More Than Clocks and Calendars: The Construction of Timekeepers by Eleven Kindergarten Children in Mexico and the United States

By: Belinda J. Hardin, M. Gail Jones, and Olimpia Figueras

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Abstract:

The purpose of this qualitative study was to investigate timekeeping constructs of 4- and 5-year-old children in Campeche, Mexico, and North Carolina, United States, as well as the sociocultural conditions that shaped changes in their ideas about timekeeping (methods to mark and measure time) before, during, and after their kindergarten year Eleven children constituted the case studies. The children entered public school kindergarten during the fall of the research period and had no prior long-term institutional experience, such as preschool or child care. Data were collected in three phases over the course of one year through: 1) semi-structured interviews with children, parents, teachers, and education administrators; 2) semi-structured activities with children, including drawings of time-related objects and concepts, verbal descriptions of time-related photographic images from the home and classroom, and problem-solving constructions; 3) observational field notes of the homes, communities, schools, and physical surroundings with a special emphasis on time indicators; 4) classroom observations; 5) the completion of a classroom environmental rating scale focused on time; and 6) a review of national, state, and local education policies affecting time in public schools. Data were analyzed within and across cases, sites, and phases to look for commonalities and differences in the children's timekeeping constructs. Three methods for marking and measuring time emerged from the data: biological, environmental, and conventional timekeepers. Each of these timekeeping methods proved to be relative to individual children, as well as replete with common features across cultural, geographical, and biological boundaries. Environmental cues and activities not ordinarily considered timekeepers proved to be m.ore temporally significant than anticipated, and formal school instruction was sometimes out of step with home and community practices. The results of this research suggest that many critical ideas about timekeeping change during a child's first year of formal schooling as children learn to adhere to external schedules, which may constrain or enhance their ability to fully engage in school activities,

Article:

Each day, numerous internal and external cues are used to construct complex, interwoven clusters of temporal information that give each of us a sense of our place in time. These clusters are referred to as temporal identity[1] (Hardin, 2001). When children enter kindergarten, their existing temporal constructs are challenged in new ways by the institutional environment of public schooling. For example, children learn to divide their school day according to specific activities (e.g., journal time, center time, recess) and by rhythmic biological processes, such as eating, sleeping, and using the bathroom; these needs become entrained by superimposed schedules. The complexities of temporal adjustments, particularly timekeeping (methods used to mark and measure time), for kindergarten children are more often than not ignored. External timekeeping systems, however, especially clock time, regulate how families organize their lives, curriculum and instructional practices, school scheduling policies, and the opportunities children have to explore, comprehend, and master learning (Gándara, 2000; Kane, 1994; National Education Commission on Time and Learning, 1993).

Changes in methods used to mark and measure time result from the interplay between individuals and their sociocultural context. Research demonstrates that sociocultural factors, such as family structure, community traditions, degree of industrialization, climate, and cultural values, as well as biological factors, such as brain functioning, age, health, and circadian rhythms, all contribute to the construction of temporal concepts (Block, 1990; Colombo & Richman, 2002; Ezzeii, 2002; Gell, 1996; Hill, Block, & Buggie, 2000; Jarrett & Burton, 1999; Levine, 1997; Pollack, 1999; Soulsby & Fraser, 2001; Takahashi & Hoffman, 1995), This dialogic process creates the "essential tension" necessary for change to take place[2] (Kuhn, 1977). Block (1990) suggests that a "time tag" exists in which contextual elements, including "associations to an event or to other events in an episode, mood states, internal physiological cues, and conspicuous external events, are encoded to create individual cognitive understandings of time" (p. 7). Thus, the boundaries of one's temporal identity are continuously negotiated through dynamic interaction between the biological self and one's sociocultural context.

This study examined children's perceptions of timekeepers in relation to their first year of public school, The following research questions guided this research: How do young children mark and measure time? What strategies for constructing timekeepers do children bring with them to the school environment? How does school entrance change young children's ideas about timekeepers? What environmental factors influence young children's timekeeping constructs, especially within the home, school, and community systems?

BACKGROUND

Where does one draw the line between individual and sociocultural influences with regard to constructing methods to mark and measure time? Multidiseiplinary research on time supports the viewpoint that these two dynamics are innately interdependent.

For example, the founder of modern sociology observed time to be collective categories common to a group—a social time (Gell, 1996; Munn, 1992), From this perspective, calendars do not so much measure time as give it rhythmic form according to cultural practices. The impact of social affiliations on timekeeping runs deep. When individuals align themselves with socially based "economies of time," not only do they experience greater potential for personal success, but entire cultures may survive or disintegrate into obscurity when their members are unable to re-organize their temporal practices (Schieffelin, 2003). These same dynamics apply to young children entering new institutional settings, such as public school kindergarten (de Vasconcellos & Valsiner, 1993; Gracey, 1975; Soulsby & Fraser, 2001). For example, when a child has difficulty reorganizing biological and psychological methods for marking and measuring time to meet classroom schedules, he or she may be unable to complete meals or finish work "on time." As a result, the child may be labeled as lazy or mentally challenged and fall behind in academic and social development.

In the natural sciences, biologists know the fertilized egg or human genome contains a living history of temporal information that will be uniquely expressed by the developing person. Although each person comes into the world with a basic road map, recent neurological research indicates these physiological pathways are refined and altered as neurological pathways are established through random and repeated experiences between the individual and his or her sociocultural context (Pollack, 1999; Restak, 1995; Shore, 1997), Studies in which newborns respond to differences in light stimuli and to their parents' voices indicate these pathways may begin to shape in utero (Braze1ton, 1992).

Circadian rhythms (from Latin circa, "about," and dia, "day") represent another aspect of biological timekeeping in humans (Arechiga, 1996; Aveni, 1989; Takahashi, 2000; Takahashi & Hoffman, 1995). Circadian rhythms follow the 24-hour cycle of the earth's rotation. Scientists now know that most, and probably all, organisms have internal clocks that dictate daily or circadian rhythms for sleep, waking states, metabolic activities, and so forth. These biological rhythms act as "pacemakers" for environmental information received through sensory pathways in the brain. Thus, once again, the dynamic interactions between biological and environmental factors create timekeeping devices.

Scholars in psychology have compiled much of what is known about young children's time conceptions (Block, 1990; Friedman, 1982; James, 1890; Macar, Pouthas, & Friedman, 1992; Piaget, 1969). Studies on infant timekeeping (Colombo & Richman, 2002) found astonishing preciseness in infants' ability to link time estimation to light stimulus intervals, as measured by heart rate response. Friedman (1982, 1990, 1992, 2000), a child psychologist specializing in time research with young children, suggests that memories are not automatically ordered, but rather are associated with locations in time in relation to a child's chronological age and environmental context. In one study, Friedman asked children to estimate time intervals separating familiar events (e.g,, waking to breakfast). Even 4-year-olds were able to correlate their judgments with real events accurately. In another study concerning young children's knowledge of the times of future events, Friedman found a distinct difference between 4- and 5-year-olds. Although 4-year-olds were unable to discern future events, 5-year-olds identified future events in weeks or months when asked questions about events such as holidays, although they still could not differentiate between the concepts of recent past and near future.

THEORETICAL UNDERPINNINGS

Valsiner's (1988, 1995, 1998, 2001) research on the sociogenetic approach (also called the comparative-cultural approach) provides a methodology for understanding human and cultural development as mutually interdependent processes. Conceptions of time-keeping from the sociogenetic perspective are simultaneously co-constructed and both socially and individually independent, while maintaining a mutually interdependent relationship across the various systems of one's sociocultural context. For example, children typically begin to learn about the concept of "date" in kindergarten. As this concept is reinforced through home and community experiences, such as birthdays, children begin to mentally categorize and store temporal information by a method previously unknown to them. The sociogenetic approach to understanding how young children construct methods for marking and measuring time forms the underlying theoretical principle of this research. It is founded on the following logic: "The goal of a sociocultural approach is to explicate the relationships between human mental functioning, on the one hand, and the cultural, institutional, and historical situations in which this functioning occurs, on the other" (Wertsch, del Rio, & Alvarez, 1995, p, 3).

Because one's sociocultural context includes multiple systems, the principles of systems thinking were used in conjunction with those of social constructivism to gain a comprehensive picture of how children developed and used timekeeping constructs. Capra (1996) summarizes system thinking as follows. Essential properties within the system define the whole, not the independent parts. When the interactions or relationships of the whole are destroyed, the isolated elements do not maintain the identity of the whole. For example, time-keeping systems created by humans, such as the Gregorian calendar, are defined by their wholeness. The word "date" has no particular meaning in isolation. However, in the context of the Gregorian calendar, it can be used to consistently identify a specific day in a particular month and year and then be associated with a special event such as a birthday, Systems are important to time-related research not only because of the numerous systems of timekeeping, but also because time itself penetrates all other systems.

The theoretical framework developed by Bronfenbrenner (1979) brings systems theory into focus as a way to understand human development. This approach includes examining the developing person's interactions with persons, objects, and symbols (called proximal processes) within multiple environments to ascertain stable patterns of behavior across time. More recently, Bronfenbrenner and Morris (1998) expanded this model to include the role of biological processes in human development, termed "biopsychological development," The revised model supports the premise that human development occurs across a person's life span and even extends to generations as an ongoing, co-constructed process between the individual and the environment. According to the model presented by Bronfenbrenner, these experiences take place in an environment (or sociocultural context) composed of four nested structures: the microsystem, the mesosystem, the exosystem, and the macrosystem. Together, the sociogenetic method for understanding human development, systems thinking, and Bronfenbrenner's nested system model constitute the theoretical approach used in this research.

METHODS

A maximum variation sample (Patton, 1990) was used to capture central themes across diverse cultural, socioeconomic, and geographical areas, according to the four criteria discussed below, These criteria were used to create a balance between maximizing the variation of the sample and delineating some basic system boundaries from which to choose the participants.

Research in social psychology suggests significant differences in the usage of time in Mexico and the United States (Levine, 1997). According to his research on the pace of life in 31 countries,[3] Levine ranks the United States 16th and Mexico 31st. Some of the characteristics contributing to these differences were identified as: economic well-being, degree of industrialization, population size, climate, and cultural values. Selecting children from both countries helped ensure the inclusion of macrosystem perspectives of time.

An ethnically diverse group of children was selected to provide a context for understanding timekeeping practices that transcended ethnic or cultural differences, an exosystem component. Six children (three each) of Maya and Spanish heritage were chosen in the state of Campeche.[4] Five children were selected from the state of North Carolina: two children of African heritage and three of European descent. Thus, the total sample of 11 children represented a minimum of four diverse sociohistorical perspectives of time (Aveni, 1989; Faust, 1998; Hill, Block, & Buggie, 2000; Levine, 1997; Milbrath, 1999; Tedlock, 1982).

Four communities, two from each country and within the same state, were chosen to represent a variety of mesosystem characteristics, including a mixture of rural and urban settings, variations in technology, and socioeconomic differences. These communities were chosen because the first author had established relationships with community members in each location. In the state of Campeche, two anthropologists who lived and worked in each site introduced the first author to education officials, In North Carolina, the first author contacted the appropriate person in each superintendent's office.

To consider differences between home environments and family practices, a variety of home environments were chosen for the study. Variations in the homes and families included: homes with different types of physical surroundings; homes with a range of furnishings (e.g., homes with clocks or not); families with different numbers of siblings; families with differences in parental work schedules; and families (microsystems) whose socioeconomic status differed.

These selection criteria were designed to provide a full range of system venues for identifying individual timekeeping constructs and a constant comparative method of data analysis within and across the systems. The following section describes the participant category representing each of the targeted systems.

Participants

Children (Microsystem). Eleven 4- and 5-year-old children constituted the focus of the case studies. These children: 1) entered public school kindergarten during the fall of the research period, 2) had no prior long-term institutional experience such as preschool or child eare,[5] and 3) were typical in their development according to descriptions of their behaviors and activities reported by their parents. When the study began, the ages of the children ranged from 50 months (four years, two months) to 65 months (five years, five months), Five children (two males and three females) were selected in Orange and Chatham counties in central North Carolina, United States, and six others (two males and four females) were chosen in the communities of Pich and Campeche in the Mexican state of Campeche. Socioeconomic and geographical differences ranged from families living in one-room houses with no electricity in a rural Mexican community of 1,500 people to urbanites with modern conveniences living in Campeche, Orange County, and Chatham County. Variations in the cultural heritage of the children included: African, European, Spanish, and Maya. Additional information obtained from the mothers, teachers, and administrators helped ensure a systems perspective for each case.

Mothers (Microsystem). The family system is the locus of early socialization and learning in a developing child's life (Bronfenbrenner, 1979; Gracey, 1975). Through interactions within family, young children construct concepts about learning processes, basic needs, sequential daily activities, and many other important aspects of life. Families are in a constant and ongoing state of defining and redefining their unique characteristics, including a culture of time. For the children in this study, the mothers were the primary caregivers. Thus, each mother was interviewed during each phase of the study to gather information on the treatment of time within the home environment. The ages of the mothers ranged from 19 years old to 46 years old. Most of the mothers were in their 30s.

Teachers (Mesosystem). The teacher has primary responsibility for shaping time constructions in the classroom through routine activities, curriculum practices, and individual teaching styles. As children enter kindergarten and begin interacting with teachers and peers, time constructs modeled by the teacher soon evolve into standard co-constructed meanings, or an intra-culture of time constructs, through the shared experiences of the group (Valsiner, 1995). Classroom teachers for 10 of the 11 children were interviewed during the second phase of the study. Since the children in both Pich and Campeche had the same teacher, a total of six teachers were interviewed. One teacher in Orange County opted not to participate. The purpose of these interviews was to understand the teachers' beliefs and approaches to time within the classroom setting and to ask specific questions related to time for each child.

Education Administrators (Exosystem / Macrosystem). To gain an understanding of the components and workings of the national, state, and local education systems, seven education administrators were interviewed, including one principal and two administrators in the state of Campeche, and one principal, two school district administrators, and one state administrator in the state of North Carolina. The administrators provided an exosystem perspective, but were also part of the macrosystem. Table 1 provides additional demographic information.

Procedures

Permissions from the Secretaria de Educación Cultura y Deporte's office in the state of Campeche and the county school district offices in the state of North Carolina were obtained prior to beginning the study. The first author met with each official, explained the project, and completed the required paperwork. The appropriate school officials for each site approved the study in writing. In addition, each school district administrator interviewed for the study signed a permission form.

The children were recruited by the researchers in collaboration with people who live and/or work in the local communities, In Mexico, children with no previous longterm child care or preschool experience were easier to find than in the United States, since the majority of Mexican mothers (71.5 percent in rural areas and 65 percent in urban areas) do not work outside the home and most young children stay at home during the day (World Bank Group, 1998). Locating children without previous institutional care in North Carolina proved challenging. Most of the participating families in North Carolina had made a conscious decision for the mother to stay at home with the children. Once potential children were identified in each location, the researchers contacted the families in person to explain the study, share the written information about the study, and obtain written permission for the children to participate in the study.

After the children were in kindergarten, the researchers contacted each school district again, as well as local school administrators and parents, to provide an update of the study and inform them that it was time to contact the children's teachers, Teachers were contacted by telephone and asked to participate. The project description and consent form were given to participating teachers during the subsequent meetings, and written permission was obtained before the interviews began.

Data were collected in three phases across the course of one year and included: 1) semi-structured interviews[6] with children, parents, teachers, and education administrators (see Appendix for examples of questions); 2) semi-structured activities with children, including drawings of time-related objects and concepts, verbal

descriptions of time-related photographic images from the home and classroom, and problem-solving constructions; 3) observational field notes of the homes, communities, schools, and physical surroundings, with a special emphasis on time indicators; 4) classroom observations; 5) the completion of a classroom environmental rating scale focused on time;

Table 1
Demographic Information for Case Studies (N=11)

Site	Child*	Age (mos.)	Gender	Cultural** Heritage	Mother*	Num. sibs.	Birth order
Campeche	Arcadia	53	F	Sp	Ramira	1	1st
Campeche	Juan	53	M	Sp	Elena	0	1st
Campeche	Karman	50	F	M/S	María	4	3rd
Pich	Ana	58	F	M/S	Evita	1	1st
Pich	Donato	63	M	M/S	Fermena	4	5th
Pich	Elisa	63	F	M/S	Lola	3	4th
Chatham	Adam	62	M	E	Edie	2	2nd
Chatham	Nina	64	F	E	Beth Ann	5	4th
Chatham	Olivia	61	F	AA	Glenda	1	2nd
Orange	Keisha	56	F	AA/E	Trisha	1	1st
Orange	Phillip	65	M	E	Nora	3	3rd

Note. * All participant names are fictitious.
** Cultural Heritage: AA=African American, E=European, M=Maya, S=Spanish

Table 2
Overview of Data Collection Activities for Each Phase (n=35)

System	Phase*	Participant	Type of data	Amount of time/ No. of visits	Observational field notes	Documentation
Individual	I, II, III	Child	Semi-structured questions and activities	2-2 1/2 hours during three visits	Descriptive information about the children	Audiotapes, interview notes, drawings
Family	I, II, III	Mother	Semi-structured interviews	1-2 hours during three visits	Descriptive information about homes	Audiotapes, interview notes, field notes
Classroom	II	Teacher	Semi-structured interviews	1-1 1/2 hours during one visit	Descriptive information about classrooms	Audiotapes, interview notes, field notes
			Classroom**** observations	3-5 hours during two visits	Observations of time-related elements	Complete classroom observation guides
Education System	II, III	Local and state administrators***	Semi-structured interviews	1-1 1/2 hours during one visit	Descriptive information about schools	Audiotapes, interview notes, documents about states, districts, and schools
Community	I, II, III	NA**	Informal observations	NA	Descriptive information about sites	Written field notes about each community
Society	I, II, III	NA	Informal observations	NA	Descriptive information about each country	Written field notes and documents for Mexico and U.S.

Note. *Phase I=before kindergarten, Phase II=during kindergarten, and Phase III=after kindergarten.
**NA means not applicable because these activities were not appropriate for individuals.
***Two interviews were completed during an initial visit prior to Phase I data collection.
****Only one observation was conducted in the classroom of the child whose teacher did not participate.

and 6) a review of national, state, and local education policies affecting time in public schools. Table 2 depicts an overview of data collection activities for each phase. All verbal and written information was presented in the person's native language (Spanish or English). Care was taken to ensure similarity in familiarity and difficulty of all interview questions and activities for all participants. The same stimulus props, such as a toy animal for event sequencing questions, were used with all children.

Analysis

Data were collected before, during, and after the kindergarten school year and then analyzed within and among cases to look for commonalities, differences, and changes in the temporal language constructs of the children across systems and time. All tape-recorded interviews were transcribed and compared with field notes for

accuracy. Transcripts, field notes, classroom observations, and other written documentation were classified, coded, and organized ac- cording to relationships to identify links for each child's case study, as well as across the entire data set.

Information from each method of data collection was compared across methods to find commonalities and differences among the timekeeping constructs of the children and the culture of time within each system. For example, interview data from one child were compared with observational field notes of the same child's home and community, and with classroom observation notes. Consistency of themes and changes throughout the year were examined by looking at the data by case across all three phases. The theoretical framework was applied by examining the children's timekeeping constructs within the context of their homes, classrooms, communities, and countries.

Approximately 15 percent of the data was read and coded by two independent parties as a measure of interrater reliability. One independent rater was given interview transcripts to code, The other independent rater was given written notes to code. The researcher trained each independent rater on the code names and definitions before they began to code the data. The researcher coded each set of data separately from the independent raters. To calculate the interrater reliability between the researcher and each of the independent raters, the following formula was used: Reliability = Number of Agreements/Total Number of Agreements Plus Disagreements (Miles & Huberman, 1994). The interrater reliability resulted in 85 percent agreement between the researcher and one independent rater and 86 percent agreement between the researcher and the other independent rater. NVivo (Qualitative Solutions and Research Pty. Ltd, 1999) was used to facilitate the analysis process.

RESULTS

Three methods for marking and measuring time emerged from the data: biological, environmental, and conventional timekeepers. Elements of conventional timekeeping (e.g., clock time), considered "objective" by many people, acquired new meanings based on individual experiences in particular settings. For example, for the children in Campeche, the time 9:00 a.m. had no particular distinction until after they entered kindergarten, when it became associated with the beginning of the school day. Similarly, the majority of the children in North Carolina reported specific bed- times during the school year that passed without notice before entering kindergarten, The following sections describe results pertaining to the three methods of time-keeping found in the data.

Biological Timekeepers

Biological timekeepers are defined as methods of marking time based on human physiology. Biological timekeeping can be examined on two levels: recurring physiological cycles (e.g., circadian rhythms), such as sleep/wake, heartbeat, and temperature cycles; and those represented by "epochal and certain irreversible biological events, such as birth, sexual maturation, or death" (Helfrich, 1996, p. 109). Biological rhythms on both levels are frequently entrained by environmental stimuli.

In this study, the majority of the children's references to recurring physiological cycles as biological timekeepers were related to daily basic needs, such as waking-sleeping patterns. Two factors significantly contributed to how the children used their physiological cycles as timekeepers: school schedules and parental values concerning biological timekeeping.

Because the children had not participated in formal child care and thus stayed at home or with close relatives, they were accustomed, when the study began, to a lifestyle that largely catered to their physical needs. Nina's responses typify these reports: "I can only fall asleep when I want to. . . or just when I'm really tired." Similarly, parent reports reflected a child-centered lifestyle across sites. A partial exception was Olivia's case. Because both of Olivia's parents worked (her mother part-time), she stayed with her grandmother during the day. She was accustomed to waking up and leaving home according to her parents' work schedule, and thus had already

experienced external factors that prohibited her from responding to biological rhythms as time-keepers on weekday mornings. Once she arrived at her grandmother's house, her day was similar to the other children's, During the school year, responses to rhythmic biological processes were altered to comply with school schedules. Children became accustomed to waiting for designated meal times at school and responding to prescribed times for waking and sleeping at home. Some of these changes became overwhelming barriers to school attendance, For example, Ana's family bought a clock to help them comply with the school schedule because she often arrived at school "a little bit late" and therefore was not allowed to stay at school, as was customary. The addition of a clock vividly represented a shift away from the family's traditional timekeeping methods based on the position of the sun, but it did not resolve the situation. When the batteries ran out, the clock was no longer used. In the last interview, it was learned Ana had continued to miss a significant amount of school because she did not arrive on time and because of a brief stay in the city of Campeche. In the context of her peers, Ana was not able to accomplish the same level of skill development and preparedness for primary school.

During the summer after kindergarten, most children experienced a lifestyle similar to what they had the previous summer, although not as attuned to biological patterns. Three children found themselves continuing to have their basic needs regulated by external demands similar to the school year, either because both parents were working and/or the children were attending summer camp. Keisha's mother described this change as follows: "The biggest change is that I've gone back to work, and so because of that, everything has changed. You know, the kids are at summer camp and preschool, as opposed to being home with Mom."

Finally, some parents encouraged their children to "listen" to biological needs for the purpose of temporal placement, For example, when Nina was asked how the doggy (an interview prop) knew it was time to do some work, she responded, "His body tells himself. Right, [Mommy?]," looking to her mother for confirmation of her answer. Others parents guided their children toward conventional timekeeping methods to regulate biological functions. In Phillip's family, eating and sleeping patterns were highly regulated by clock times.

At the same time that daily recurring processes were being used to construct temporal placement, the children were formulating biological time markers based on epochal and irreversible physiological changes. These timekeepers were heavily influenced by cultural rituals; in particular, celebrations to mark chronological age changes (birthdays), kindergarten graduation as a rite of passage into school life, and losing a tooth (an age cohort developmental marker).

Methods for recognizing birthdays varied by family and community, although everyone reported some type of celebration. In three of the four sites (all but Pich), birthday celebrations were marked each year with roughly equal significance, In Pich, a child's first and fifteenth birthdays were special celebrations. All others were honored with smaller gatherings. Family members trained the children to connect age changes with numerical representations as a method of timekeeping. Although the majority of the children did not fully understand these linkages, they worked hard to incorporate their family's teachings into their ideas about timekeeping. Some families emphasized knowing one's age more than others.

To examine the children's understand- ings of birthdays and marking changes in age, during each phase of data collection they were asked, "How old are you?," "How old were you last year?," and "How old will you be next year?" or "How old will you be on your next birthday?" Their responses revealed some interesting patterns, Eight children appeared to be able to make distinctions between the meanings of the questions. Of the three remaining children, Ana continued to be uncertain about her age throughout the study. It may be that Ana's family did not place as much emphasis on knowing one's age as other families. For example, Ana's mother provided contradictory information about her own age during two different interviews. In general, the concept of "next year" appeared to be more difficult to answer than "last year."

Some children provided contextual information that demonstrated changes in their ideas about age changes. During the first interview, Adam correctly answered questions about his current age, as well as those about his

age the prior year and the coming year. In the second interview, he connected changes in age with calendrical concepts. When asked how old he would be after his next birthday, he explained, "I'm gonna be six." [Then?] "Seven." [Then?] "Eight." [Then?] "Nine." [Then?] "Ten." His responses indicated some understanding that age changes were sequential, By the last interview, Adam was associating his chronological age with grade levels at school:

Interviewer: How old will you be on your next birthday?
Adam: Seven.
Interviewer: And after that how old will you be?
Adam: I'll be eight and I'll be in 3rd grade, I'll be nine and I'll be in 4th grade and then 5th grade, then 6th grade, then 7th grade, then 8th.

For some children, linkages between age changes, birthdays, and aging reflected a connection with death and dying. When Nina was asked if she thought birthdays keep going on and on, her reply was, "Until you die. You just keep having birthdays until you die. Nope, birthdays never stop because you also have birthdays in heaven." Nina's answer was probably influenced by the ways in which her family honored her deceased grandmother. Nina's mother described helping the children write notes and attaching them to helium balloons to be sent into the "heavens" to her deceased mother.

Local cultural practices at all four sites reinforced completing kindergarten as a developmental milestone and rite of passage toward student life and citizenship. Elisa's mother described local customs related to kindergarten graduation in Pich as follows: "On Sunday, we had her party with cake and pastries. Her godmother and grandmother were there and us." When asked if it was customary for godmothers to attend kindergarten graduations, Elisa's mother replied "yes" and explained that, in Pich, godmothers were expected to go with their godchild to pick up the kindergarten certificate. A photograph of Elisa and her grandmother was proudly displayed. Dancing was a distinct part of kindergarten celebrations in the state of Campeche, Donato's mother remarked, "The most important [event during the year] for the child was graduation and he danced with only four other kids." She added that Donato had handled the arrangements for wearing special clothes for the dance himself, which she considered an example of his increased maturity. In both North Carolina sites, children reported celebrating similar events with singing and refreshments. Regardless of the specific way in which kindergarten graduation was arranged, it was clear this event had mediated each child's image about kindergarten as an important rite of passage into school life and toward adulthood.

Finally, losing a tooth was a developmental timekeeper reported by several children as an indicator of "getting older," both for those who had lost teeth and for those who lamented not yet having had the experience. Some children linked loosing a tooth with specific months, At school, some teachers reinforced this developmental timekeeper. A large representation of a tooth was displayed on the wall in Olivia's classroom, under which was written, "Look who lost a tooth!" The names of the children who had lost one or more teeth were posted on the display. Adam, who did not lose his first tooth during the year, wistfully expressed his disappointment about it in the last interview: "I wish sometimes, I wish sometimes I would lose a tooth." In sum, losing a tooth appeared to be a biological timekeeper recognized by this age cohort as a shared developmental event.

Environmental Timekeepers

In this research, timekeeping methods based on rhythmic patterns in the external environment are defined as "environmental timekeepers." De Vasconcellos and Valsiner (1993) describe the temporal aspects of environment as follows: "The existing environmental context sets up (affords) a range of possible actions by the persons (of given age and cultural backgrounds), which then unfold at some specific pace and rhythm-bounded by the actors' cultural conceptualization of time in respect to their actions" (p. 4).

Rhythmic environmental cues are critical to timekeeping, even in the most clock-driven societies. In this study, children marked the end of outside play by the onset of night, the time for the main meal of the day by a parent coming home from work, or the time for bed by the end of a television program. All environmental timekeepers

were established well before the children began to understand and use clock time. In classrooms, the children also constructed time measurement systems according to environmental markers, including the end of the morning "routine" in Pich signifying going back to the classroom, or lights being turned off and on in North Carolina kindergartens to signal the beginning and end of rest time. As is evident in these examples, environmental timekeepers, by their very nature, are contingent on interactions between individuals and events, people, or objects. Environmental timekeepers constructed by the children to mark and measure time fell into four categories: natural, home, community, and school environmental timekeepers.

Natural environment timekeepers were linked to diurnal cycles (e.g,, daylight means waking up and going to school) and observations of yearly seasonal changes, including differences in temperature, precipitation, and the proportion of daylight and darkness. Some children also expressed an awareness of lunar cycles by drawing and reporting the moon as a "circle," "banana," or "half moon," although they had not begun to recognize a regular rhythm to the changes they were observing. Some children made cultural associations to the moon. When Arcadia, a child in Campeche, was asked to draw a moon, she reported the moon has "an old rabbit." The image of a rabbit and the moon are associated in Maya cosmology, The Maya saw the rabbit as an alter ego of the moon because when the moon is full, an image of a rabbit can be detected on the face of the moon (Milbrath, 1999).

Some children specifically referred to the sun as a timekeeper. Others made statements about playing outside until nighttime, or knowing it was time for bed because it became dark. During the second interview, children began associating these natural events with school. For example, Ana reported not only seeing the sun when she got up, but "also when it's time to go to kindergarten." Other children made similar comments. Several mothers reported their children making associations between bed-time and changes in the amount of daylight, such as Keisha's mother in this response:

> During school, she's consistently going to bed between 8:00 and 8:30 and now it's more like 9:30 or 10:00. And that's more due to the fact that there's more daylight now, so it's harder to convince them that it's bedtime when it's bright outside. And what she tells me is, "But it's not dark yet." So she does know that when it's nighttime, you go to bed. And she'll ask, "What is nighttime? What is evening? What is sundown?"

Other references to natural environment timekeepers reported by the children included climatic seasonal changes, such as the rainy season in the state of Campeche and associations between snow and winter in North Carolina. Formal school instruction and seasonal contexts were sometimes out of step with each other. All the children in this study, for instance, were taught that the scientific year is divided into four seasons. However, the children in both sites in the state of Campeche experience only two seasons (rainy and dry seasons), so the formal instruction of four seasons was abstract and unrelated to their personal experiences as a method of timekeeping.

Three methods for marking and measuring time in the home environment dominated the children's responses—family routines, television programming, and parenting practices. Family routines were reported in association with a particular part of the day (e.g., morning, afternoon, nighttime) or a specific activity (e.g., bathing after coming indoors at night). As shown in Table 3, the frequency of family routines as timekeepers increased steadily across the year. These results reflect the more structured home environments during and after the school year and the children's heightened awareness of these rhythmic changes.

Television programming rivaled conventional timekeepers as a method for marking time in the home environment. Of the nine families with televisions during the first interview, both children and mothers made reference to watching television during certain portions of the day (e.g., morning, before bed). By the last interview, all of the families had a television and described it as a timekeeping device in addition to an entertainment source. Researchers observed a shift from solar timekeeping to using television program-

Table 3
Methods for Marking Temporal Intervals at Home as Reported by Children Across Phases (N=11)

Method	Example	Total Number of Responses for Each Phase		
		I	II	III
Family routines	"When my dad Aldopho comes home [from work] . . . I go to sleep."	23	35	49
Television programming	"After I watch TV, I go to bed to go to sleep."	17	12	27
	"My favorite show comes on tonight . . . at 6:00."			
Parenting practices	"When you're a kid, you have to wait till the grown-up says it's time to come in [the bathtub]."	2	2	15

ming for marking time in homes that acquired their first televisions during the study. Some children began associating television schedules with specific days and times of days. When Phillip was asked to describe his favorite time of day in the last interview, he unequivocally said, "It's four and I don't ever want to miss my favorite shows." Interestingly, the number of references to television schedules as timekeeping devices was lowest during the school year and more than double this number after kindergarten.

Parenting constraints influenced home timekeeping constructs. Adam's mother, for instance, used a timer to regulate his time to play Nintendo before entering kindergarten. Adam was acutely aware of when his 30 minutes a day were scheduled. During the school year, Adam's Nintendo time occurred on Friday afternoons, which he mentioned more than once. These dynamics provide a vivid illustration of the co-constructive process. Adam's ideas about the 30 minutes as an interval of time and Friday as the last school day during the week were mediated by his mother's rules for playing Nintendo. Likewise, the reason the time constraints were established was because of Adam's unrelenting interest in playing Nintendo, which his mother felt was inappropriate.

The third method of environment timekeeping originated from community events, including references to bus schedules, hours of operation for local businesses, and annual celebrations. Rhythmic events within the community were especially important to the children in Pich, where homes are not "hermetically" sealed and the sounds of outdoor activities flow in and out without restraint. One of the first community timekeepers observed in Pich was the buses traveling down the main street, honking their horns to announce the beginning of the day at 5 o'clock each morning. The bus schedule was used for daily timekeeping by everyone in Pich, acting as a calibration device for knowing when to awake, leave for school or work, have the midday meal, or watch a favorite television program. Annual celebrations to commemorate national holidays, religious holidays, or local school festivities were reported by families in all four sites as time markers. Holidays reported by the children and mothers in the state of Campeche included the Three Kings celebration, Mother's Day, Day of the Dead, Easter, Children's Day, and Independence Day. Similarly, in North Carolina, holidays such as Christmas, New Year's Day, Halloween, Mother's Day, Father's Day, Easter, and Fourth of July were reported. These holidays as important cultural time markers were reinforced at school as well.

At school, environmental cues, such as classroom rituals and routines, teacher directions, and group observations, emerged

Table 4
Methods for Marking Temporal Intervals at School Reported by Children in Phase II (N=11)

Method	Example	Total Number of Responses
Teacher directions	[Knows time to wash hands] "Because the teacher says to go to the room." [Knows time to line up] "Because the teacher does this" (demonstrates raising hand).	28
Classroom routines	"Went to nap because I finished centers." "I do my journal when I get to the classroom."	14
Group observations	[Knows time to leave playground] "Because we know when we see the big kids coming. All of us know."	8

as elements shaping the children's new constructs, In addition to providing descriptions of a typical day at school, the children answered such questions as, "How do you know it's time to go to recess?" or "How do you know it's time for breakfast?" Based on these responses, three methods for marking temporal intervals at school were reported, as depicted in Table 4. Within school activities, patterns emerged and were noted by the children. For example, there were letters of the day, letters of the week, and themes that were implemented sequentially; the children also noticed patterns of group behaviors, such as getting in line to go somewhere or seeing another class enter the playground and knowing it was time to leave.

Conventional Timekeepers

Conventional timekeepers reported in the study included clocks, watches, and calendars. The power of conventional timekeepers should not be underestimated. In more than one study, developmental psychologists have found that the behavior of children as young as age 3 can be controlled through the use of an external clock (Pouthas, 1992). A shift toward conventional timekeeping penetrated every aspect of the children's temporal identity development. Both parents and teachers sent a clear message to the children that learning conventional timekeeping was essential to school participation.

The children's understandings about clocks and watches and their relationship to time fell into four distinct categories: 1) identifying and defining the function of clocks and watches; 2) understanding the mechanics of clocks and watches (e,g., use of large and small hands on face clocks); 3) associating numbers on clocks and watches with telling time; and 4) associating clocks and watches, and ultimately specific times, with specific events.

The children were asked to identify and define the function of at least one watch and/or clock during each phase of the study. If both items were available, the children were asked to identify and define each one separately. When the interviewer pointed to a clock or watch and asked, "What is this?," all 11 children correctly identified the object during the first interview and each subsequent interview. Seven children (across all four sites) described the hands on a face clock or watch as a method for telling time. Four children specifically referred to digital clocks separately from face clocks. In these cases, the children's conceptual understanding of what the mechanics of the timekeepers meant varied, and no one appeared to fully understand the nuances between how clocks and watches function and timekeeping. Several parents reported that their children could read digital clocks better than face clocks. Teachers varied in their incorporation of clocks and watches in the daily curriculum. Some teachers provided direct instruction on telling time using both clocks with hands and digital clocks. Other teachers (in both countries) believed that teaching children the function of clocks and watches was not their responsibility or that the children were not developmentally ready for learning clock time.

Most of the children's associations between numbers on clocks or watches and telling time were reported in hours (e.g., eight o'clock), and occasionally half hours. Interestingly, while only five children mentioned clock

time during the first interview, by the last interview each child used clock time as a reference in at least one of their answers. However, the times reported by the children were often inaccurate.

The children's calendar constructs were categorized as: 1) identifying and defining the function of calendars, 2) days of the week, and 3) months of the year. Many children had only limited experience with calendars, unlike with clocks and watches, before entering kindergarten. Two children did not have calendars in their homes, and the mother of a third child reported having a calendar, but it was not visible or used. Therefore, these three children were not asked to identify and define the function of calendars. Of the eight remaining children, six described the function of a calendar (e.g., "To see the days when you forget what the days are"), and two were unable to do so throughout the study. Although most children were able to recite the names of the days of the week by the end of the study, these labels were meaningless unless they connected them with personal experiences. Others did not make a direct association between calendars and days of the week, but rather referred to the days of the week as independent entities. The days of the week were taught in all of the kindergartens, although the amount of emphasis varied. For example, Elisa, who attended the Pich kindergarten, reported that, "The teacher asks us what day it is and we tell her if it's Monday, Tuesday, Wednesday, or Friday," While the days of the week were not displayed in Elisa's classroom, the teacher was observed teaching the children a days-of-the-week song and writing the date on the board as part of the daily group time. By contrast, in three of the four North Carolina classrooms, children were drilled on a series of sequential calendrical concepts each day through the use of elaborate displays of the calendar, lists of the names of the days of the weeks and months, and adverbials, such as "yesterday," "today," and "tomorrow."

Months of the year usually were expressed in reference to a specific event, such as birthdays or holidays. Only two children defined the term "month" as a conceptual part of the calendrical system. By the second interview, some children were beginning to link the names of the month being taught in school with events. For example, Olivia reported that sometimes the calendar "Goes to last month." When asked what happens in the last month, Olivia responded, "Christmas," Then she added that the "calendar goes over and over again," In addition, several children referred to the term "date" during the last two interviews, seemingly as a result of their school experiences. Each of the kindergarten classrooms observed during the study had a daily ritual to recognize the date, although some classrooms did this more consistently than others.

DISCUSSION

To date, only limited research in early childhood education has concerned young children's ideas about timekeepers and the temporal transitions they experience when entering school. Little attention has been given to the temporal knowledge they bring with them from their homes and communities or how this knowledge affects their learning at school. The results of this study indicate that the interplay between an individual's physical and psychological self and his or her sociocultural milieu (e.g., public school kindergarten) can expand or constrain the development of such temporal concepts as timekeeping.

The push and pull of the dialogic process that occurred between the children and the natural, home, community, and classroom environments manifested itself through identifiable changes in the children's understandings and uses of timekeepers after entering kindergarten. Previously held constructs were mediated by new experiences related to going to school, For example, old environmental rhythms, such as being awakened by the sun, took on new meanings. Seeing the light of day now meant it was time to get ready for school. Accessibility of specific types of rhythmic patterns was a deciding factor in terms of the types of environmental timekeepers developed by the children. For instance, all children had access to solar rhythms, but family routines for meals were not al- ways rhythmic and therefore inaccessible to some children as time markers.

Schools, by their very nature, foster the development of institutional time constructs, which are linked to family, community, national, and even global practices (Ezzeii, 2002). Timekeeping constructs such as clock time, calendar concepts, and national holidays reflected societal priori- ties, and will ultimately contribute to the children's ideas of citizenship. Research examining the politics of school culture related to time and what

educators teach children related to time and politics could be conducted, For example, how are daily, weekly, or yearly rituals of famous people and national events indoctrinating children's values about time? How does the distribution of time in educational settings reflect the values of a particular group or ideological beliefs? While adapting biological rhythms to school schedules was a viable change in the sense of successful participation in an institutional setting, it may not be viable in terms of quality of life. Additional research could investigate how superimposed schedules constrain young children's biological processes and whether these disruptions affect learning. Are there "critical periods" of temporal identity formation during the first five years of life? If so, what are the most formative periods?

The availability and degree of emphasis on clocks or watches as daily timekeepers and calendars as timekeepers of larger amounts of time by adults in the home, community, and classroom settings differed, Additionally, the methods used to teach the children about conventional timekeepers varied. In a few homes, the children were being shown how clocks worked in relation to numbers and hands on face clocks or numerical sequences on digital clocks. Similarly, some children were taken to a calendar and shown a special date, such as their birthday, which the parent circled. Other parents reported simply pointing to the clock and telling the children the time or not really talking with the children about clocks or calendars. Further investigation concerning the impact of these factors on children's ability to learn conventional timekeeping could help inform educators about differences in school participation.

Differences in telling time with digital rather than analog devices raised interesting questions about changes in children's understanding of conventional timekeeping. For example, children only need to recognize numbers to read a digital clock. Some children in this study recited numbers and dots (e.g., "5 dot, dot 10" for 5:10) on the digital clock but were unaware of the meaning of the numbers in relation to time. Comparison of children's use of different time measurement instruments is beyond the scope of this study, but further research to determine how digital clocks affect the process of children's development of time concepts could extend understanding of children's temporal knowledge.

Many critical ideas about timekeeping in relation to institutional participation are formed during the kindergarten year. Environmental cues and activities not ordinarily considered timekeepers proved to be more temporally significant than anticipated across the case studies, and formal school instruction on timekeeping was frequently unrelated to home and community practices. For example, children reported solar cycles, bus schedules, animal sounds, television schedules, and other rhythmic environmental cues as ways to mark time throughout the study. However, these timekeeping practices were not recognized or connected to their school experiences. In the formulation of education policies and practices, it cannot be assumed that conventional temporal indicators are the sole substance of what constitutes children's temporal identities. Yet, children must learn institutional "time economies" (Schieffelin, 2003) to be prepared to participate in local, national, and global activities. Further research needs to be conducted to understand the relationships between school and home timekeeping practices and their effects on young children.

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FOOTNOTES

1. The five areas of temporal identity development examined in the overall study were: 1) temporal structures, or awareness of time-related rhythmic events; 2) timekeepers, or methods used to mark and measure time; 3) emotional bonds, or emotional responses and affiliations to time; 4) temporal language, or expressions showing awareness that time is related to objects, activities, people; and 5) nonrhythmic cues, or contextual factors affecting temporal identity development (Hardin, 2001).
2. In his writings about paradigm shifts in the scientific community, Kuhn (1977) argues that an essential tension, the dynamic between two opposing forces, is necessary for change to occur and new paradigms to be established.
3. Three experiments were conducted in each of the 31 countries measuring pace of life: "(1) walking speed—the speed with which pedestrians in downtown areas walk a distance of 60 feet; (2) work speed—how quickly postal clerks complete a standard request to purchase a stamp; and (3) the accuracy of public clocks" (Levine, 1997, pp. 130-131).

4. Throughout the article, the term "Campeche" refers to the city. The state of Campeche will be identified as such.
5. One Chatham County child was in child care from age five months to about age 18 months. The two children in Orange County attended a one-month program sponsored by Orange County Public Schools called "Kindergarten Academy" during the summer prior to starting school.
6. A set of prepared questions (see examples in Appendix) was used during the semi-structured interviews to stimulate purposeful responses related to time concepts. The interviewer asked each prepared question, which was answered by the participant. Additional follow-up questions or related topics were discussed as deemed appropriate by the interviewer. Each group of participants (children, mothers, teachers, administrators) was asked the same questions.

Appendix

Examples of Semi-Structured Interview Questions

Child	Mother	Teacher	Administrator
1. Here's (doll's name). What does she do when she gets up in the morning? Do you do that? What do you do? Continue daily sequence.	1. Tell me about a typical day at home.	1. Please describe a typical day in your classroom. Do you have a written daily schedule? Is it posted in the classroom?	1. From your perspective, what role does time play in (local, state, or national) schooling in general and kindergarten in particular?
2. Look for time-related objects in the home or school and ask, "What it this? What does it do?"	2. What is your opinion about (clocks) and how they are used in your home? (Only use time-related objects visible in each setting.)	2. Can you think of ways the classroom environment contributes to the development of time concepts?	2. How do federal/ state/system-wide policies affect time-related components in the educational system?
3. (Using prop) (Dog's name) is sleepy. Is it time for her/him to go to bed? How do you know? Repeat with repetitive activities such as mealtimes, play times, work times.	3. How do you let (child's name) know when it's time to go to bed? Eat? Play? Work?	3. Do you have instructional materials that directly relate to learning time concepts (e.g., books, games, toy clocks)?	3. What is the relationship between instructional practices in kindergarten and time (e.g., ability grouping, lecture, learning centers?)
4. How old are you? How old were you last year? How old will you be next year?	4. Does (child's name) talk about time in relation to certain objects? Activities? People?	4. Please describe examples of peer interactions in the classroom that may contribute to the development of time concepts.	4. Briefly describe state/ federal standards and their impact on curriculum in relation to time.