involvement in an additional program. Numerous programs for this age range have been initiated in the Greensboro area in the past few years which serve increasingly larger numbers of families, and some of the children in the UNC-G program not participating in the study attended other programs as well. Thus, the children who were observed were not as unique as it would appear initially.

Organization of the Study

The first chapter of this study provides a general overview of what is to follow in the later chapters. All phases of the study are considered in this initial chapter.

A review of the human periodicity research, and its relationship to both ethological research techniques and the field of child development, are the foci of the second chapter. The review is not comprehensive with respect to any of the aforementioned fields, but is, rather, an attempt at indicating possible interfaces between the various disciplines.

The third chapter is concerned with the study methodology. Characteristics of the programs and children involved in the research, as well as data collection and analysis techniques, are considered.

The fourth chapter is focused on the results of the data collection and analysis processes. The fifth chapter is concerned with a discussion of the study results and methodologic considerations. The sixth

chapter, the final chapter of the study, provides concluding remarks with respect to the general outcome of the study. Follow-up research questions and areas implicated by this study are treated as well.

Supplementary material is provided in various appendices in the back of the text. Reference is made to the appropriate appendices in the body of the text.

CHAPTER II

REVIEW OF THE LITERATURE

Studies in the fields of behavioral and physiological periodicity have become more common and more sophisticated since the early part of this century (Kleitman, 1963; Luce, 1971). The phenomenon of periodicity is now an integral component in the theoretical systems dealing with physiological homeostasis and individual differences (Escalona, 1965; Mills, 1966; Thomas et al., 1970). Until recently, however, most research focused on rhythmicity in plants and in lower species of animals (Aschoff, 1965; Mills, 1966). Applications of the concept to humans developed rapidly and concomitantly with an understanding of the ramifications of such an internal system to human development and functioning (Aschoff, 1965a; Aschoff, 1965b; Chapple, 1970; Chapple, 1974; Halberg et al., 1973; Kleitman, 1963 & 1969; LeVine, 1973; Luce, 1971; McGrew, 1972; Mills, 1966). Rather than duplicate previous literature reviews in the area of behavioral and physiological periodicities, human ethology, and child development, it is felt that an erudite review of literature should focus on the following research areas: 1) a general theoretic presentation of conceptual and definitional studies, with special reference to the significance of the studies to the field of human development; 2) a summary of trends in research with human adults in the area of periodicity; 3) the cultural significance of, and influence on, cyclical behaviors;

4) a survey of the human developmental periodicity research literature, from the prenatal period to the preschool period; and 5) a summation of the literature indicating the interface between periodicity research, human ethology methodology and theory, and the field of child development. With this format, an understanding of the relative position of child development studies within the context of the research area of periodicity might be reached, as well as an appreciation of the significance and value of such studies as more is learned about the variabilities and individuality of human development.

General Considerations

Kleitman, in his studies of the patterning and general characteristics of sleep behavior conducted in the 1930's, found that there were certain regularities in the type, duration, and behavioral and physiological manifestations of sleep. He proposed the term basic rest-activity cycle (BRAC) to describe the cyclic variations which occurred in the process of human sleep. Later, it was found that cyclical variations were not merely a function of sleep activity, but of wakeful activity as well. Also, the formal definitions of temporally-cued behaviors were developed. Rhythms, he maintained, were "a regularly recurring quantitative change in some particular variable biological process, irrespective of whether or not it takes place in a cell, tissue, structure, organism, or population"(Kleitman, 1963, p. 131). He further noted two basic conditions of a rhythm:

> 1) it must be extrinsic in origin, deriving from variations within the environment and developing in each biological system de novo; 2) when fully established, it must persist for some time, even when the environmental changes are absent. (Kleitman, 1963, p. 131)

Cycles were defined as "repetitive series of events or successive changes of state, either quantitative or qualitative in nature, the distinctive feature of which being order of occurrence" (Kleitman, 1963, p. 131). Causal, synchronous, associated or coupled periodicity was defined as being dependent upon environmental changes such that it shows no persistence of variations when the external variations are made uniform.

The BRAC model was first noted in the electro-encephalograms (EEG's) of sleepers and was then noted to function in the wakeful state. It was also noted as an integral component of human development. Kleitman maintained:

> The BRAC increases in duration, in proportion to body size, in the course of phylogenetic and ontogenetic development. ... The BRAC lengthens from birth to maturity in all species exhibiting the cycle--in man, from 50 to 60 minutes in the infant to 85 to 90 minutes in the adult. (Kleitman, 1969, p. 34)

Further, he postulated:

> There is a short-term, basic rest-activity cycle in the functioning of the central nervous system of higher vertebrates that, although independent of the alternation of sleep and wakefulness, periodically modifies both of these states. (Kleitman, 1969, p. 37)

Through 1963, Kleitman recognized 24-hour variations in the following physiological processes: alpha frequency, blood composition, blood pressure, blood sugar, cerebrospinal fluid composition, digestion, eosinophil count, epileptic attacks, heart rate, kidney activity, knee jerk, mitosis, oculomotor activity, performance, phosphate excretion, respiration, sensitivity to foradic current, susceptibility to audiogenic convulsions, visceral activity, as well as others. Researchers since that time have elaborated significantly on that initial listing (Luce, 1971), the validity of studying periodic, physio-behavioral fluctuations having been established. (see also Reinberg, 1974)

It was Halberg (1959) who coined the term "circadian" to describe 24-hour periodicities. He stated:

> The term circadian ((L) circa, about + dies, day) will be used to denote daily periods which may differ from 24 hours by not more than a few hours. (Halberg, 1959, p. 804)

Halberg noted two basic characteristics of circadian rhythms: the circadian period is synchronized with (entrained to) the rotation of the earth by regular periodic factors in the environment termed Zeitgeber (from the German: synchronizer); and illumination and temperature are the most critical of a number of Zeitgeber (Halberg, 1959).

Aschoff, another major researcher in the field of periodicity, maintained that body rhymicities were expressions of a physiological clock, a factor endogenous to all living systems (Aschoff, 1965b). From his studies, he

postulated that in living systems, circadian rhythms continued undamped in experimental conditions, and maintained themselves in changed environments. Thus, he felt that the rhythm is an endogenous phenomenon, a self-sustained oscillation, with its own inherent frequency. Although there were a number of critics of the internal-timing mechanism postulated by Kleitman (1963), Aschoff (1965a & 1965b) and others (cf. Brown, 1965) a number of years ago, most have given way to the self-sustained circadian model (Mills, 1966).

Aschoff was a pioneer of studies of human subjects without time cues. He isolated individuals in underground bunkers and, later, self-contained apartments, and recorded the biological functioning of those individuals to determine what physiological time-scheme they would develop. He found that the normative periodicity adopted by the subjects in those experiments was approximately 24 hours, or circadian (Aschoff, 1965a).

Aschoff postulated further that there was an adaptive significance of human circadian rhythmicity for the following reasons: 1) they enable the organism to behave appropriately at the appropriate time; 2) they provide an anticipation of external, environmental changes by means of the state changes of the internal organismic system; 3) Zeitgeber allow for species-specific adaptation to the environment; and 4) the entrainment process facilitates the temporal organization of the multiple internal oscillating variables. Overall, he maintained that circadian rhythmicity was a strong internal mechanism which was a factor in human, as well as other animal, behavior (Aschoff, 1965b).

Other investigators have elaborated support of the endogenous nature of human rhythmicity. Bunning (1963) maintained that innate rhythmicity was characteristic of human functioning from infancy through death, probably even extending into the prenatal period. Sollberger (1965) lent further corroborative evidence to such a position, noting especially the circadian patterning of the functioning of the adrenal-cortical and nervous systems. (Note: see Axelrod (1974), and Brownstein & Axelrod (1974), for physiological explication.) Reinberg (1974) argued not only for the endogenous, entraining character of human rhythmicity on a circadian level, but also on seven-day (circaseptan), thirty-day (circamensual), and one-year (circannual) levels. He included such factors as natality, testosterone level, menarche, and endocrine levels in his consideration. Lobban(1965) added a social interaction Zeitgeber to light and temperature, the two entraining variables which had been primarily researched and which had been felt to be primary in the process (Kleitman, 1963; Aschoff, 1965b). The social environment was thus postulated to be a critical variable in the rhythmic, physiological functioning of the individual.

Mills (1966), in a review of the human circadian rhythm literature through 1966, delineated a number of factors which researchers had considered in that area of research. One of the most important components added to research of the physiology and behavior of human beings by the rhythm researchers was the fact that "any observation may be suspect without a statement of the time of day at which it was made" (Mills, 1966, p. 128). Alternations of light and

darkness, he maintained, produced behavioral differences as a function of time of day. These differences were seen as pervading all aspects of social life, even for those persons without sight.

Rhythmicity research, Mills maintained further, might focus on one of three different levels: "1) those that have only been observed within a circadain periodicity of social or climatic environment, which may thus be exogenous, immediately dependent on this fluctuating environment; 2) those in which some attempt has been made to exclude or appropriately modify the environmental periodicity and thus demonstrate the persistent 'free-running' character of the periodicity -- that is, to demonstrate that it is a 'rhythm' in the sense used by Kleitman; 3) those where the causal connection between different rhythmic events has been explored as a step toward defining the organ or tissue where the rhythmic property resides and its mode of influence on the manifestation under observation" (Mills, 1966, p. 130). With respect to the debate over the endogenous versus exogenous nature of circadian rhythms, Mills provided five categories of evidence to support an endogenous, internal clock system: 1) the rhythm persisted while the envoronment remained constant; 2) when the external environment was shifted, as in change of longitude, the rhythm reverted to its initial phase; 3) the rhythm was maintained while the environment changed; 4) variabilities in rhythmicities occurred across individuals in a constant environment; and 5) the internal clock became entrained to a new external system (Mills, 1966). Finally, however, a conclusive answer as to the etiology of human rhythmicity was not forthcoming,

as it seemed some hormonal and neurological systems exhibited endogenous origins, while the rhythmic gestalt was of probable exogenous origin. Further, more elaborate research was indicated.

Gooddy (1969) has provided a somewhat more elaborate, mechanistic, logical perspective on the body as a clock, or the endogenous patterning of periodicities.

> Since each of the atoms of our structure obeys the same laws as those of any other structure of the universe, we must be directly related to 'cosmic time'. The most accurate modern clocks depend upon the oscillations of molecules of ammonia or of cesium and at first sight appear remote indeed from human structure; but we must remember the innumerable atomic and biochemical rhythms already fully demonstrated in our own structure. (Gooddy, 1969, p. 247)

He elaborated further a proposal, established in logical progression, which presented the central nervous system as a clock:

1. Because of its fundamentally rhythmic type of activity (associated with the 'all or none' phenomenon of transmission) at all physiological levels;
2. Because the nervous system mediates sensory and motor activity and thus is completely integrated with the reception and creation of rhythmic phenomena (e. g., light and sound waves and habitual movements such as walking, breathing, talking, etc.);

3. Because the nervous system is the final mediator of the person's awareness of all the clock systems derived from rhythmic systems not primarily nervous; and
4. Therefore, the nervous system provides both the anatomical structure and the physiological activity required for a clock mechanism, and may be regarded as a clock. (Gooddy, 1969, p. 248)

Gooddy then noted that the human species has become adapted to a relatively constrained spatio-temporal environment, both external and internal to the organism. This adaptation has provided man with a number of "chronometric systems" (Gooddy, 1969, p. 250) and biochemical regulation systems, which, when altered by arhythmic activities, have deleterious biochemical, physiological, and psychological effects on organismic functioning. Bodily health, of all sorts, he maintained, depended upon rhythmic functioning of the individual.

Halberg et al. (1973) stressed the significance of consideration of rhythmicity in the fields of education and preventive medicine. They noted that the human species functions within the general framework of time and rhythmic cues which emanate from both internal and external sources, the fourth dimension of time being a critical variable in all phases of life. Rhythms occurred, they found, in such disparate physiological functions as weight gain, hormonal secretions, heart rates, and the adrenal cycle. Such rhythms had the characteristics of being both persistent in non-temporally-cued environments, and critical to the internal mechanisms of the organism.

They went on to outline a number of salient properties of rhythms in most all animate organisms, humans not excepted. First, bioperiodicities were seen as comprising a fundamental property of living matter, virtually without exception. Second, rhythms of varying frequencies have been found in animal species from unicellular organisms to human beings. Third, rhythms function at all levels of life organization, from the cellular to inter-species. Fourth, rhythms have been found to be desynchronized by such factors as rapid geographic displacement and changes in work schedules which have potentially debilitating effects on the organism. Fifth, rhythms have been shown to be critical variables in preventive health care, as rhythmicity data are keys to an understanding of the normative functioning of an organism. And, finally, along with the three usual "R's" of education, reading, writing, and arithmetic, Halberg et al. (1973) included rhythms as an integral component in the formulation of an optimal learning environment, as had Kleitman (1970) some time earlier.

Adult Literature

Research on periodicity in adult humans has been focused on a number of issues raised by theoretical considerations: 1) what happens to human periodicity if light, time and social cues are experimentally removed from an individual's environment; 2) can 24-hour (circadian) periodicity in the human being be changed to shorter or longer cycles, e.g., 18-hour, 48-hour; and 3) are there different capacities of individuals as a function of time of day? This segment of the review is to be focused on circadian variability

in human functioning as it is the research area most salient to this study, while the other areas of investigation are reviewed briefly and trends in those areas indicated. (cf. Luce, 1971, for a comprehensive review of the research pertaining to adult periodicities.)

Isolation Studies

Aschoff's work at the Max Planck Institute was the forerunner of, and provided the format for, the experimental isolation studies (Mills, 1966). His basic methodology was to isolate an individual in underground bunkers away from all external spatio-temporal cues. The subjects determined their schedules, making the day as long or as short as they desired. Physiological and temporal data were collected to determine the periodicities of human functioning in such a free-running environment. Basically, a circadian rhythm (Halberg, 1959) was established by most of the subjects in such studies (Aschoff, 1965b). Variations on this basic theme have been conducted for a number of years (Kleitman, 1963), the techniques, methodologies, and experimental conditions being more or less sophisticated relative to the earlier studies. Overall, there seems to be a self-sustained oscillator at work within the human body which keeps it in a circadian pattern even in isolation conditions (Aschoff, 1965a; Aschoff, 1965b; Gooddy, 1969; Kleitman, 1963; Mills, 1966). As to the etiology of the oscillator, Mills maintained:

> Whether this rhythm arises directly in the central nervous system or whether it results from changes in body temperature, in adrenal activity, or in some other system is quite unknown.

...This is a clearly endogenous rhythm, since it persists even in mice kept in the dark for several generations. (Mills, 1966, p. 134)

Rhythmic Modification Studies

Kleitman was a pioneer in the study of artificially-entrained cycles in human subjects. His methodology, again adapted by later researchers, was similar to that of the isolation studies with a few changes: multiple-subject groups were used, and the experimental environment was time-cued according to the desired cycle, e.g., 18, 22, or 28 hours, by the establishment of a routine. Physiological data was collected on each subject to determine if his body had become entrained to the non-circadian cycle or if he was merely adapting behaviorally to the new environment. Some physiologic functions entrained to different cycles, e.g., heart rate to an 18-hour cycle, while still others entrained completely to 21- and 28-hour cycles (Kleitman, 1963).

As with the isolation research concept, the rhythm modification concept has been germinal in producing scores of follow-up studies. Bruce (1960) provided a comprehensive review of literature through 1960, as well as some research data on the modification of rhythmicity in the hamster. Lobban (1965) conducted a cycle modification study on subjects in Norway, with altered cycles of 21 and 27 hours. She found entraining to the 27-hour schedule occurred in one subject. From a generalized perspective, she concluded:

Much more work is needed upon the human subject in different environmental conditions and on different work

> schedules before the roles of environmental and social factors and the activity pattern in the maintenance of the normal human physiological daily rhythms can be fully evaluated. (Lobban, 1965, p. 227)

Lund (1974) found that subjects who experienced desynchronization in a constant environment devoid of time cues (approximately 20 percent of the total) showed temperature and activity rhythms significantly different from those who experienced no desynchronization. The 20 percent of subjects who became desynchronized showed a greater tendency for neuroticism on psychological testing and complained of physical ailments more frequently (Lund, 1974).

Taub and Berger (1974) shifted the sleep times of ten subjects, and tested their performance on a calculation task after each sleep shift. Although the amount of sleep remained constant throughout, performance on the task showed a decrement after each shift.

Finally, Chouvet et al. (1974) conducted a polygraphic study on subjects isolated in caves for 5-6 months and entrained to a bicircadian (48-hour) rhythm. Of the three subjects, only one was able fully to adapt to this rhythm. (cf. Siffre, 1975)

The studies chosen for this particular area of the review illustrate the basic trends in this area of research. Some, e. g., Chouvet et al. (1974), incorporated both isolation and modification techniques, the two areas not being mutually exclusive. Both isolation and modification studies were designed to test the two basic conditions of rhythms postulated by Kleitman (1963)

and the five categories of evidence which would indicate endogenous patterning of rhythmicity in human beings as developed by Mills (1966).

Twenty-four Hour Variation in Activity and Performance

Kleitman (1963) again provided the initial, germinal research framework around which later studies have been built. He found that a direct relationship existed between body temperature and performance on a number of cognitive tasks, and that the body-temperature curves varied according to the individual. Some persons reached a body temperature and activity peak early in the day, shortly before or after noon, while others reached theirs later in the afternoon or early evening, giving rise to the colloquial terminology of "morning" and "evening" types (Kleitman, 1963, p. 161). The "morning" subjects performed tasks better early in the day, while the evening subjects showed progressive improvement on tasks as the day progressed. Intermediate groups were also found which functioned between the morning-evening poles of the periodicity spectrum (Kleitman, 1963).

Barton and Cattell (1974), in a study design somewhat similar to that of Kleitman (1963), tested over two thousand junior high school students on psychological state measures at different times of the day. Anxiety, stress, regression and depression were reported more frequently as the day progressed. They maintained that test norms should have a temporal reference.

Lavie et al. (1974) tested eight subjects on the spiral after-effect from four p.m. to midnight. The BRAC which Kleitman found to be active in sleep states, they postulated was at work in wakeful states as well, an hypothesis supported by periodic alternations in alertness in the subjects.

Patkai (1970) looked at diurnal differences between habitual morning workers and evening workers (college undergraduates), the groups being differentiated on the basis of a questionnaire. Each group was better in verbal-rote learning and visual-choice reaction tasks in their preference period, i.e., evening or morning. In line with Kleitman's (1963) findings, the body temperature was higher in the evening for the evening group although no diurnal variation was exhibited by the morning group.

Ostberg (1973) found a circadian rhythm in the food intake and oral temperature in "morning" and "evening" groups of individuals. There were significant differences between the groups as the morning group had an oral temperature peak five hours before the evening group and had a cumulative food intake curve one and three-quarters hours ahead of the evening group. He concluded that food intake was a good measure of intraindividual differences in circadian rhythms (Ostberg, 1973).

Kripke et al. (1971) investigated the impact of night working on sleep and work performance on workers at an Air Force base. Subjects slept better, worked better, and felt better after several weeks on the night shift as they became accustomed to that time shift. Felton and Patterson (1971), in a similar vein, argued against shift rotations for nurses as acclimitization (entrainment) was never effected with such a periodic variation in work time.

Individual, adult preferences for morning or evening activity have been established, as indicated. What have societies done with these diurnal,

biological differences in developing functioning patterning? More importantly with respect to this study, how have rhythmicities developed through infancy and childhood into the adult patterns?

Cultural Implications

The previous sections have focused on individual functioning and on human species functioning with respect to biological, behavioral periodicities. Man, in line with his primate heritage, has elaborated socio-cultural systems within which he develops and functions. Rhythmicity has played some role in shaping man's relationship with his environment and socio-cultural milieu, and has provided a potentially cohesive variable in socio-cultural functioning (Chapple, 1970; LeVine, 1973). How has man adjusted his rhythmicity to socio-cultural patterning and how have socio-cultural regimens affected human rhythmicity?

Chapple (1970) was the initial investigator to consider the relationship between the biological endowments and characteristics of Homo sapiens and his cultural adaptations, with specific reference to periodicity. Reiterating the fundamental nature of physiological and biochemical rhythmicities in all living matter, he added, "no matter what the species, individuals show the highest consistency in the regularities with which their rhythms manifest themselves" (Chapple, 1970, p. 25). Further, he maintained that the activity-inactivity levels within each organism was relatively constant, and was either expressed directly or in compensatory behaviors. It was

the individual's internal rhythms which formed the basis for his personal individuality and intra-species interaction (Chapple, 1974). That is:

> Through its own endogenous rhythms, the organism anticipates each stage of adaptation. ... It is always prepared and this prevision (almost literally) enables it to survive. (Chapple, 1970, p. 27)

Of the three primary environmental Zeitgeber, light, temperature and social interaction, the latter has received the least research attention, although in the human cultural context it may prove to be the most pervasive.

The centers of control of periodicity in mammalian young have not been fully developed at birth (Chapple, 1970; Sollberger, 1965). Chapple maintained that the developmental character of periodicity gave some leeway in the course of the process. For example, human infants have been found not to entrain to their nursing mother's rhythms (Chapple, 1970). Overall, in line with the postulated endogenous etiology of periodicity, physiological maturation of the organism was said to be the key to rhythmic development rather than the environment.

Kleitman (1963) noted that the human rhythmic developmental sequence was characterized by the change from the polycyclic nursling to the monocyclic child. The role of social interaction upon this process he summarized as follows:

> The development and maintenance of 24-hour sleep-wakefulness and body-temperature rhythms stem from being born into, and living in, a family and community run

according to alterations of light and darkness, resulting from the period of rotation of the earth around its axis. (Kleitman, 1963, p. 147)

LeVine (1973) was concerned with human rhythmicity from a cross-cultural perspective. He noted, as did Chapple (1970), that adult cycles tended to be highly individual and constant for a given person; and that social communication and living routines were importantly involved in synchronizing the circadian cycles of different individuals with each other and with 24 hours under experimental conditions of continuous darkness (LeVine, 1973, p. 231). Circadian rhythms did not exhibit much variation cross-culturally with the possible exceptions of the Arctic populations which adapted to the light-dark cycle, and the post-prandial "siesta" found in some cultures. (The siesta pattern has been noted in non-human primate populations, thus providing a possible phylogenetic explanation of the phenomenon in humans.) (cf. Jolly, 1972)

LeVine found a 24-hour organization in all human populations with a sleep phase usually occurring at night and a longer awake stage (sometimes including a nap, but always punctuated by some rest stages) usually occurring during the day (LeVine, 1973). The differences between sleep and waking, and rest and activity were posited to be human universals: sleep, characterized by the Rapid Eye Movement (REM) state; and wakefulness characterized by an activation state (alert orientation) and a nonactivation state (fatigue, relaxation) (LeVine, 1973). The 24-hour day was seen as a pancultural

situational context, it being the task of the rhythmicity ethnographer to develop "an ethnography of the daily cycle" (LeVine, 1974, p. 234). He advocated the production of an ethnographic picture of a particular culture's patterning of the daily activity cycle to discern, for example, how that culture incorporates psychophysiological rest-activity cycles into its social structure. Such a study he felt could "...be used as a reliable contextual background for identifying idiosyncracies of daily activity" (LeVine, 1973, p. 235). He noted that such questions as how children are socialized into culturally appropriate cyclical behavior would be particularly germinal.

Gooddy (1969) maintained that much of the turmoil found in human social existence, whether on the individual, societal or global level, stemmed from conflicts "between those forms of time (man-made) to which we adhere for public conformity and those forms of time which are provided by our personal structure and function" (Gooddy, 1969, p. 249). Time standardizations, especially in developed nations, have become virtually all-pervasive, encompassing such disparate areas of societal functioning as human developmental milestones and the time at which one reports to work. Gooddy indicated a salient point which was overlooked, for the most part, in societal temporal patterning:

> In us is working a set of chronometric systems which have evolved at a minutely slow rate, varying according to Darwinian principles. We are still related to the rise

> and fall of the oceans and the moon. We have intrinsic tides of biochemical forces. (Gooddy, 1969, p. 251)

Luce (1971) lent support to the potentially-debilitating effects of cultural scheduling, effects which might not be noticed:

> In general, the sound and fury of social life mask our underlying rhythmicity; moreover, it is difficult to keep continuous records of changes over time, especially when life's demands are exigent. (Luce, 1971, p. 89)

Life tempos have been culturally-determined from infancy and early childhood. For example, the American culture she categorized as a "lark" culture which has built-in castigations for owls, e. g., where could one get breakfast at eight p. m., or dinner at three a. m., yet, as Gooddy (1969) noted, there are physiological bases for the human differences. Luce maintained further that such individual-cultural clashes provided potential problem areas for children as they made the adjustment to school, home life, and general societal functioning. She felt that recognition need be given the regular undulations of human performance, rather than the cultural expectation of constant peak performance.

Developmental Implications

How does periodicity develop in human beings? More specifically, is rhythmicity a given at birth or does it undergo the maturational process of the individual? What effects does rhythmicity in infancy and childhood have

on individual behavior and development? It has been demonstrated that in order to fully understand the human developmental process and to appreciate the full behavioral ramifications of adult functioning, the phylogenetic endowments of reduced instinct and increased learning capacity and the developmental significance of the prenatal, neonatal, infant, and childhood stages need be considered (Ausubel & Sullivan, 1970). Research literature reviewed in previous sections has indicated that circadian rhythms are certainly no exception to this axiom. That is, strong arguments have been made for the developmental, yet endogenous, nature of periodicities (Aschoff, 1965b; Chapple, 1970; Kleitman, 1963; LeVine, 1973), it being the role of the developmental literature to confirm or reject such a postulation.

Kleitman was a pioneer in research studies of sleep-wakefulness in the neonate and infant, and provided the initial impetus to other areas of periodicity research. He and co-researchers made extensive studies of the sleep-awake activity cycles of newborns and infants. In general, they found:

> In the newborn infant, there is the operation of the 50- to 60-minute basic rest-activity cycle, but it soon becomes coupled with the 3- to 4-hour gastric cycle and the daily astronomical and social periodicity, eventually becoming a 24-hour rhythm. (Kleitman, 1963, p. 133)

Generally, the neonatal-infant sleep pattern was equally distributed between day and night sleep, but gradually developed a night-time prevalence during the course of the first year. Development of object relations, smiling, and

occipital EEG pattern, perceptual integration, and increased awareness of environment were cited as correlated phenomena to the decrease in day sleep time toward the end of the second trimester of the first year of life. Maturational factors were also found to be at work in the establishment of a periodic temperature curve in children, stability being established sometime in the second year of life (Kleitman, 1963).

Sollberger (1965) corroborated Kleitman's (1963) findings in noting that the sleep-wakefulness cycle in neonates and infants was a seemingly endogenous periodicity, possibly present embryonically. He maintained further that circadian rhythms were inherited, so there was support for the notion of prenatal rhythms. A developmental formula for rhythmicity was implied: maturation of the nervous system + greater contact with Zeitgeber (light, temperature, social contact) yields changes after birth (Sollberger, 1965).

Parmelee, in two studies, chronicled the development of sleep patterns from the neonatal period through eight months in infants. Overall, the changes in the sleep patterns were as follows: there was a decrease in duration of sleep; fewer, yet longer, awake periods were noted; a diurnal pattern of sleep was noticeable at approximately the sixth week, with a lengthening of single sleep and wakeful periods; and pattern development was seen as a function of central nervous system maturation (Parmelee, 1961; Parmelee et al., 1961).

Hellbrugge (1960) summarized the development of circadian rhythms in infants. Three characteristics of human infants were considered with respect

to development of periodicity: 1) human infants are immature at birth; 2) the basic precondition to a circadian rhythm is a fully mature neuro-hormonal system and functional efficiency of organs on which the rhythms are based; and 3) day/night rhythms are bound to the functioning organs of perception through which the synchronizing effects of Zeitgeber are mediated (Hellbrugge, 1960). From his research study on the development of circadian rhythms in ninety-six infants, the following conclusions were drawn: 1) different physiological functions developed a certain day and night rhythm independently from each other; 2) the rhythm of different functions became apparent at different times after birth; 3) during the development of day and night periodicity an increase in the range of oscillation occurred in all physiologic functions; 4) the increased range of oscillation was a function of the increase in upper width of oscillation during the daytime hours, and of the increase in the lower width of oscillation in the night hours; 5) the decrease in night values occurred, for the most part, between five and seven p. m. ; 6) the broadening of the nightly lowering necessitated, developmentally, a continuously later morning onset of the different physiological functions; 7) the developmental sequence of periodicity seemed to be the change from the spontaneous, 25-hour period polyphasic neonate to the 24-hour, monophasic adult; 8) physiological maturity was seen as being the key to the development of periodicity, a contention strongly supported by the lag in rhythmic development of prematures, as opposed to full-term infants (Hellbrugge, 1960, pp. 321-322).

Luce (1971) reviewed the phases and characteristics of rhythmic development in the human neonate and infant, incorporating considerations of familial and social, as well as individual, ramifications of the process. Infant rhythms, she noted, were not aligned with the familial rhythms of the adults, creating a source of potential conflict. Due to the lack of central nervous system maturation at birth, as previously noted, it was not until approximately the sixteenth week of life that the rhythms of the child and family became more similar. Infant sleep needs, as with adult sleep needs, were found to differ from individual to individual, usually ranging from 16 to 21 hours per day. As noted by Kleitman (1963), the infant REM cycle ranged from 50 to 60 minutes. REM sleep patterns were found to be related to the cognitive processes of the brain, as retarded children had less REM sleep than did normals.

Luce also maintained:

> The regularity of sleep cycles is one early indication of central nervous system maturation. The foreshadowings of a basic activity and rest cycle begin long before birth. (Luce, 1971, p. 97)

Two rhythms were found to be at work in the fetus: 1) an activity rhythm of 30 to 50 minutes; and 2) a non-active rhythm related to the REM state of the mother, with a duration of 90 to 110 minutes. At the time of birth, the 90 - minute rhythm has disappeared, at which time the aforementioned 40-50-minute rhythm begins. The feeding rhythm was shown to

be on a 180-minute cycle. At approximately eight months of age, the 90-minute REM cycle has appeared once again (Luce, 1971).

As noted by Hellbrugge (1960) and Kleitman (1963), the infant circadian rhythmicity did not develop until approximately the sixteenth to twentieth week, the different systems of the body acquiring rhythmicity at a differential rate. More simply, the child has not developed the rhythmicity of an adult. For example, the newborn was found to be completely out of synchronization with the world during the first week, while urine flow became more prevalent in the day during the second and third weeks. The circadian rhythmic excretion of chloride and creatinine, by-products of muscular activity, has usually been developed by two years of age. Mature rhythmic functioning of the adrenal hormone system has usually been established by approximately three years of age:

> The levels of adrenal hormones modulate sense perception and fatigue. Because adults are rhythmic, they can predict these subtle changes in themselves, but the child under three is presumably not very predictable. The rate at which a child develops circadian adrenal rhythms may be partly enhanced by his environment. (Luce, 1971, p. 100)

The time of fatigue, and sensitive moments of taste, smell, and hearing in two-year olds were found not to necessarily coincide with those of adults. Social Zeitgeber were seen as potentially altering those patterns.

Luce (1971) cited evidence of the precocious development of day-awake: night-sleep patterns in infants who were allowed to cry at night in a lying-in nursery. The adrenal hormone level was increased by the prolonged crying, resulting in dramatic behavioral changes. After ten days of unattended night crying, those infants adopted an adult-like rhythmic pattern.

Luce further stressed the significance of the development of rhythmicity in children:

> A child whose own body is unpredictable, and who cannot foresee what it will do next, is bound to have a more difficult time learning the simplest kind of self-control. (Luce, 1971, p. 106)

In light of that factor, and of the significance of the social Zeitgeber, there seemed to be some evidence for instituting regular feeding and handling schedules from birth on, thus strengthening the child's synchronization with the outside world.

Infants sleep and wake in a series of naps as do older persons, both tending toward a polyphasic BRAC. The major difference between the very young and very old was the fact that elderly persons do not experience deep slumber, or Stage IV of the sleep cycle (Luce, 1971). Samis (1968) reiterated the similarities between the temporal organization of old and young, pointing out the fact that the young were making the transition from polyphasic to monophasic while the reverse trend was taking place with the aging populations.

The development of the individual temperament as a function of rhythmicity was considered by Luce (1971) as well. Children previously thought to be

out-of-sorts and disagreeable may very well have been out of synchronization with the environment. That is, the individual's endogenous, physiological rhythms may have been at odds with the exogenous, social rhythms, as amply illustrated by Gooddy (1969). He felt that research on child rhythmicities and temperaments might help provide a better family life with children, if not simply a better understanding of individual temperaments.

> It is likely that the pendulum of child-rearing will swing away from feeding infants on self-demand, toward providing a routine that will help entrain body cycles, to enhance a baby's ability to be synchronized with the home and school in which he lives. (Luce, 1971, p. 113)

Rhythmicity and Individual Development

The postulation that rhythmicities were significant factors in the study of individual differences was pursued by Escalona (1965). She noted the seemingly innate distinction between "active" and "inactive" children and the fact that they seemed to have different relationships with the spatio-temporal environment. Although she did not specifically mention rhythmicity in the study of differences, it could be implied from activity-time utilization references.

Thomas et al. (1970), in a paper significantly titled "The origin of personality", included rhythmicity, along with eight other variables, in their general categories of children's temperament. They postulated that the three types

of children, "easy", "slow to warm up", and "difficult", were directly related to the child's rhythmicity (Thomas et al., 1970).

Table 1

Relationship of Rhythmicity to Temperament Characteristics

Type of Child	Rhythmicity (regularity of hunger, excretion, sleep, and wakefulness)
"Easy"	very regular
"Slow to warm up"	varies
"Difficult"	irregular

Note. From Thomas et al., 1970, p. 106.

They also contrasted the different behaviors exhibited by children who were either regular or irregular in their rhythmicity from two months to ten years of age. Of specific interest to this study, the regularly rhythmic two-year old was found to eat a big lunch each day and always to have a snack before bedtime, while the irregularly-rhythmic child had nap times which changed from day to day and had difficulty in toilet training because of the unpredictability of the bowel movement (Thomas et al., 1970).

Such factors as circumcision of neonatal males were found to have a disruptive effect upon the rhythmic development of infants (Anders & Chalemian, 1974). Overall, however, individual predispositions and physiological structures have been found to be more ciritical as the individual interacts with the rhythmic factors in the environment, including "soothability" of a child: "the mother-child relationship may be influenced by how effectively the mother responds to her child's individual predispositions" (Birns et al., 1966, p. 322).

Rhythmicity and the Preschool Child

Although the general field of periodicity research has remained relatively constrained since its beginnings, the study of rhythmicity in preschool children within the preschool environment and their natural environments has been almost totally neglected. As McGrew noted, "ongoing rhythms in activity and social interaction in naturalistic surroundings remain to be investigated" (McGrew, 1972a, p. 193). He noted too that developmental psychologists have ignored the area, as they have made no consideration of the time-of-day variable.

Musumeci and Misiak (1974), in support of McGrew's contention, found that the Critical Flicker Frequency (an index of physiological activity used in psychobiological research) showed a definite circadian variation. They noted that future research utilizing the CFF must consider those variations to be fully valid, and that the CFF-circadian variation results were possibly related to other physiological functions and worthy of study.

Although Wade et al. (1974) did not mention the temporal variable specifically in their study of biorhythms in the activity of children in free play situations, they did find that variations in the physical environment (social interaction Zeitgeber) produced variable rhythms in the children's play activities. They had hypothesized that additional play equipment in the environment would increase the play acitivity of the children, but found that manipulation of the number of children per group produced biorhythm variations among the children, especially when two children were involved. (Wade et al., 1974)

McGrew (1972a) conducted an ethological investigation of the development of social and motor behaviors of children in three nursery school settings. Although the frequencies of agonistic and non-agonistic behaviors were the actual foci of the study, he also built in the component of periodicity of those behaviors in the children. Various types of rhythmicities were observed: 1) daily and weekly periodicity in one setting; 2) weekly, lunar, monthly, and annual periodicity in another nursery school; and 3) daily periodicity in yet another preschool.

Daily periodicities were found in five general motor patterns (hand, arm, leg, gross body, locomotory), six gross and locomotory motor patterns (walk, stand, run, bend, lift, climb), and five specific motor patterns (manipulate, pick up, place, pour, scoop) in one of the nursery school settings (McGrew, 1972a). In another nursery school, three motor behaviors exhibited significant weekly periodicities: running, immobility, and automanipulation.

Weekly periodicity, which McGrew noted was tied to cultural rather than natural phenomena, was noted in five general motor patterns (hand movements, arm movements, other movements, gross body movements, locomotory movements), and ten social behavior patterns (walk, smile, crouch, jump, look, push, automanipulate, wrestle, vocalize, verbalize) in that same setting. Lunar, monthly and annual periods showed no significant cyclicities in the frequencies of thirty social behaviors. McGrew noted that cross-sectional, rather than longitudinal, study designs should be utilized in long-term research efforts in order to distinguish cyclicity from ontogenetic changes (McGrew, 1972a).

Overall, McGrew felt that studies of periodicities in preschoolers could provide a better understanding of children in the nursery school setting. Understanding of intra-daily and intra-weekly differences in children's behaviors was often clouded by a lack of recognition of periodicities. As noted previously, individual differences in testing, behavior, temperament, and related factors were in numerous instances a function of the time of day and/or the day of the week. He concluded that "the notion of the environment of social novelty" (McGrew, 1972a) found in the nursery school setting on a day-to-day basis seemingly accounted for much of the periodicities in the children's behaviors, though endogenous physiological factors (internal rhythmicity) could not be ruled out in the case of daily (circadian) periodicities.

Methodologic Considerations: Interface Between Child Development and Ethology

Ethological principles and theory have been closely associated with periodicity research (Eibl-Eibesfeldt, 1970 and 1974; McGrew, 1972a) and have provided the basic design of this study. Thus, it was deemed most appropriate to include a summation of ethological considerations at the conclusion of the review of literature section. (For complete reviews, see Eibl-Eibesfeldt, 1974; Hass, 1970.)

Eibl-Eibesfeldt (1974) considered temporal factors to be significant in the development and functioning of most all living matter. Periodicities in human behaviors, developed phylogenetically and ontogenetically in the individual, have not been excluded from the numerous bio-social behaviors noted by ethologists. He maintained further that the behavioral characteristics of the human species, which form the foundations of human ethology, have only been superficially studied, periodicity being no exception. Phylogenetic considerations were viewed as significant in all phases of human study (Eibl-Eibesfeldt, 1974).

McGrew (1972a) provided an elaborate, erudite reasoning for the utilization of ethological methodology in child development research. He noted that the ethological model provided strengths to the research which other fields lacked. Developmental psychologists were limited to a few traditional subjects whose categories of description were general, inferential, or both. Although such terminology had applicability when objectively

defined and specified, such was rarely the case. Psychologists tended to exclude evolutionary, phylogenetic factors in development in the adoption of a complete tabula rasa stance (McGrew, 1972a).

Sociologists and anthropologists, on the other hand, generally excluded consideration of human behavioral universals, stressing differences rather than similarities between the various forms of Homo sapiens (McGrew, 1972a). Callan (1970) made a pedagogic and epistemological comparison of social anthropology and ethology and found the two disciplines to be utilizing observational techniques almost exclusively as a methodology, although from different perspectives and toward divergent ends. The eventual merging of the two forces was not totally dismissed, albeit such a merger would be marginal in nature (Callan, 1970).

The strengths of ethology as a methodology were also noted by McGrew (1972a). First, ethology has provided objective definitions of behaviors in terms of body parts and motor patterns. Inferential and adverbial labels have been eschewed for specific, recurring fixed-action patterns, with extensive definitions couched in the simplest terms. Secondly, the ethologist observed behaviors as they occurred. In that manner, behaviors have been observed in real-life situations. Sophisticated recording aids (videotape, audiotape, etc.) have provided the ethologist with the means to observe ongoing behaviors without disrupting the environment. Thirdly, the use of quantitative analysis techniques has been facilitated by the use of discrete behavior patterns. Constellations of behavior have been developed which,

in turn, have led to the development of general categories, e.g. maternal. Fourthly, there has been an emphasis on the evolutionary significance of behaviors. In that manner, morphological similarities, operational similarities, functional similarities, and situational similarities have been noted across the primate species. Finally, ethology has provided an objective basis for intraspecific behavioral comparisons (McGrew, 1972a). (see also Blurton-Jones, 1972b.)

McGrew's (1972a) contentions were supported by Charlesworth (1975). He maintained that the task of the human ethologist was:

> Observing behavior as it occurs in everyday surroundings, examining it in terms of its ultimate adaptive value for the species as well as its proximate adaptive value for the individual, studying behavior patterns comparatively by demonstrating analogous behaviors in other species, searching for phylogenetic reasons underlying needs and need-associated behavior patterns, identifying contemporary ecological factors which may account for inter-species resemblances and differences, seeking cross-cultural universals in behavior, and developing 'standard' definitions, glossaries, dictionaries, taxonomies, and film archives of behavior. (Charlesworth, 1975, p. 1)

He noted, too, that observational techniques were basic to the methodology, videotape having come into increasing use (Charlesworth, 1975).

Blurton-Jones (1972a), along with McGrew (1970) and other researchers, e. g., Leach (1972), has developed an extensive taxonomy of preschool children's social and motor behaviors. He has utilized that taxonomic system in other studies (Blurton-Jones, 1967), and established its validity and reliability in preschool-aged children from two to four years of age (Blurton-Jones, 1972a). Thus, a definite link has been established between ethological and child development research.

As noted, McGrew (1972a) brought ethology, child development and rhythmicity together in a single study design. Since methodology was posited as being as important as theory with respect to ethological research, there would seem to be almost-limitless potential application of the methodology to child development research. Human development, which has been an open field for research, would thereby add yet another tool, another technique, to its research arsenal.

Summary

The following conclusions have been developed from the periodicity and ethological literature:

1. A basic rest-activity cycle (BRAC) has been found to permeate human sleep and activity periods, creating cyclical variations in the characteristics of those states;
2. The BRAC has developed phylogenetically and ontogenetically within the central nervous system, having gone from a 40-50 minute cycle

in the human infant to 90-110 minutes in the human adult;

3. Twenty-four hour periodicity, termed circadian, has been found in most all physiological functions of the human body;
4. Rhythmicity has been found to be an endogenous factor found in all living matter, and to be an adaptive factor as living creatures have interacted with the environment;
5. Endogenous rhythmicity became time-cued (entrained) to various exogenous factors (Zeitgeber = time givers) such as light, temperature, and social interaction;
6. Rhythmicity has been found to be a significant variable in all facets of human behavioral research, preventive medicine, and education;
7. The human central nervous system has been repeatedly shown to function much as would an internal clock;
8. Adult research has been focused on isolation studies, variable entraining studies, and studies of human functioning capacities as a function of time of day, all attempting to ascertain whether rhythmicity was endogenously or exogenously induced and controlled;
9. Cultural periodicity studies have indicated that the social environment, as well as the individual physiology and physical environment, has a direct effect on the temporal patterning of human functioning, sometimes to the detriment of the rhythmicity of the individual organism;
10. Development of periodicity has been found to be a function of the maturation of the individual central nervous system, and of greater

contact with the various Zeitgeber over time;

11. Rhythmicities in the various organ systems have been found to develop at differential rates, the central nervous, and adrenal-cortical, systems being of special significance as the organism develops overall rhythmicity;

12. Monocyclic periodicity of the human adult was found to have developed from a polycyclic infancy;

13. Periodicity has been noted as a significant variable in the development of individual differences;

14. Behavioral periodicities have been noted in three- and four-year old nursery school children;

15. Ethological research methodology has been shown to be an applicable technique in the study of both periodicity and child development.

CHAPTER III

METHODOLOGY

The purpose of the present study was to investigate through ethological techniques possible rhythmicity of ten selected social and motor behaviors in eight selected two-year-old children. Daily time units were used as the basic reference units. The ethological study model and behavioral referents were adpated from McGrew (1972a and b), Blurton-Jones (1972b), and Leach (1972). The methods of data collection were adapted from McGrew (1972a and b), the viability, limitations and applicability of such having been elaborated by Hutt and Hutt (1970). McGrew (1972a) found a number of periodicities in the social and motor behaviors of three- and four-year-old children. It was the focus of this study to observe possible significant differences in the frequencies and durations of selected behaviors in a group of two-year-olds as a function of time of day.

Facilities

Observations of the selected two-year-old children were made at two preschool facilities for that age group extant in the city of Greensboro, North Carolina: the two-year-old group of the Nursery School in the Department of Child Development and Family Relations of the School of Home Economics at the University of North Carolina at Greensboro; and, the two-year group in the weekday preschool program at Centenary United Methodist Church.

The two-year center at the University was housed in a family dwelling which had been purchased to provide space for establishing the program. The first floor of the house consisted of two large rectangular rooms, formerly the living room and dining room; an entrance foyer in which the children's lockers were located; a kitchen, in which art supplies, miscellaneous office and repair equipment, information files from the program, and snack-related material were located; a screened porch off the dining room which served as additional play/storage space; and the office of the director of the Nursery School, formerly a small bedroom with a half-bath. The downstairs, with the exception of the kitchen area, was carpeted with a green indoor-outdoor carpeting. It was the first floor of the house which was utilized as the setting of the program. A parent education program was conducted on the second floor by the department of Child Development and Family Relations for the parents of the children in the group.

The program was equipped with a wide array of age-appropriate toys for both toddler and two-year-old children. Toys considered traditionally appropriate for male children, e.g., trucks, helicopters, tools, were concentrated in the "living room" space, while those considered appropriate for female children, e.g., dress-up, dolls, kitchen area, were located in the "dining room". Equipment appropriate for both sexes, e.g., blocks, riding toys, rocking horse, were located in both areas.

The unit was one of three funded and/or operated by the Department of Child Development and Family Relations of the School of Home Economics at

the University of North Carolina at Greensboro. The lead teacher with the two-year-olds was a male graduate assistant in the Department of Child Development and Family Relations. He was assisted on Mondays and Wednesdays by two undergraduate child development majors working there as part of their work-study program. On Tuesdays and Thursdays, assistance was provided by undergraduate and graduate students enrolled in the parent education course, Home Economics 522, in the department. All were relatively skilled workers, having worked previously in some capacity with young children in group situations.

The two-year-old program at Centenary United Methodist Church was located in rooms that were originally designed for, and were concurrently being used by, one-and one-half- to two-year-old children in Sunday School. The area used by the children consisted of two rectangular-shaped rooms divided by a small walk-through kitchenette and separate bathroom. The larger room, facing the front of the building, contained toys designed for more active play, e. g., a small sliding board, rocking boat, push toys, and riding toys. In addition, the housekeeping area, the block area, a record player, and various other toys such as small trucks and cars, pounding benches, etc., were located there. The room had a large oval rug, as well.

The smaller room contained three tables, fifteen chairs, a science table, and a low shelf for books and manipulative table toys. This room was used for art activities, puzzles, table games, and snack time. An area for changing diapers and some storage for furniture were also in the smaller room.

Cubbies for resting mats and extra clothes were located in both rooms. The bathroom contained a child-sized toilet, two potty chairs and a sink. The kitchenette contained a small refrigerator, two adult-height counters, one with a sink and two cabinets used to store snack supplies, art materials, toys, and the children's information folders.

The lead teacher of the group was a female graduate student in Child Development and Family Relations at the University of North Carolina at Greensboro. She was assisted each day by a woman with no formal training in child care. Four female students in child care training from Guilford Technical Institute observed, two on Tuesday and Friday and two on Wednesday and Thursday.

Subjects

Twenty-four two-year-old children attended the two-year program at UNC-G during the course of the academic year. They were divided into two groups of twelve children each. The groups met regularly throughout the year on either Monday and Wednesday at 1:00 p. m., or Tuesday and Thursday at 3:00 p. m., each session lasting one hour. As noted previously, the parents met upstairs in the center in a parent education discussion group during the course of the hour.

There were forty two-year-old children enrolled in the Centenary United Methodist program. Unlike the UNC-G program, children could attend on a one- or two-day basis. The group coming Tuesdays and Thursdays

represented a relatively regular unit, while the children attending on Mondays, Wednesdays, and Fridays varied with respect to number of days attending, and the days on which they came. Thus, there was a cohesive two-day unit on Tuesdays and Thursdays as at UNC-G, while the group compositions varied on Monday, Wednesday, and Fridays. Enrollment on any given day was 15. The children attended from nine-twelve each morning. The mothers, except in unusual circumstances, left the children and came back for the children at the end of each session.

Eight children "self-selected" themselves for participation in the study by being enrolled in both two-year programs. The children were in group settings at varying times of the day, (only one child attended both programs on the same day), providing the ideal population for a time-sampling study. It was possible to observe the same child at different times of the day in similar nursery school settings. Such an arrangement provided an ideal design for observing potential periodicities in the child's behavior (Sollberger, 1965). In addition, a late afternoon behavioral peak has been noted for young children by previous researchers (cf. Kleitman, 1963; Luce, 1971) that time corresponding with the later meeting time at UNC-G, i.e., three to four p. m. It was therefore possible to observe the children as their daily cycle begins at nine a. m., in the middle of the day at one p. m., and toward the end of their functioning day at three p. m.

At the beginning of the data collection period, the children had a mean age of 30. 5 months ($\pm$ four months). They had a mean of 0. 6 siblings (range: 0-2).

No siblings attended school with the children. All were Caucasian, native-English speaking, and in good physical condition. The only significant difference between these children and the others in both programs, as noted, was that they attended these two particular programs while the remainder attended one or more other programs.

Nursery Routines

The two-year program at UNC-G began in late August and ended the last of April, while at Centenary Methodist the children attended the program from September through May. The daily routines varied primarily as a function of the differential durations of the programs. Similar activity planning, space, teacher philosophies, physical facility design, and general program functioning were found in both programs, the time-in-program variable being the major difference. (Note: The two lead teachers of both programs for two-year-olds had worked together in a singular program in the summer of 1975.)

At UNC-G, the children were brought into the center by their parents and entered the playroom. The first half hour of the period was spent in free play activity during which time they had relatively free access to all the equipment in both rooms. In addition, extra material, such as pla-dough, was placed on tables in the front room. A short snack period followed as the children were usually given something to drink, usually milk or fruit juice, and something to eat, such as apple wedges, graham crackers, or cookies. After snack, a group story-song-fingerplay period was conducted in which

all the children participated. Art experiences and/or other special activities were also planned for that period. A limited free-play period finished out the hour, after which the mothers came downstairs and took their children home.

The schedule at Centenary Methodist was similar in structure to that of the UNC-G program, the duration of each activity being somewhat longer, of necessity. Upon arrival between 8:45-9:30 a. m., the parents brought the children to the room and assisted in removing coats and wraps and in helping the child make the transition to the group setting. The first hour of the program, from nine to ten a. m., was a scheduled free-play period, during which time the children could play with all available equipment. As at UNC-G, additional activities were provided during that time. A regular toileting period was provided between 10-10:15 a. m., although it need be noted that toileting was done throughout the day at the child's behest. A clean-up period was conducted conjointly with the toileting period. Following the toileting-cleanup period, a short group time was conducted until approximately 10:25. The children participated in stories, songs, and/or fingerplays. A snack period was then conducted between 10:25 and 10:35. From 10:35 to 10:45, the children prepared to go outside to play. The outdoor play period extended from 10:45-11:20. at which time the children went back indoors and prepared for rest time. The children rested from 11:30 to 11:40, after which table activities were available for them until departure time at 12:00. An additional toileting period, including diaper changing, was provided between 11:40 and 12:00.

Selection of Behavioral Categories

General Methodological Considerations

The major difficulty encountered in designing the study was the seemingly simple question, what is to be observed? Some general descriptions of the common behavioral repertoires of two-year-olds were readily available (Blurton-Jones, 1972a; White, 1975). However, those studies were either interaction-oriented and consequently delimited in scope with respect to the behaviors of two-year-olds (Blurton-Jones, 1972a), or were non-ethological, and idiosyncratic in design (White, 1975). The researcher was presented with the single option of developing an inclusive description of what was taking place in the classrooms in terms of the behavioral repertoires (ethogram) of the two-year-old child and consequently incorporating those behaviors into the observational procedures. It was thus determined that a preliminary observational period be conducted prior to the data collection procedures to establish which social and motor behaviors are exhibited by two-year-olds in free play periods in a preschool setting.

The ethological methodological format stresses just such a procedure. As Hutt and Hutt noted:

> The ethological approach differs from that of experimental psychology and other branches of behavioral sciences in that it insists upon an ethogram as the legitimate point of departure of any experimental study. Before attempting to modify behavior, the ethologist demands to know what behavior there is to modify. (Hutt & Hutt, 1970, p. 16)

Once the behaviors have been identified and the attending behavioral repertoires identified, the mode of research techniques and/or the foci of further studies may be designed to incorporate that knowledge. More generally, they maintain that "the ethological approach...demands that we drop our preconceptions and assumptions of special inside knowledge about human behavior" (Hutt & Hutt, 1970, p. 27).

In a similar vein, McGrew (1972a) maintained that although those individuals who are engaged in human ethological research may vary in terms of the specific etiologies and characteristics of their study designs, "the description of behavior patterns is the primary problem" (McGrew, 1972a, p. 14). The basic task of the human ethologist was viewed as "recognizing stereotyped, recurring patterns in a behavioral stream, then abstracting and defining these patterns in an objective, reliable way" (McGrew, 1972a, p. 15). This task was characteristic, too, of the problem facing this researcher: what do two-year-olds do in a group setting during free play?

The two-year-old children were seen as busy, industrious individuals as they were engaged with some facet of the environment most of the time they were in the play groups. The children who were observed gave the definite appearance of being constantly involved in the exploration of the preschool setting and attempting to gain mastery of the sundry play articles placed there for just that purpose. The preschool settings were designed by the teachers to provide novel stimulation to the children and to introduce the children to various educational concepts, e.g., shape, color,

and size, and motor skills, e.g., eye-hand coordination, climbing, and fine motor skills. Such items as small scooters, trucks, puzzles, pegboards, toy barns with animals, a slide, a rocking boat, blocks (both large hollow blocks and smaller unit blocks), hammering toys, dress up clothes, and the like provided the medium through which the children could gain such experiences. The teachers, too, were educational factors in the environment from whom the children could learn and/or refine skills, and with whom they could exchange verbalizations, share experiences, and come to a better, general understanding of their surroundings. The school settings, in short, were arranged by the teachers to promote the acquisition of social, physical, and general educational skills in the children.

From the standpoint of what specifically took place on a day-to-day basis within the aforementioned educational environment (novelty environment, in McGrew's (1972a) terminology , generally speaking, most of the children's time was spent developing those skills which the toys and other play things were designed to teach. Mastery of the environment, in short, was the primary concern of all of the children. The free play period in both programs was the first half hour or hour of the day. Thus, as the children entered they were presented with an array of play activities from which they could choose. The children varied somewhat as to their modes of entry, i.e., some would walk in and immediately become immobile, frozen on the spot, while others immediately would engage themselves in one of the various activity centers in the room(s). The children generally wasted

little time standing and looking, and became readily involved with something (someone) in the environment. As noted, there was a range of activities from which they could choose.

Following the entry process, there was a continual flow of interest and energy on the child's part. One day, for example, one of the children might find nothing in the environment to be of particular interest and meander from one play area to another, manipulating ten or more objects in the space of a half hour. Conversely, another child might stay with one toy and/or object for most of the free play period, playing with and manipulating it with few, if any, interruptions. Yet another child might behave in a manner which placed him somewhere in between the two extremes. Each of these modes of environmental interaction, as well as numerous intermediate gradations, was observed by the researcher.

The most salient aspect of the play patterns was that irrespective of the amount of time a child would spend with a given toy or object, he was spending most of his time manipulating the toys and objects in the environment. Rather than living up to the assumption that two-year-olds were rather primitive in their interest in environmental mastery and not capable of much in terms of object manipulation and task orientation previously made by preschool teachers and child developmentalists (Blurton-Jones, 1972a), the children observed were constantly exploring the preschool setting and utilizing the objects found therein. This is not to say that they were always engaged in acceptable activities according to

the limits established for behavior within each of the schools, sometimes to the chagrin of the respective teachers. Rather, their free play periods were spent in actively mastering many, if not all, aspects of the environment. In short, the most frequently occurring behavior observed was a form of child-object interaction.

An accompaniment to the children's object manipulation episodes was a phenomenon best described as a convergence of interested parties. The specific components of such episodes were relatively consistent. One child would show an interest in a particular object and begin to manipulate it in a fashion either appropriate to its designed function or to his individual predilection. Another child would notice that the first child was playing with an object and would consequently walk over to that child and observe the activities in an unobtrusive manner or make an attempt to procure that object for himself. The final outcome would then be resolved according to the relative strengths of the two children and/or by teacher intervention. At times, more than two children would be involved in such an episode. A number of related behaviors emerged from such conflicts and ranged from passive to aggressive responses. Conflicts of this sort were quite common, although not nearly as frequent in terms of occurrence as interacting with objects in the environment.

The children would also exhibit facial expressions indicative of positive states of emotion, i.e., smiling and laughing. At times, these behaviors

would be associated with seeming surprise at the nature of the action of another child or toy, with teacher responses, or with general activities within the room. Although an adultomorphic tendency might tend one to suspect that such behaviors would occur frequently in two-year-old children, such behaviors were observed only infrequently.

The typical daily experience during the free play period centered around two basic factors: integration of the child into the preschool setting, which was accompanied by any number of positive and negative responses on the part of the child (the parents were not usually affectively neutral at that point either); and, the children's seemingly constant interest in mastering the environment, with its consequent potential for child-child conflict. Although, other behavioral factors emerged at rest time, snack time, and other activity periods, free play activities were concentrated upon interaction with all that was made available to the children. Once a child mastered a toy or object, he would generally sit or stand, seemingly transfixed, and determine which aspect of the environment he would explore next. He might choose to play with something another child was playing with, or he might choose an unclaimed object or unoccupied area. Often, he might choose to converse at length with the teacher, another child, or a student observer.

This is not to maintain that all social interactions of the two-year-old child are negative in nature, as some cooperative play was observed within the groups of two-year-olds. One particularly interesting example of the

positive aspects of child-child interaction at this age was noted. Two of the children, one male and one female, shared activities, toys, and general experiences at both programs on a regular basis. One child was constantly engaged in activities with the other child, as they would ride together in the pretend car, go shopping together with hats on their heads and pocketbooks over their arms, and rock together in the boat. To find one child, one had only to look for the other. Other such relationships were extant to a more limited extent among the other children. Even in these cases, however, conflicts arose as to which child would carry the brown pocketbook and which would carry the black one, for example.

In conclusion, the children observed spent most of their time playing with (manipulating) the various and sundry articles and toys available in their schools. Social interactions were far less frequent, as were all other behaviors. Blurton-Jones (1972a) and White (1975) provide corroborative evidence in this regard. From these observational experiences, the ethogram was to be developed.

A further problem encountered, and one which is a function of the initial problem of developing a behavioral repertoire, was that of constructing a verbal description which adequately defined and characterized those repertoires observed. Generally, five main categories of movement were noted as being critical in the naming process:

1) Visual fixations, i.e., direction of fixations which last one and one-half seconds or more;

2) Postures, i.e., orientation of the trunk and limbs while static relative to the horizon;

3) Locomotion, i.e., manner and direction of changing locus relative to fixed points on the ground;

4) Manipulation, i.e., what objects are manipulated and how, including moving objects with the hands or feet;

5) Gestures, i.e., bodily movements which do not bring the child into contact with selected parts of the environment. (Hutt & Hutt, 1970, p. 34)

Hutt and Hutt (1970) further noted that for the single experimenter, as in this case, a permanent record of behaviors, e.g., videotape, was idyllic if not mandatory. With such a record, the individual could constantly check and re-check the behavioral categories for efficacy, accuracy, and reliability, as well as establish a further level of reliability with one or more other observers.

As far as specific behavioral definitions are concerned, McGrew (1970) had developed the most elaborated glossary with respect to the behavioral repertoires of preschool-aged children. His listing included 111morphologically distinct items. Hutt and Hutt (1970) maintained that although all 111 behaviors did occur and that additional behaviors would in all probability be added, "in practice effectively the whole of a child's motor activity could be subsumed under sixty categories" (Hutt & Hutt, 1970, p. 37). They felt, too, that although all behaviors have potential significance in their occurrence, "that part of the behavioral repertoire which most commonly

is displayed by most subjects is of greater utility than more idiosyncratic behaviors" (Hutt & Hutt, 1970, p. 37). In general, Hutt and Hutt maintained:

> A cumulative percent time curve enables a decision to be made as to when a behavioral repertoire shall be declared closed on the basis of how much of the total time is accounted for. In this way, a catalogue can be kept within manageable limits. (Hutt & Hutt, 1970, p. 37)

Specific Methodological Considerations

With the aforementioned ethological considerations in mind, the researcher videotaped free-play sessions at both programs at all the times of day prior to the actual data collection process. It should be noted, as well, that informal, yet intensive, observations were conducted concurrently so that some understanding might be reached of the general characteristics of the behavioral repertoire (behavioral Gestalten, to use Hutt and Hutt's (1970) terminology) of two-year-old children.

Generally, it was noted that social interaction was relatively uncommon in the group and that, for the most part, the children were intent upon exploring the environment of the preschool, and, in so doing, interacting with the toys, games, puzzles, etc., which were to be found in that setting. Such a finding was reiterated by White (1975) as he noted that "for the vast majority of a child's waking hours during his first three years of life he will be exploring the nonsocial world and practicing motor skills" (White, 1975, p. 196).

The problem in viewing the pilot tapes was determining the extent and nature of the behavioral catalogue (Hutt & Hutt, 1970) which most adequately reflected the full range of behaviors in the general population of two-year-old children and in the specific sample of the study. Intensive observational sessions, both "live" at the preschools, and technological with the videotapes, were conducted during a two-week period by the researcher and a co-worker before the final observational periods of the study. It was determined from those sessions that ten social and motor behaviors adequately met the criteria for a viable behavioral repertoire catalogue as defined by Hutt and Hutt (1970). The ten behavioral patterns and their respective definitions were drawn from a number of sources, and were as follows:

1. Immobile - A cessation of all motion of the trunk, arms, legs, and head for at least three seconds. Most common while standing or sitting, and following a loss of possession and/or aggression attack. Also common in "social stressful" situations not directly involving the particular child, e.g., another child crying (McGrew, 1972, p. 89);
2. Automanipulate - Related to immobility and digit sucking, it includes fingering, which is the use of the fingers to manipulate part of one's body in an unattached and disengaged manner; and fumbling, which consists of similar movements with small objects (McGrew, 1972, p. 69);

3. Manipulate - To move the hands and fingers with continuous flexion and extension while contacting an object (McGrew,1972a, p. 228);
4. Hit - A forceful movement, whether a downward movement of flexed arm from above shoulder height, or any other such blow to the object child, by one child with his/her hand(s) (Blurton-Jones, 1972a, p. 105, "hit and beat");
5. Laugh - Produced by a series of short, repeated expirations and long inspiration of breath, accompanied by some characteristic noise, e.g., hee, hee (Leach, 1972, p. 277);
6. Cry - Vocalization of some sort, e.g., roaring, growling, shrill, sobs, accompanying a secretion of the lacrymal glands such that the eyes become watery and tears spill over the eyelids (McGrew,1972a, p. 67);
7. Take - Extension of the hand of one child to grasp an object held by another child, or an object about to be grasped by the other child (Leach, 1972, p. 274);
8. Digit suck - Digit placed in contact with tongue and lips or placed in mouth and licked by tongue (Leach, 1972, p. 277);
9. Push - "To push a person, the child flexes the arm(s) and then extends it, with the hand flat against the other person's body, in one continuous, rather violent, movement; or, the hand is placed on the person's body with the arm slightly flexed, and the arm is then extended" (Leach, 1972, p. 273);

10. Smile - 1) slight raising of the mouth corners, and lips closed; 2) wide-open mouth, with mouth corners retracted horizontally and both rows of teeth visible; 3) mouth wide open, mouth corners up, and teeth partly or totally covered by lips (Leach, 1972, p. 276-277).

As may be readily noted, the ten behaviors represented a broad range of behavioral categories, e.g., from laugh to cry, and from immobile to hit and push. A range in terms of behavioral complexity was also included, as, for example, the act of hitting is rather simple, while that of being immobile has a number of components associated with it. These ten behavioral categories accounted for well over 90 percent of the activities engaged in by the children, both when observed directly and on videotape. Thus, it was determined that these same categories would be utilized in the final research design. It should be mentioned as well that the definitions, though general for the most part, clearly distinguished the ten behaviors from one another and from any other behaviors which might have occurred. Generally speaking, they clearly delineated and described the behavioral repertoires of the children at that point in time.

Observation Procedures

Observations were made November 10 - December 17 in the UNC-G and Centenary programs. The weeks chosen represented the last consecutive weeks of program operation in both centers before a major vacation break.

The potentially confounding variable of introduction to a social setting was controlled for in that manner (cf. McGrew, 1972b), as the children had maximal program involvement at that time in both programs.

Videotapes were made of the first half hour of the free play period in both groups, focusing on the children in the study. Each child was observed on two different occasions in both groups. Thus, there was a total of two hours of videotape data per child, a figure not surpassed by several similar studies (cf. Blurton-Jones, 1972b; Blurton-Jones & Leach, 1972; Leach, 1972). As noted, a pilot taping session was conducted in both groups prior to the dates of data collection to make the children accustomed to the taping machinery, and to provide the researcher with preliminary, practice data which both indicated significant social and motor behaviors to be used in the study and to give the researcher experience at taping and data analysis. While conducting the pilot study it was found that the videotape equipment did not disrupt the children's behavior in any way. Only one child acknowledged briefly the equipment's presence in the room. The methodological technique utilized to eliminate curiosity, as noted by McGrew (1972a) and Hutt and Hutt (1970), was to keep the monitor unseen by the children.

The equipment used consisted of the following: two Panasonic Studio Videotape cameras with 10:1 zoom lenses; a JVC KV360 videorecorder; and a Panasonic videorecorder with a Panasonic one-point cardioid monaural

microphone. The equipment was provided by the Instructional Resources Center of the University of North Carolina at Greensboro.

Data Transcribing and Analysis Procedures

The data transcribing process was rather lengthy. It consisted of viewing each of the tapes in its entirety, and entering the behavior which was occurring at each 15-second interval on a coding sheet. The duration of the behavior was noted simultaneously upon its occurrence. Each episode of a behavior, for example manipulating the toy barn, was counted as one frequency irrespective of its duration. More specifically, a frequency was defined as an episode of a behavior which was present at the start of a 15-second interval, was not present at the beginning of the preceding 15-second interval, and terminated at some point thereafter. Checks were made on the coding sheet (see Appendix B for a sample coding sheet) for each occurrence of a behavior (frequency count), while side notes were made to indicate factors such as behavioral durations, changes of toys, and time off camera. A Setchell-Carlson 24-inch monitor was used with the JVC videorecorder in the transcribing process. Overall, it took approximately ten hours of taping, viewing and transcribing to produce each hour of study data per child.

Observer reliability was established on three different occasions with three different individuals. The principal research transcribed all the tapes, but asked three persons to view tapes chosen randomly with him to assure reliability of the data recorded. The formula used by McGrew to establish reliability coefficients was utilized in this study as well:

$$\frac{\text{No. of agreements (A \& B)}}{\text{No. of agreements (A \& B) + no. seen by B only + no. seen by A only}}$$

(from McGrew, 1972a, p. 24). A reliability coefficient of .70 was assumed to be satisfactory (see McGrew, 1972a, p. 24). The coefficients ranged between .9 and .97, a more than satisfactory level. The high reliability figures were seen as products of the highly distinct nature of the chosen categories. (see Appendix C for computations of the coefficients.)

Upon completion of the transcribing process, the frequencies, durations and changes made were organized in table form so that they might be more easily analyzed. Each child's morning data was placed with his/her afternoon data to further facilitate the analysis procedures. These data are presented in Table 2.

The initial procedures included a total of ten behavioral categories which were to be analyzed. However, four of those categories occurred so infrequently that they were dropped from the analysis procedures after the transcribing process. The choice of behavioral categories was proven to be representative of the children's behavior as the mean time spent not doing those behaviors was 45 seconds (range: 15 seconds - 8 min. 20 sec.). The children were rarely doing anything other than these behaviors in the thirty minute observation period. If they were, it was generally some minor activity such as washing hands, going to the toilet, or waiting for a bib to be put on for finger-painting.

Table 2

Behavioral Frequencies and Durations (in seconds)

Child	Behavior											
	Immobile		Automanipulate		Manipulate		Take		Digit Suck		Smile	
	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.	Freq.	Dur.
Kendal												
a. m.	2	45	3	60	14	1080	7	7	2	60	2	25
p. m. (late)	4	60	3	40	12	1232	5	8	0	0	11	51
Clark												
a. m.	6	105	6	112	18	952	2	4	6	90	13	201
p. m. (late)	10	144	4	71	13	1436	4	8	1	8	4	20
Seth												
a. m.	4	82	1	30	8	1628	4	4	0	0	1	4
p. m. (late)	6	92	0	0	10	1298	3	6	1	8	2	8
Courtney												
a. m.	3	52	4	52	12	1542	2	3	6	150	12	184
p. m. (early)	4	270	2	142	7	1448	0	0	4	130	11	92
Rob												
a. m.	4	105	6	82	16	1455	6	7	2	30	9	98
p. m. (early)	2	32	2	22	12	1605	3	6	0	0	1	8
Katie												
a. m.	4	75	4	68	14	1552	2	2	2	30	9	134
p. m. (early)	4	68	1	8	12	1552	1	1	1	8	1	5
Caroline												
a. m.	4	60	3	52	13	1335	4	8	0	0	2	8
p. m. (early)	2	18	1	15	6	1665	2	4	0	0	1	2
Elaine												
a. m.	4	68	7	202	12	795	1	1	2	98	10	123
p. m. (early)	7	117	2	22	10	1635	2	5	2	30	6	14

The behaviors analyzed were: immobile; automanipulate; manipulate; take; digit suck; smile. A number of factors might be posited to account for the change in character of the behavioral repertoire. First, the additional group experience which the children gained between the pilot-taping, and study-taping sessions may have altered their relations within the group. McGrew (1972b) argued very strongly for such a change over time in the incidence of certain behaviors, e.g., cry. However, such an explanation would not in itself account for the decrease in laugh.

Second, the nursery school routines may have changed over time in such a manner that the highly aggressive behaviors (hit and push), and the highly emotional behaviors (laugh and cry), were discouraged and consequently decreased in incidence. That explanation seems implausible as well, as the format, planning, and general characteristics of the program remained unchanged during the course of the year.

Finally, and most plausibly, the children acclimated themselves to the group setting and to being separated from their mothers (the sources of crying, in most instances). Also, having gained a modicum of group social skills, hitting and pushing were probably replaced by appeals to the teacher and/or other such coping techniques. Similarly, as the children became increasingly involved with the environment and were "entertained" less by the actions of the teacher as they engaged in play as a function of their increased exploring tendencies (White, 1975), laughter may have decreased in frequency. It must be stressed that the explications of behavioral change are

only speculative. One vital study which could be seen as an off-shoot of this effort would be the development of a descriptive picture of the social growth of the two-year-old utilizing ethological methodology.

Although the children were divided into two general groups for most of the data analysis procedures, i.e., morning and afternoon, there was also a sub-group division of the afternoon, as noted: early afternoon, which met from 1-2 p. m. (N=5); and late afternoon, which met from 3-4 p. m. (N=3). Thus, the larger groups were compared by means of t-tests and treatments by subjects to determine if there were any significant differences between groups across time (teacher and general environment not controlled here), while the afternoon sub-groups were similarly considered for treatment effects of time (teacher and environment controlled in this instance). All calculations were madeby hand by the researcher.

CHAPTER IV

RESULTS

The results of the study will be presented in four sections, each concerned with an aspect of data analysis. As mentioned previously, the data collection methodology, videotape, is invaluable in capturing rapidly-occurring behaviors for repeated analyses, although it is demanding in terms of the actual taping process involved and the time required to complete analysis procedures (Hutt & Hutt, 1970). In order to be effectively utilized, video technology with a fixed observational population needs to be limited in terms of the scope of subjects included in each taping session. Attempts to record the behaviors of more than one subject per camera per session invariably results in incomplete data sets for all subjects included. That factor, plus the relative expense of the material of the medium, the videotape, dictated both a relatively small population, N = 8, and a delimited amount of observation time per child, two one-half hour tapes per child per preschool setting.

Analyses of Frequency Change

Frequency: t-tests

As noted in Chapter III, the lack of data collected in four categories of behavior prompted the deletion of those behaviors from the analysis procedures. They were hit, laugh, cry, and push. Thus t-tests were conducted on the remaining six behaviors with respect to the percentage of change

of frequencies between groups from morning to afternoon. In that manner, an initial indication could be discerned as to behavioral differences across time.

Of the six t - tests conducted, only one, automanipulate ($t = 3.62$, $df = 7$, $p < .01$), reached the level of significance established ($p < .01$). The results of the other five analyses of behavioral frequency change indicated a certain consistency between groups across time as manipulate ($t = 2.52$, $df = 7$, $p < .05$) and digit suck ($t = 2.92$, $df = 7$, $p < .05$) approximated the significance level, the remainder having a $p > .1$. On two of the categories, take and smile, the t value was less than one. In Table 3 these data are presented.

Table 3

Results of t - tests of Frequency Counts

Behavior	$\bar{X}$ % Change: a. m. - p. m.	t	p
Immobile	-28.12	1.89	$> .1$
Automanipulate	+57.88	4.2	$< .01$
Manipulate	+21.12	2.56	$< .05$
Take	+12.88	< 1	—
Digit Suck	+45.75	2.92	$< .05$
Smile	+25.62	< 1	—

Frequency: Analysis of Variance

Automanipulate was the only behavioral category which reached a level of significance $p < .01$ in the t-test analyses. Consequently, a treatment by subjects analysis of variance was conducted on the frequencies of that behavior. The t-test of percentage of behavioral frequency change indicated a possible treatment effect, as did the analysis of variance ($F = 17.62$, $p < .005$). Thus, there was a significant decrease in the occurrence of this particular behavior in the afternoon ($\bar{X}$, a. m. = 4.25; $\bar{X}$, p. m. = 1.88).

Group Differences: Durations

Group differences in durations of behaviors across time were analyzed by means of treatment by subjects analysis of variance for each of the six behavioral categories. The intermediate step of t-tests was not deemed necessary with respect to this data. The results of analysis were much the same, however. In this instance, digit suck ($F = 11.25$, $p < .025$) and smile ($F = 7.9$, $p < .05$) showed the greatest change over time. The remaining four categories showed little change over time, two of the four having an F ratio value less than one. These data are presented in Table 4.

Afternoon Differences: Early Afternoon vs Late Afternoon

As noted, the children all attended the morning program at the same time (9 - 12 a. m.), while three of the children attended the afternoon program at UNC-G from 3 - 4 p. m., and five of them participated at UNC-G from

Table 4

Means and F Ratios of Behavioral Durations (in seconds)

Behavior	Morning	Afternoon	F (1,7)
Immobile	74	100.12	< 1
Automanipulate	82.25	40	2.69
Manipulate	1298.62	1490.12	2.29
Take	4.5	4.75	< 1
Digit Suck	57.25	18	11.25*
Smile	97.12	25	7.9**

*$p < .025$

**$p < .05$

1-2 p. m.. Although the time varied as to when the children met in the afternoon, the location, teacher, and aides were the same, thus controlling for the confounding variables of different teachers and environments. Differences between these two time groups were considered by means of t-tests conducted on the percent of behavioral frequency change between the afternoon times. In so doing, it was possible to concentrate on the time differential extant in the afternoon, if any existed. Since the afternoon data was grouped together in the initial analysis procedures, it was also important to see if the afternoon periods were indeed homogeneous and if there was a treatment effect of early afternoon versus late afternoon.

Table 5

Results of t-Tests of Percent Behavioral Change Between Afternoon Time Groups: Means and Values of t

Behavior	Early Afternoon N=5	Late Afternoon N=3	t
Immobile	1.6	72.33	2.13
Automanipulate	-39.2	-44.33	1
Manipulate	-30.4	-5.67	1.61
Take	-30	15.67	1
Digit Suck	-36.6	-27.67	1
Smile	-55.2	160.33	1.9

The treatment effect of early afternoon versus late afternoon indicated no time differences. Only the t-values of manipulate ($t = 1.61$) and smile ($t = 1.9$) were greater than one. These data may be found in Table 5.

Individual Trends

Although insufficient data were collected which could be considered in any formal analysis of individual trends, it is possible to present in graphic form the behavioral frequency counts of each individual across time. The histograms are not presented as formally-analyzed groups of data, but rather as visual illustrations of the behavioral changes of each child at the two data collection times. These data may be found in Figures 1-8.

The frequency counts are presented for each behavioral category for each child. The figures represent the mean totals of the two observational periods from each preschool program for each category. Thus, the histograms represent graphically the data presented in Table 2. This form provides the reader with a clearer picture of the changes noted in each individual as a function of time of day, and of the relative frequencies of occurrence of each of the behavioral categories.

Figure 1

Histogram: Child 1

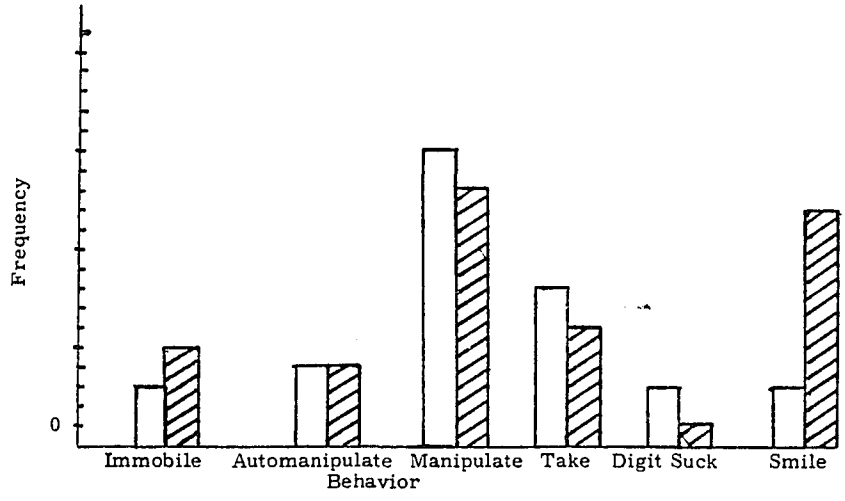
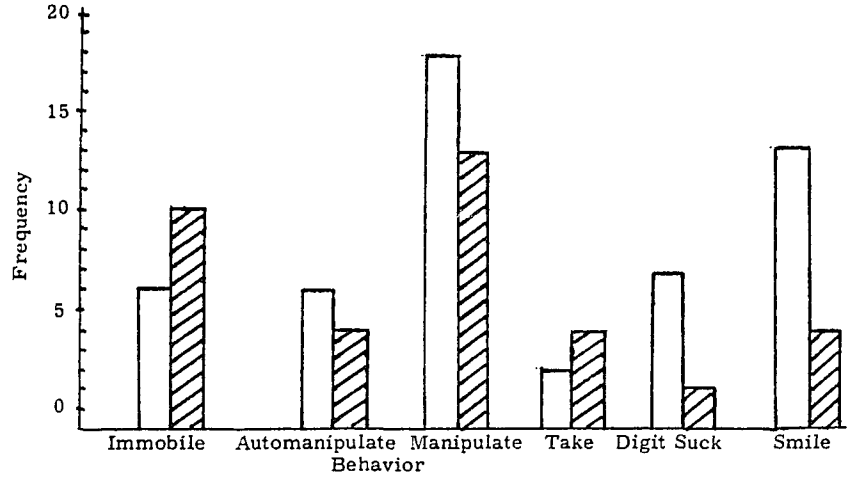


Figure 2

Histogram: Child 2



Key: Morning
Late Afternoon

Figure 3

Histogram: Child 3

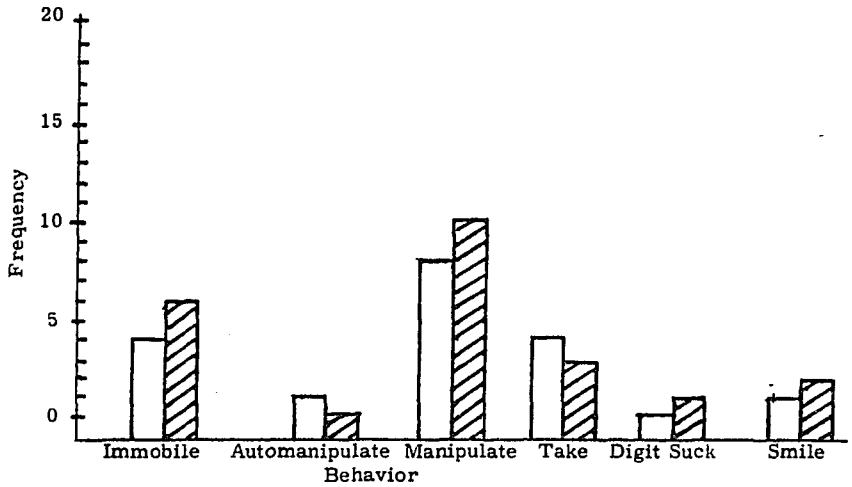


Figure 4

Histogram: Child 4

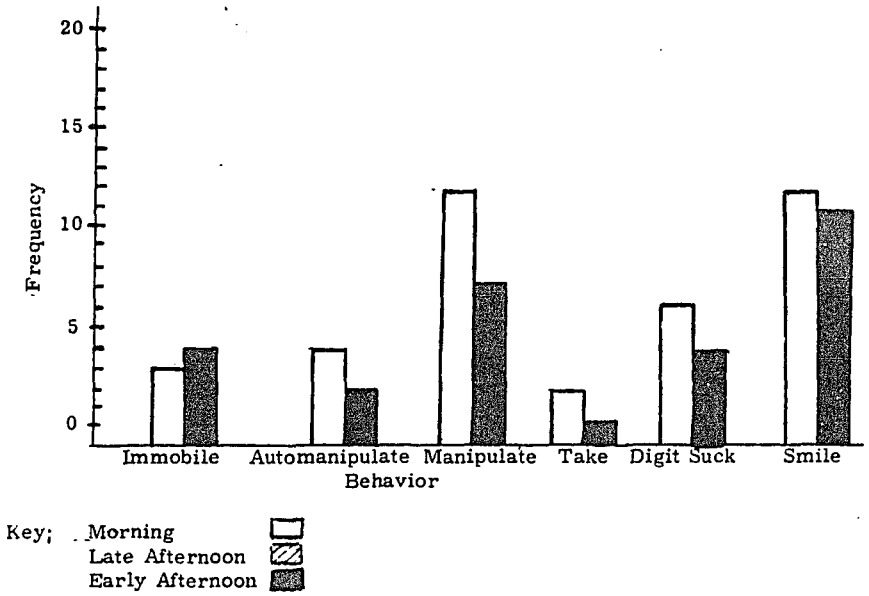


Figure 5

Histogram: Child 5

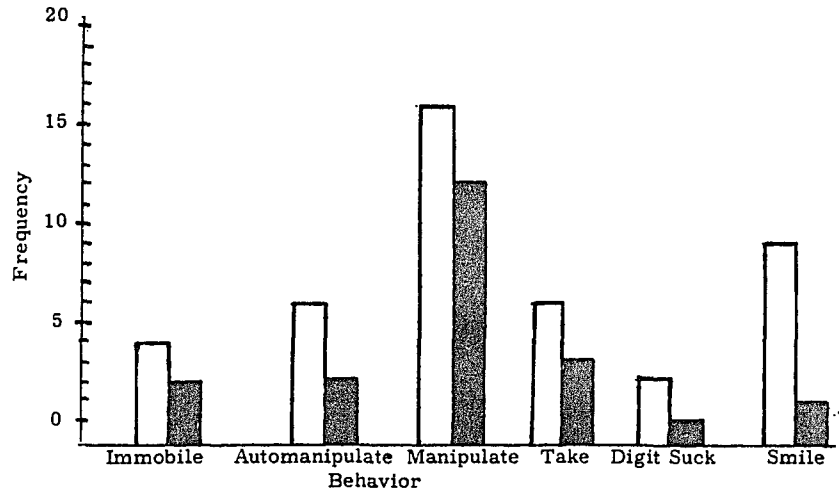
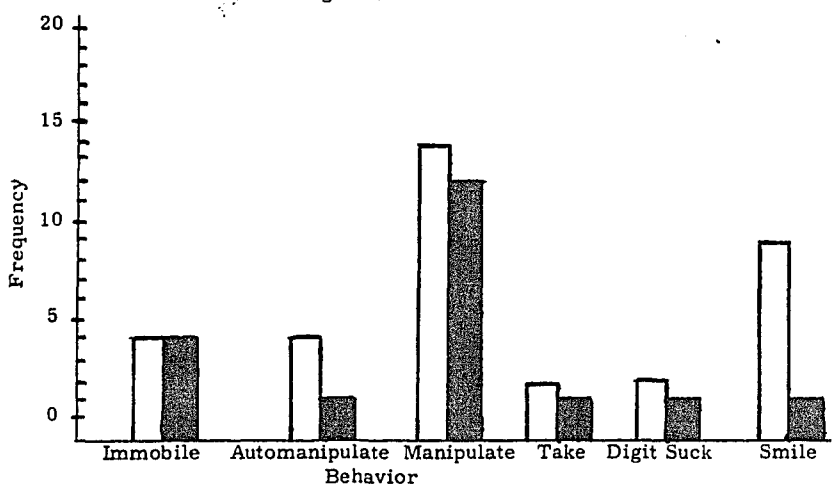


Figure 6

Histogram: Child 6



Key: Morning
Early Afternoon

Figure 7

Histogram: Child 7

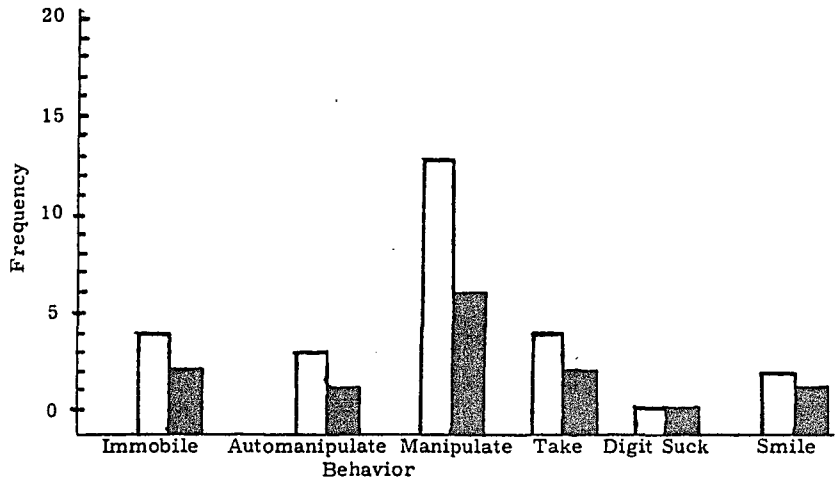
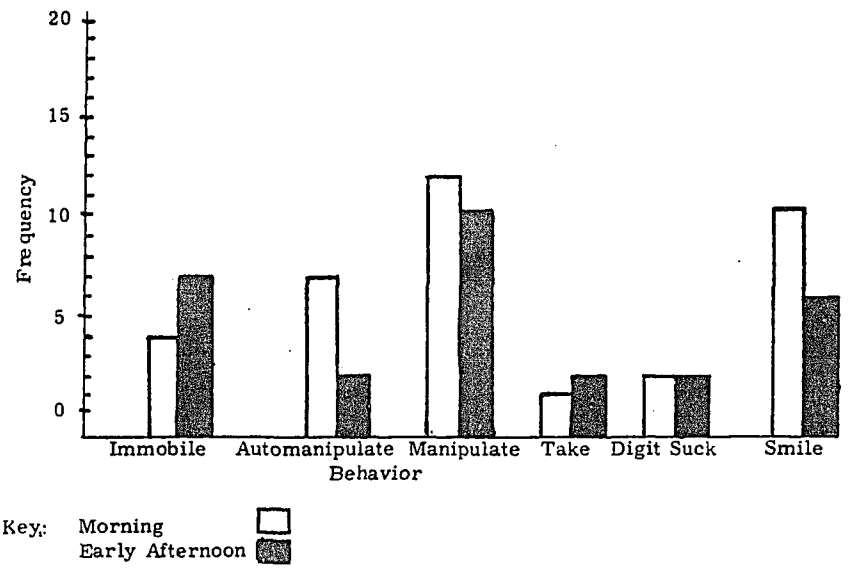


Figure 8

Histogram: Child 8



CHAPTER V

DISCUSSION

The discussion of the present study will be concerned with two aspects. First, the results of the observations will be considered, with an emphasis on the lack of treatment effects. Secondly, methodological considerations will be presented. It should be reiterated that the significance of the study is not in its impact as a full-blown, conclusive research statement, but rather as an initial indicator of potential research questions left unexamined at this time, and as a preliminary , tentative starting point of consideration for those individuals who administer preschool programs for the two-year-old child.

Observational Results

Before considering the results specifically, a look at the nature of human rhythmicity may aid understanding. It should be kept in mind that humans at birth do not have an internal, functioning rhythmicity that in any way approximates adult functioning. The process of growth and development consists of any number of physiological, psychological, behavioral changes, rhythmicity being no exception. Also, since many of the more complex psychological processes depend upon the subsequent complex development of physiological organ systems in order to reach fruition, not all forms of functioning are possible, at any level, early in human life. Such is the case with rhythmicity.

As Luce (1971) noted, it is only when the child's adrenal-cortical system reaches physiological maturity that the individual has internal mechanisms which may act to cue him/her to slow down, speed up, and the like, or, more simply, to develop rhythmicity. Until that time, temporal cues are, for the most part, externally induced. It is not until approximately the third year of life that the physiological time-cue system, the adrenal-cortical system, begins to mature. Thus, for example, the study population (mean age = 30 months, $\pm$ 4 months), might not be expected to have any elaborated time sense, either physiologically or behaviorally, and might be expected to behave relatively similarly in equivalent environments across time if such were the case. This study would lend support to further research efforts designed to elicit such a psychological-biological relationship.

As far as significant differences of group behaviors across time in this study are concerned, as previously noted, few were observed. Of the six behavioral categories, only automanipulate showed any significant treatment effect as it decreased in frequency over the course of the day (t = 4.2, $p < .01$; F = 17.62, $p < .005$). However, even here, the durations of automanipulate did not vary over time (F = 2.69, $p > .1$).

Of the other behaviors, only digit suck and smile exhibited any differences across time, although those differences were only potentially indicative and not significant (Smile, durations: F = 7.9, $p < .05$; Digit Suck, durations: F = 11.25, $p < .025$). While digit suck showed a similar trend with respect to

percentage of frequency change ($t = 2.92$, $p < .05$), smile did not. Although speculation might be made as to why smiling and digit sucking seemed to last longer in the morning, the amount and significance of data precludes any such speculation.

In general, then, it can be said that these eight children exhibited a great deal of behavioral consistency across time in two different environments with two different teachers and different teacher aides. Only one of the behaviors, automanipulate, showed any significant time-related change, and that only in terms of percentage of frequency change. It is not possible, therefore, to reject the initial null hypothesis that there would be no difference between groups across time except in that one instance.

Although one rarely embarks on a research project to confirm the null hypothesis, and runs the risk of committing a Type II error by doing so (Keppel, 1972), sometimes the results confirm such an inconclusive end. This is not to say, however, that the study was a fruitless endeavor contributing little to the literature. From an experimental perspective, the study may seem unsound in that it provided neither a control group chosen from the general population of two-year-old preschool children nor an older population of preschool children who would have potentially exhibited treatment effects of time. However, as Ausubel and Sullivan (1970) stringently indicate, the field of child development research relies predominantly upon objective observational techniques rather than formal experimental design.

Accordingly, this particular study was approved as an ethological, observational effort, and was conducted to the fullest extent of that methodology. The results, too, are the first to be elicited with respect to behavioral rhythmicity in this particular age group. Thus a small, tentative start in this research area has been established. With respect to the six motor and social behavioral categories chosen for consideration in this study, no time-related variations were noted.

Although other parameters and/or behavioral categories might be utilized which would have indicated a treatment effect of time, such was not the case in this research effort. McGrew (1972a), with an older study population, found significant treatment effects of time in terms of frequency in the categories of manipulate, immobile, and automanipulate (all decreasing with a $p < .001$). The question which arises at this juncture is why did rhythmicities occur in the older sample but not in the group of two-year-olds with respect to the same behavioral categories? Certainly extrapolation from this data in answer to that question would be inappropriate, although a cross-age-group circadian study could be conducted which would provide a tentative answer to the problem.

Other questions which arise in this regard deal with the nature of the ethogram, the so-called behavioral catalogue. The behaviors chosen for consideration in this study adequately met the criteria established for an ethogram as delineated by Hutt and Hutt (1970) in that they were the behaviors which the children exhibited over 90 percent of the observation period. However,

other facets of behavior not noted in this study, e.g., walking, bending, or vocalization, may have occurred differentially as a function of time. Such a possibility would seem remote considering the virtually universal consistency of occurrence of the six categories in the study, but it cannot be ruled out altogether at this point.

The categories chosen for consideration of circadian periodicity were also general in the sense that some of them, e.g., automanipulate and immobile, include a number of variations under their general definitional descriptions. For example, staring can, and in many cases does, occur with immobility. In this instance, perhaps the more specific component of the larger category, i.e., staring with immobility, exhibited rhythmicity while the larger category did not. In that manner, as well, potential temporally-related variabilities would be overlooked. Thus, it might be argued that more stringently defined categories be utilized in later research efforts incorporating the same basic design.

Finally, behaviors may occur in clusters or groups (McGrew, 1972a), for example, push and smile. It may be that the occurrence of a group of behaviors, such as manipulate and stare, occur rhythmically, while the individual behaviors occur singly on a consistent basis. Again, closer scrutiny in further designs is indicated.

Methodological Considerations

Hutt and Hutt (1970) enumerated the various positive and negative aspects of utilizing videotapes in observational studies. For example, they maintained

that the method provides a permanent, objective record of the situation observed, while the final analysis procedures still require a great deal of personal, experimenter observation. Although, as noted earlier with respect to this study, videotape worked to delimit the scope of the study somewhat, it provided an extremely viable research medium for the individual researcher who is unable to produce a corps of observers to gather data. In this instance, it was possible for the researcher to gather data within the environment in which he was a participant without any undue disruption of the group being observed by several strangers. (see Connolly & Smith, 1972, for further consideration of observer disruption.) Thus it can be strongly maintained that the results, (lack of results, as the case may be) obtained in this study are by no means the residues or direct products of the data collection process, but represent a normal behavioral picture of the children's environments on the days observed.

Several precautions need to be mentioned with respect to videotape methodology, however. Although they were duly noted by Hutt and Hutt (1970) and McGrew (1972a), this researcher's experiences lend strong support for their consideration. First, no more than one child should be observed per camera if facial and other behavioral details are to be noted over time. The fleeting and individualistic nature of children's behaviors precludes inclusion of any more than one subject per tape. Otherwise, detail and cross-time consistency may be lost, leaving a generalized, amorphous body of data. Second, all equipment used should have been recently maintenanced and in

perfect working order, as dirty recording heads produce a fuzzy, unsatisfactory final picture. The monitor should be kept out of the children's sight at all times. They rarely, if ever, acknowledged the presence of the camera in their midst, but might respond most readily if they gain a glimpse of the monitor. This would be particularly true of older children. If these factors are kept in mind, videotape technology can provide an extremely viable means of data collection for the individual researcher.

One further methodological consideration merits mention, that of population selection. The eight children observed ideally self-selected themselves for such a behavior-across-time study. Had the researcher set out to delimit a perfect population for this piece of research, he would have chosen children equally familiar with the teachers in both programs, enrolled in equivalent programs which meet the same number of times per week but at different times of the day, from the same socio-economic bracket (virtually all the same neighborhood), and with generally similar life styles. Such was the case with this study population. Finally, the general problems associated with cross-sectional samples in assessing the impact of treatment effects (Keppel, 1973) were avoided entirely. Thus, the sampling procedure was a positive factor in the study's design and execution.

CHAPTER VI

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

The problem investigated in this study was the relation between the frequencies and durations of selected behavioral categories in a group of two-year-old children and time of day. Specifically, the question asked was, do two-year-old's behaviors change in a free play setting in a nursery school as a function of time of day? It was hypothesized that there would be no group differences in either frequency or duration of behavior at different times of the day in similar preschool settings.

The question was investigated by means of ethological, observational techniques, utilizing videotape technology in the data collection process. The subjects observed were eight two-year-old children concurrently enrolled in a morning nursery school program at Centenary United Methodist Church and an afternoon nursery school program in the Department of Child Development and Family Relations at the University of North Carolina at Greensboro. There were two major time groups, morning and afternoon, and two afternoon time sub-groups, early afternoon (1-2 p. m.) and late afternoon (3-4 p. m.). The subjects were all of the middle socio-economic structure, and Caucasian.

The subjects were taped in the first part of the school year to provide the researcher with both an indication of the most frequently occurring behaviors of that age group and experience in viewing and transcribing behaviors from videotape. The data collection process took place during a four-week

period in November and December, 1975. During that period, each of the eight children was taped twice in each setting, one-half hour per tape, while he/she was engaged in free-play activities. A total of two hours of observations per child was obtained.

Ten social and motor behavioral categories were initially chosen for inclusion in the study. However, upon completion of the data transcribing process it was noted that four of the categories occurred extremely infrequently and were dropped from the statistical analysis procedures. The final six categories, whose definitions were from Blurton-Jones (1972a), Leach (1972), and McGrew (1972a), were as follows: 1) immobile; 2) automanipulate; 3) manipulate; 4) take; 5) digit suck; and 6) smile.

The two-day scores per preschool setting of each child were summed for each behavioral category. The statistical analysis consisted of:

1) Comparison of the percent of change of frequencies of behaviors between groups across time by means of six *t*-tests.
2) Direct comparison of those behavioral frequencies which reached significance in the initial *t*-test procedures.
3) Comparison of the durations of behaviors between groups across time by means of six separate one-way analyses of variance.
4) Comparison of the morning and afternoon frequencies of behaviors between the afternoon sub-groups by means of twelve separate *t*-tests.

The results of the analyses revealed one significant difference in frequency of behavior at the different times, as automanipulate decreased over

time (t = 4.2, $p < .01$). No other significant differences were noted with respect to either frequencies or durations of behaviors in the group across time, including the durations of automanipulate.

Conclusions

The conclusions of the study were drawn from both the data concerning differences in behavioral frequencies and durations across time, and the general process of rhythmic development. That is, those conclusions presented were concerned with the specific findings of the study and the significance/insignificance of those findings as related to the literature extant in the field of circadian periodicity.

Generally, it was concluded that no real significant differences in the behavioral patterns of the children were noted as a function of time of day. It was seen that the children were consistent across time and across centers with respect to the frequency and duration of the chosen behavioral categories. Although automanipulate showed a significant decrease over time (automanipulate; t = 4.2, $p < .01$) in terms of percentage of change in frequency, did not show a similar trend when the durations were considered (F = 2.69, $p > .1$). Thus, even in that particular instance, it would be more accurate to maintain that consistency was more prevalent than fluctuation over time. These findings supported the notion that little variation in the behavioral patterns would be present among children under three.

In terms of afternoon time group differences, much the same conclusions were reached. None of the behaviors showed any change in percentage of frequency change across the afternoon times, 1-2 p. m. and 3-4 p. m.. The three children who attended the late program at UNC-G were shown to be generally similar in terms of behavior patterns to those who attended the earlier program by means of t-tests of the percentage of frequency change. Specifically, percentage of behavioral frequency change within the time sub-groups was shown to be similar by means of t-tests. Thus, in the same environment, with the same teacher, the factor of time seemed to have little or no effect on the children's behavioral patternsn.

It was not possible to reject the null hypothesis that no behavioral differences were expected to occur as a function of time of day. In a more positive sense, however, an initial picture was gleaned of behavioral rhythmic development in two-year-old children. The children who participated in the study showed consistency in the frequencies and durations of six selected social and motor behaviors across time of day, across environments, across sex of teacher, and across time period of program, in two half-hour observation periods in each center. It would have seemed that some factor, either the variable of time, or some confounding variable such as individual dispositions and/or environment, would have elicited some change in the childrens' behaviors. Such was not the case. As noted, consistency prevailed.

Interestingly, the researcher questioned the parents, other preschool teachers, and other individuals who deal with children as to their guesses regarding the study's outcome. Although the responses were only informally elicited and recorded, without exception each person questioned felt that two-year-olds behaved extremely differently in the morning as opposed to the afternoon. The children were viewed as being more aggressive, disagreeable, and distractible in the afternoon. This particular sample, at least, failed to support such a position. It may be, however, that the adult respondents' evaluations represented reflections of their adult periodicities, with their concomitant fluctuations in attentiveness, energy level, irritability, and the like. Again, that information was only informally gathered, but may be seen as an indicator of future research efforts, i.e., a consideration of the development of mutual child-parent rhythmicities.

As far as specific conclusions to this study are concerned, it would seem more appropriate to delineate a number of significant questions generated, but left unanswered, by this piece of research. First, what factor(s) account for the lack of treatment effects found in this population of two-year-olds across time, as opposed to the rather numerous effects of time noted by McGrew (1972a) with three- and four-year-old children? Is the critical period in the development of behavioral rhythmicity sometime after two years of age but before three years of age? Was the ethogram elicited for this study significantly stringent to indicate any treatment effects of time? McGrew (1972a) utilized automanipulate and immobile in his study and found significant

differences across time in both instances. Again, no positive answers may be forthcoming at this juncture, only more questions.

Second, what does behavioral periodicity in preschool children mean? Thomas et al. (1970) and Luce (1971) both maintain that some amount of regular rhythmicity in the preschooler's life facilitates such facets as toilet training, sleep patterns, and the like. Are differences across time merely reflections of the individual's differential reaction to a social situation as McGrew (1972a) maintained, or are they indicators of rhythmicities of internal processes? What is the meaning of behavioral consistency across time? Does that mean that the behavioral patterns of the children in this study showed either a total absence of reaction to differences in the social milieu, or, conversely, a constant social-group effect? A more elaborated, across-age study seems to be indicated to speak to this particular group of questions.

Finally, what is the relationship between physiological maturation of the neuro-hormonal system of the preschool child and his/her subsequent development of adult-like rhythmic factors? A situationally-related observational study would seem to be the next step in terms of behavioral research, as the full environmental context of each behavioral occurrence would be noted. Once those parameters were established, physiological measures such as EEG's (cf. Wade et al., 1973), temperature (cf. Kleitman, 1963), or urine creatinine level (cf. Luce, 1971), might be correlated with behavioral rhythmicities and their consequent environmental factors. Until such studies are conducted, however, only speculation may be proffered in answer to the final question.

Recommendations

This study was limited in a number of areas. First, the number of observation periods per child were too limited to allow analyses of individual trends to be considered. Group differences were the focus of this study, but, certainly when looking at the development of a personal characteristic such as rhythmicity, individual trends would be most illustrative and appropriate. Thus, a similarly-designed study which incorporated a greater number of individual observations would be a logical next step.

The population considered in this study was and probably will be relatively unique in that not many parents enroll their children in multiple nursery-school programs at such an early age. It would be worthwhile, however, to seek out other such populations at any age and observe potential variations in the behavior as a function of time of day. Matched-sample techniques should not be excluded, either.

Videotape methodology was found to be most useful and illuminating, as behaviors could be observed over and over again. However, the methodology has drawbacks as well, most especially that of expense. In addition, time of data transcription, facial details, and off-camera periods presented methodological complications which personal observations with check-lists would generally avoid. It is recommended that unless unlimited research funds and time are available to the researcher, trained observers should be used in further similar studies. It need be maintained, however, that

for the individual researcher, as in this study, videotape is both convenient and adequate when teams of observers cannot be solicited and trained.

Finally, with respect to study limitations and recommendations aimed at correcting those deficiencies, little is currently available in the periodicity research literature in terms of information pertaining to rhythmic development. Therefore, intensive observational studies seem to be indicated which would have as their foci the year-to-year development of rhythmicity in the preschool child. Those factors associated with the development of rhythmicity (or lack of development, as the case may be), might also be considered.

Studies should be conducted which encompass subjects from different cultural groups, not just Caucasian, middle-class American children. As LeVine (1973) aptly indicated, ethnographers could develop ethnographies of rhythmic patterning cross-culturally, including the socio-cultural Zeitgeber in each environment. The broader aspects of species-wide characteristics of rhythmic development would potentially follow from such research efforts.

In conclusion, research efforts designed to observe the development of individual rhythmic functioning within the family system, with specific reference to both child and parent rhythmic patterns, would be most helpful in developing a full understanding of the social Zeitgeber (Lobban, 1965), and of the development of complementary (noncomplementary) rhythmic functioning within the individual and the family. That is, it is not yet fully understood how the neonate, infant, and preschooler progress from

a very primitive rhythmic system to the more elaborated adult pattern, and what mutual impact that process has on all family members (Luce, 1971). It is the role of future research to explore and explicate these areas of human functioning.

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Appendix A

Circadian Vocabulary

CIRCADIAN VOCABULARY

Period: time after which a definite phase of the oscillation occurs

Circadian rhythm: oscillation with a period of about 24 hours

Synchronization: state in which two or more oscillations have the same frequency due to mutual or unilateral influences

Entrainment: coupling of a self-sustained oscillation to a Zeitgeber (forcing oscillation) with the result that, either both oscillations have the same frequency (synchronization), or that the frequencies are integral multiples (frequency-demultiplication): possibly only within limited ranges of frequencies

Range of entrainment: range of frequencies within which a self-sustained oscillation can be entrained with a Zeitgeber (a forcing oscillation)

Forcing oscillation: oscillation (e. g., periodic environmental factor) capable of synchronizing or entraining another oscillation

Zeitgeber: that forcing oscillator which entrains a biological rhythm (also: synchronizer, entraining agent)

Free-running rhythms: self-sustained oscillations under constant conditions

Note: From Aschoff, 1965, x-xiv.

Appendix B

Sample Coding Sheet

IBM FORTRAN Coding Form

GX28-7327-6 U/M 050** Printed in U.S.A.

PROGRAM	Child's Name -- Child 1-8	PUNCHING INSTRUCTIONS	GRAPHIC								PAGE OF
PROGRAMMER	Name of program	DATE Date of tape	PUNCH								CARD ELECTRO NUMBER*

Notations

Behavior — Key: Each space = 15 seconds — FORTRAN STATEMENT (Durations and notes entered in margins) — IDENTIFICATION SEQUENCE

Immobile — Line 1 = minutes 1-15; Line 2 = minutes 16-30

Automanipulate

Manipulate

Hit

Laugh

Cry

Take

Digit Suck

Push

Smile

*A standard card form, IBM x-in-to BR1157, is available for punching statements from this form.

**Number of lines per pad may vary slightly

Appendix C

Reliability Coefficients

Reliability Coefficients

Observation Period I:

Number of agreements: 55
Number seen by A only: 3
Number seen by B only: 2

$$\text{Reliability} = \frac{55}{55 + 2 + 3} = \frac{55}{60} = .91$$

Observation Period II:

Number of agreements: 58
Number seen by A only: 0
Number seen by B only: 2

$$\text{Reliability} = \frac{58}{58 + 2} = \frac{58}{60} = .97$$

Observation Period III:

Number of agreements: 57
Number seen by A only: 2
Number seen by B only: 1

$$\text{Reliability} = \frac{57}{57 + 1 + 2} = \frac{57}{60} = .95$$