

SUBSISTENCE ECOLOGY AND PLAY AMONG THE OKAVANGO DELTA PEOPLES OF BOTSWANA

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Children's play is widely believed by educators and social scientists to have a training function that contributes to psychosocial development as well as the acquisition of skills related to adult competency in task performance. In this paper we examine these assumptions from the perspective of life-history theory using behavioral observation and household economic data collected among children in a community in the Okavango Delta of Botswana where people engage in mixed subsistence regimes of dry farming, foraging, and herding.

We hypothesize that if play contributes to adult competency then time allocation to play will decrease as children approach adult levels of competence. This hypothesis generates the following predictions: (1) time allocated to play activities that develop specific productive skills should decline in relation to the proportion of adult competency achieved; (2) children will spend more time in forms of play that are related to skill development in tasks specific to the subsistence ecology in which that child participates or expects to participate; and (3) children will spend more time in forms of play that are related to skill development in tasks clearly related to the gender-specific productive role in the subsistence ecology in which that child participates or expects to participate.

We contrast these expectations with the alternative hypothesis that if play is not preparatory for adult competence then time allocated to each play activity should diminish at the same rate. This latter hypothesis generates the following two predictions: (1) time allocation to play should be

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unaffected by subsistence regime and (2) patterns of time allocation to play should track patterns of growth and energy balance.

Results from multiple regression analysis support earlier research in this community showing that trade-offs between immediate productivity and future returns were a primary determinant of children's activity patterns. Children whose labor was in greater demand spent significantly less time playing. In addition, controlling for age and gender, children spent significantly more time in play activities related to tasks specific to their household subsistence economy. These results are consistent with the assertion that play is an important factor in the development of adult competency and highlight the important contributions of an evolutionary ecological perspective in understanding children's developmental trajectories.

KEY WORDS: **Botswana; Children's play; Human evolutionary ecology; Life-history theory; Time allocation**

Play, especially with playmates, is the most important experience of young children. In play they learn, and they develop physically, mentally, emotionally, and socially. . . . Growth is a continuous process from conception through maturity, but each child has his own rate of development. There is an orderly sequence to growth which cannot be changed by training or environment. One stage of growth is the basis for the succeeding one and full development at each stage is necessary. Within general laws, each child has his own needs, abilities and individual responses.

—Statement of educational philosophy from the newsletter of a southern California nursery school

Play is the child's work.

—Maria Montessori

Children's play is widely believed by educators and social scientists to have a training function that contributes to psychosocial development as well as the acquisition of skills related to adult competency in task performance. In this paper we examine these assumptions from the perspective of life-history theory using behavioral observation and household economic data collected among children in a community in the Okavango Delta of Botswana where people engage in mixed subsistence regimes of dry farming, foraging, and herding. Within the evolutionary literature on play, some researchers argue that play incurs little cost and has little measurable benefit (Martin and Caro 1985; see Barber 1991 and Power 2000 for reviews). We refer to this as the "neutralist" perspective. Other play researchers, whom we call "functionalists" (Bekoff and Byers 1998; Bjorklund and Pellegrini 2002; Fagen 1981; Pellegrini and Bjorklund, 2004;

Smith 1982) have focused on the adaptive and preparatory nature of play, arguing that differing forms of play entail large costs in terms of energy expenditure and risk, with payoff coming in the form of developmental benefits. We contribute to this debate by asserting that the construction of a dichotomy between play and work obscures the effect of trade-offs and opportunity costs in determining children's time allocation across all available activities (see Johnson and Bock (this issue) for an analogous argument regarding time allocation in juvenile nonhuman primates). Throughout the set of activities available to children, each activity can be analyzed according to the trade-off between immediate productivity and the acquisition of skills for future productivity (Bock 2002a, 2002b).

Within current discourse on human life-history evolution, and especially the evolution of the juvenile period, there has been a diversity of opinions that is in some ways analogous to the positions of the play neutralists and functionalists (for reviews see Bock and Sellen 2002; Leigh 2001). The adult mortality model proposed by Charnov (1993; Charnov and Berrigan 1993) and extended to humans by Hawkes, Blurton Jones, and others (Bird and Bliege Bird 2002; Bliege Bird and Bird 2002; Blurton Jones and Marlowe 2002; Blurton Jones et al. 1999; Hawkes et al. 1998) directs attention to low adult mortality as the primary selective force in the evolution of extended juvenility in humans. Proponents of this model have focused on body size rather than cognitive abilities as constraining the task performance of children relative to adults. According to this model, cognitive abilities acquired through experiences such as social learning are beneficial, but those benefits were not sufficient selection pressure to extend the human juvenile period. Blurton Jones and Marlowe (2002) have used this model to argue that many skills used by modern human foragers are acquired through relatively short bouts of social learning rather than through continuous learning lasting throughout childhood.

Two other models of the evolution of childhood place a great deal of emphasis on the acquisition of skills through social learning as a selective force. The brain growth model (Bogin 1999) and the embodied capital model (Kaplan 1996; Kaplan and Bock 2001a; Kaplan et al. 1995, 2000) both assert that the human niche requires vast amounts of experientially acquired skills to achieve social and ecological competence. According to these models, the extensive time required to acquire these skills and program the brain accordingly has great benefits that outweigh the costs of growing more slowly, and therefore selection favored extending the juvenile period. The embodied capital model differs from the brain growth model by proposing that the costs of extended juvenility resulted in selection for a complex pattern of intergenerational exchange and lateral food sharing, extensive male parental investment, and extended life span. In addition, the embodied capital model separates the effects of body mass from other factors influencing productivity.

The punctuated development model (Bock 2002a, 2004; Bock and Johnson 2002b) builds on the embodied capital model by distinguishing growth-based and experience-based forms of embodied capital. Growth-based forms of embodied capital are attributes like body size, strength, balance, and general coordination. Experience-based forms of embodied capital are attributes such as cognitive function, memory function, task-specific skills, learned knowledge, endurance, and specific coordination. Growth-based forms tend to be more related to general competency, while experience-based forms tend to be more related to specific competency. The ability to perform any task comprises a suite of both growth-based and experience-based embodied capital. The mix of growth-based and experience-based embodied capital required will depend on task complexity and the physical demands, and those in turn are dependent on subsistence ecology.

The punctuated development model predicts that interaction between growth-based and experience-based embodied capital was the primary selective force on the evolution of childhood. From this perspective, the pattern of growth and development emerged from the growth-based embodied capital constraining the payoff to investment in learning during human evolutionary history. While this perspective recognizes that many tasks require large amounts of experience-based knowledge or cognitive development, they need not be acquired in a contiguous time period. Rather, according to the punctuated development model the timing of acquisition of experience-based embodied capital should be predicted by the potential payoff to that acquisition given an individual's complement of growth-based embodied capital at that specific point in time. We would expect an individual to allocate resources to acquiring growth-based embodied capital when there are experience-based skills that can be applied using that growth, and we would expect an individual to allocate resources to experience-based embodied capital when there is sufficient growth-based embodied capital to apply that experience. In this way, growth- and experience-based embodied capital have interacted to produce the pattern of growth and development, including the sensitive periods. According to the punctuated development model, in some subsistence ecologies adult competency could take all of childhood to achieve, but this is because competency in a given task might require alternating investment in growth or learning over a period of time, competency in many tasks might be acquired simultaneously, and adult competency in performance of complex tasks might require the sequential acquisition of a large number of skills.

The punctuated development model can be used to frame the effects of paternal investment of time and resources on child competency in terms of the different forms of embodied capital outlined above. In different subsis-

tence ecologies and across different tasks, the amount of investment in growth that would bring a return in learning will vary (Bock 2002a; Bock and Johnson 2002b). The degree to which growth constrains learning will vary as a function not only of subsistence ecology but also of the economics of production and may be strongly influenced by the value of labor and the opportunity cost to alternative activities. In foraging economies as in all others, the variety of tasks performed can be expected to reflect a number of different levels of growth constraints on payoffs to learning. Investment of parental resources and time can be used to build growth-based embodied capital or it can be used to develop experience-based embodied capital. The optimal solution to the trade-off between investment in growth- and experience-based embodied capital is expected to be dependent on the societal-based gender- and age-patterning of production, on the specific labor needs of the household, and on the reproductive interests of parents.

From the perspective of children's play, these life-history models result in different general hypotheses concerning the effect of play on the production of adult competency. The adult mortality model deemphasizes childhood as a period that was selected for experiential learning. An implication of this model is that the experiential learning component of play should have relatively little effect on the development of adult competence, thereby contradicting the conventional wisdom of educators. The brain growth and embodied capital models, on the other hand, in many ways parallel the conventional wisdom and predict that the experiential learning components of play should be strongly related to adult competence. The punctuated development model agrees with this prediction, but also asserts that the time spent playing should be subject to trade-offs between immediate productivity and future returns. Moreover, the punctuated development model emphasizes that adult competence is specific to a subsistence regime, and that parental influences on children's time allocation to play should mirror the parents' interests in maximizing returns on children's time allocation in general (Bock 2002a).

While there has recently been substantial interest in evolutionary child development among evolutionary psychologists (see Bjorklund and Pellegrini 2002), behavioral ecological studies employing life-history theory have the potential to provide a two-way illumination of both our evolutionary past and the way that our adaptations to past environments affect children's interactions with their present environment.

HYPOTHESES AND PREDICTIONS

Although our focus is on the costs and benefits of individual activities, we begin with a general prediction regarding the age-specific frequency of

nonproductive activities we have categorized as play. From the perspective of the parents, the mix of productive and nonproductive activities should be such that the point where the marginal increase from one more unit of time spent in productive activities would be less than the long-term payoff to the parent of spending that unit of time in some activity related to the development of general or specific skills and strength. This leads to the prediction that, in terms of overall time allocation, work and play should be negatively related throughout childhood. The trade-off between productive and nonproductive activities varies in accordance with age, sex, the labor needs of the household, and present versus future returns.

For a specific activity, play related to that activity should be negatively related to the return rate to that activity, which in turn is positively related to the time allocation to that activity (Bock 2002a). Therefore, if we were able to isolate play activities which are directly related to the acquisition of skills used in the performance of an activity, we should see an inverse relationship between the amount of time spent in the play activity and the time spent in performance of the activity. Since we hypothesize these relationships are due to age-related changes in development, we can further predict that they are a function of age. This leads to the hypothesis that if play contributes to adult competency then time allocation to play will decrease as children approach adult levels of competence. This hypothesis generates the following predictions:

1. Time allocated to play activities that develop specific productive skills should decline in relation to the proportion of adult competency achieved;
2. Children will spend more time in forms of play that are related to skill development in tasks specific to the subsistence ecology in which that child participates or expects to participate; and
3. Children will spend more time in forms of play that are related to skill development in tasks clearly related to the gender-specific productive role in the subsistence ecology in which that child participates or expects to participate.

We contrast these expectations with the alternative hypothesis that if play is a characteristic of the juvenile period that is not preparatory for adult competence then time allocated to each play activity should diminish at the same rate. This latter hypothesis generates the following two predictions:

1. Time allocation to play should be unaffected by subsistence regime; and
2. Patterns of time allocation to play should track patterns of growth and energy balance.

THE STUDY COMMUNITY

These hypotheses are tested using data collected in a multi-ethnic community of approximately 400 people in the Okavango Delta of northwestern Botswana (for detailed description of the study community see Bock 1995, 1998; Bock and Johnson 2002a, 2002b). Five ethnic groups are represented: Bugakhwe, ||Anikhwe, Hambukushu, Dixeriku, and Wayeyi. ||Anikhwe and Bugakhwe people are San speakers who inhabit the Okavango drainage in Namibia and Botswana. Hambukushu, Dixeriku, and Wayeyi people are Bantus who inhabit the Okavango River drainage from Angola through the Caprivi Strip of Namibia into northern Botswana. Historically, they have participated in mixed economies of farming, foraging (fishing, hunting, and the collection of wild plant foods), and pastoralism.

Among the San-speaking people in the community, the ||Anikhwe have historically had a riverine orientation in their foraging, while Bugakhwe have been savanna foragers. The ||Anikhwe living in the study community practice a mixed economy but farm at a much less intensive level than the Bantus. All ||Anikhwe families acquire the bulk of their resources from foraged foods. Moreover, among 50 ||Anikhwe there are only four head of cattle, whereas a typical Bantu homestead of 20 people has an average of 12 head. Bugakhwe in this community are largely oriented towards fishing, hunting, and the collection of wild plant foods. None own cattle, and a few have small gardens where they grow tobacco and specialty foods such as vegetables.

People from all of the ethnic groups live in extended family homesteads based on patrilineal organization. Among the Bantus polygyny is common, with 45% of the men over 35 participating in polygynous relationships at any one time. Polygyny is rare among the San speakers. Marriage and reproductive unions, however, are fluid among all the ethnic groups. Multipartnered sexuality is commonplace, and disputes over paternity and child support are common in the tribal court. For all ethnic groups the norm is for men to marry and become fathers in their thirties.

At the time of the study, there was very little cash economy in the study community. Most men of all ethnic groups over the age of 35 had worked in migratory labor, usually in the mines of South Africa, for an average of five years. Many of the ||Anikhwe and Bugakhwe men over the age of 25 had been soldiers in the South African Defence Force during the bush wars of the 1970s and 1980s. Few women, however, had ventured beyond the next community 30 km away. There was no school, clinic, or borehole, with water being drawn from a river source.

The nearest primary school was in the next community, and children attending that school needed to board while attending school. Although there are no school fees in Botswana, the cost of boarding, uniforms, and books, as well as the lost labor, made school costly to parents. At any one

time, approximately 25% of the children in the community attended primary or secondary school. Those attending secondary school boarded at communities at least 100 km away. Owing to the lack of vehicles and roads, children attending school returned home only sporadically.

Historically, the Bantus represented in this community have all had some degree of matrilineality with a tradition of the avunculate in their social organization (Larson 1970). In particular, this implies that in earlier times a boy's strongest male influence would not be from his father but from his mother's eldest brother. Both \parallel Anikhwe and Bugakhwe were strongly influenced by Bantus over at least the past hundred years and also have some degree of matrilineality and the avunculate. The situation is not clear-cut, however, since all ethnic groups in the study community have been under strong political and social influence of Tswana-speaking tribes for at least two hundred years. The Tswana have a strong tradition of patrilineality, and their social organization and customs regarding marriage, the family, and childrearing have been codified as Botswana's Customary Law. All disputes are settled using this legal code regardless of the ethnic origin of the litigants, and this has had a profound impact on the maintenance of social organization and tradition by non-Tswana groups.

Work in this community began in 1992 as part of a dissertation project focusing on the determinants of children's activities. An additional field session in this community covered most of 1994, and there have been frequent subsequent visits with the latest occurring in 2001. A second community composed mostly of \parallel Anikhwe and Wayeyi families that was far more market incorporated was included in the study beginning in 1996, with two years of data collection ending in 1997. Again, there have been frequent subsequent visits to this community. Future research in these and other communities will focus on the effects of the HIV/AIDS epidemic on the family and child development in Botswana, which has one of the highest HIV prevalence rates in the world (approximately 36% of adults).

METHODS

Data Collection

The time allocation dataset used in this chapter consist of instantaneous scan data in combination with data from focal follows of children. The instantaneous scan samples were collected over the course of 11 months in 1992. Extended family homesteads were sampled on a rotating basis repeatedly over three 4-hour periods, 0600–1000, 1000–1400, and 1400–1800, which roughly correspond to the daylight hours. On an hourly time point, the activity, location, and interactants of all residents of the homestead

were noted. For residents who were not present, other residents were asked for that person's activity and location, and this information was verified with the focal subject either on his or her return or later. Focal follows of individuals away from homesteads were conducted so that each of the major activities in which children engage (as determined by the household samples) were represented adequately. These follows were designed to determine the amount of time people spend in activities when they were away from homesteads, intensity of activity, and return rates for activities. During follows the beginning and ending times of all activities, instantaneous records of behavior every ten minutes, and the identity of co-participants were recorded. In addition, food acquired was weighed, and all food consumed was recorded in terms of species, acquirer, field or herd of origin and immediate giver. These data consist of repeated follows on 40 boys and 35 girls from 3 to 18 years old. A total of 1,435 observations at 10-minute intervals were made between April and October 1992, for an average of about three hours per individual. There was no significant difference in the average for boys or girls. This compares with an average of 35 hours of instantaneous scans for each individual ($n = 4,184$ total observations; $n = 2,137$ observations on boys; $n = 1,947$ observations on girls). These datasets were concatenated, and the observations from the instantaneous scans were then weighted to reflect the difference in time scale of the observations.

Data Analysis

No a priori definition of possible play types existed before the initial data collection. As the data collection proceeded, a list was created from observed events and continually expanded. The activities coded as various forms of play during data collection were recoded into broader categories. The categories chosen correspond to those used in play research by psychologists: object play, fantasy play, and rough-and-tumble play (Cohen 1987). In addition, play was further subcoded into the readily identifiable subcategories. These were play pounding, ball games, and two games in which we observed children playing with some frequency, called the "aim game" and the "cow game." Play pounding is a very common activity for girls and is a fantasy imitation of the pounding phase of grain processing (see Bock 1998, 2002a, 2002b for detailed description). Although occasionally played with a real mortar, it is usually played in the dirt with an imaginary mortar and a reed or stick for the pestle. The "aim game" is played by boys, wherein one boy picks a spot on the ground and throws a stick at it. Other boys follow suit. The "cow game" is a fantasy, role-playing game involving cattle. Some children pretend to be oxen and are "yoked" to a "sledge" by other children. Usually the yoke involves

leftover twine, which is easy to find lying around the yard. The sledge can either be a toy sledge, which is often made for the children by their fathers, or some other object imagined to be a sledge. The sledge is loaded with dirt or other materials, often imagined to be something else, and transported by the "oxen." One child acts as the driver or handler. The "oxen" will occasionally bolt or lose the load or rear up in imitation of real oxen. The driver must then use the appropriate techniques to calm down the oxen and once again get his or her load underway. The data represent observations of activities that are distinctive and readily identifiable.

The proportions of the total observations of play for each type of play were calculated for each individual. These were then converted to mean minutes per day spent in that activity as the proportion of time spent in the specific play activity \times (the proportion of total time spent in play \times 720 minutes/day). Regression analysis was conducted using SPSS version 10.

RESULTS

Figure 1 shows the age-specific time allocation to all types of play for boys. There is a significant declining trend. Each point represents the mean daily time allocation to all types of play for each boy. A first-order OLS regression shows that there is a significant negative trend across ages ($n = 40$, $p < .0001$, $r^2 = .366$).

Figure 2 shows the same relationship for girls ($n = 35$, $p < .0001$, $r^2 = .409$). The overall decline through time is consistent with the prediction that there should be an inverse relationship between time allocated to productive and nonproductive activities throughout the developmental process.

Besides age, however, we predict that features of the social and subsistence ecologies will interact to affect the economic value of children's immediate productivity versus future returns. In subsistence ecologies where children's immediate productivity has greater benefits than the opportunity cost to acquiring skills, we expect that children will spend less time overall in play. This leads us to expect that a household's participation in agriculture will decrease the amount of time spent in play, since there is substantial evidence in this (Bock 2002b) and other traditional communities (Blurton Jones et al. 1989; Bulatao and Arnold 1977; Cain 1977; Caldwell 1982; Lee and Kramer 2002; see Kaplan and Bock 2001b for a review) that children are more able to contribute to the household economy in farming subsistence ecologies than in foraging or herding. Furthermore, we predict that female children will play less since in this community there are more labor activities available to female children (Bock 2002a, 2002b). We also predict that children attending school will be less likely to be observed in play since they are spending more time in directed learning

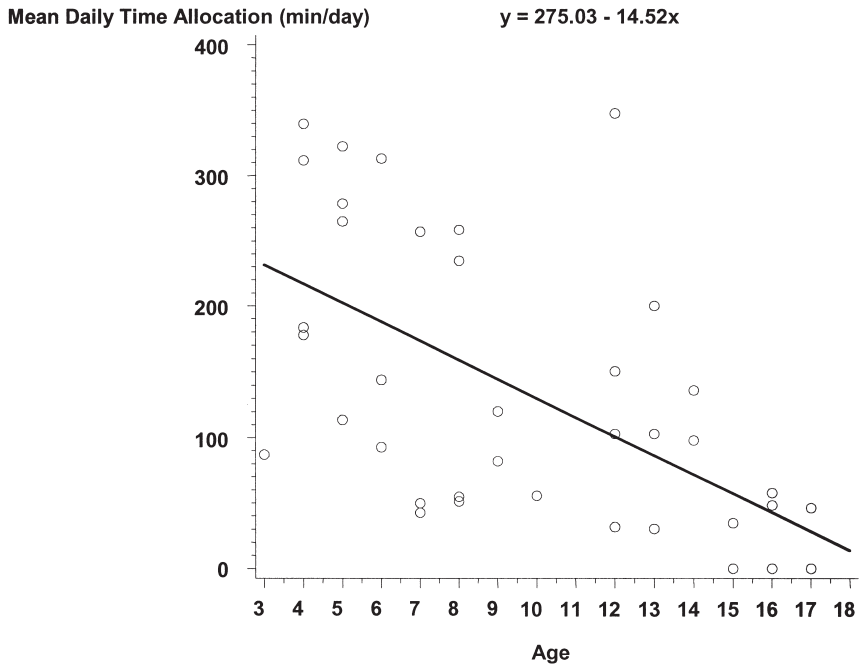


Figure 1. Age-specific time allocation to all types of play: Boys

through didactic pedagogy. We expect that children will be observed in play less in households where the father is a labor migrant since there are fewer laborers available in the household. Lastly, we predict that children of a junior wife will be less likely to be observed in play owing to potential labor and resource deficits (see Bock and Johnson 2002a).

Results from multiple regression analysis support these predictions (Table 1). Controlling for all other variables in the model, children play significantly less as their household's reliance on agriculture increases. Female children play significantly less, as do children who attend school. Children of men who are migrant labors and children of junior wives also are significantly less frequently observed in play than other children. Together, these results indicate that in situations where the trade-off between immediate productivity and future returns due to skill acquisition favors immediate returns, children play significantly less.

Play pounding is an overwhelmingly girls' activity which was not observed in children older than age 10. Univariate regression shows a significant age effect in children 10 and under ($n = 35$, $p = .0015$, $r^2 = .282$). We would expect that, in addition to the age effect, if play pounding is

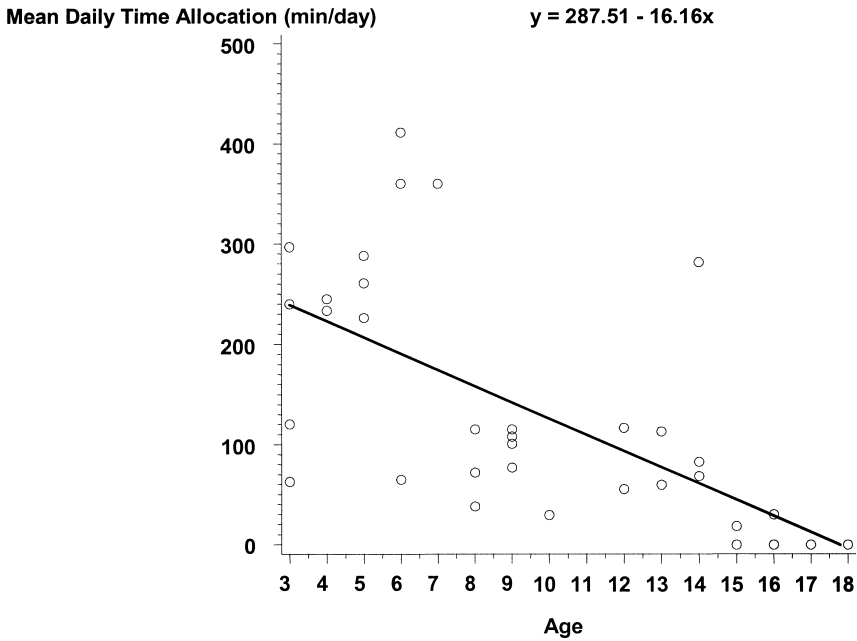


Figure 2. Age-specific time allocation to all types of play: Girls

Table 1. Multiple Regression of Likelihood of Being Observed in Play

Variable	Parameter estimate	Standard error	p-value
Agricultural calories	0.011	0.009	<0.0001
Female gender	-0.022	0.011	0.0318
Age	-0.011	0.001	<0.0001
School attendance	-0.082	0.012	<0.0001
Father absent	-0.058	0.012	<0.0001
Junior wife's child	-0.049	0.012	<0.0001

preparatory for adult competence in pounding it should be observed more in families with greater participation in farming. Multiple regression analysis shows that, controlling for age and gender, as households derived more of their per capita nutrition from millet, children were significantly more likely to be observed play pounding (Table 2).

The “cow game” is primarily a boys’ activity that was not observed after the age of 12. We would expect that, if this game is preparatory for adult competence in herding, then children in households with more per capita cattle would be more likely to be observed playing this game. Controlling

Table 2. Multiple Regression of Likelihood of Being Observed Play Pounding

<i>Variable</i>	<i>Parameter estimate</i>	<i>Standard error</i>	<i>p-value</i>
Millet calories	0.046	0.027	0.0890
Female gender	1.678	0.450	0.0002
Age	-0.067	0.036	0.0641

for age and gender, multiple regression analysis found no significant effects of number of cattle on the likelihood of being observed playing this game (Table 3).

The "aim game" is also primarily a boys' activity and was not observed after the age of 12. We would expect that if this game is preparatory for adult competence in hunting, as households derived more of their per capita nutrition from agriculture, children should be less likely to be observed in this game. Controlling for age and gender, multiple regression analysis supported this prediction, showing that as per capita nutrition derived from agriculture increased, children were significantly less likely to be observed playing the "aim game" (Table 4).

DISCUSSION

The results support earlier studies showing that the trade-offs involved in meeting the labor needs of the household are major influences on the time

Table 3. Multiple Regression of Likelihood of Being Observed in the "Cow Game"

<i>Variable</i>	<i>Parameter estimate</i>	<i>Standard error</i>	<i>p-value</i>
Number of cattle	-0.00002	0.003	ns
Female gender	-0.00021	0.001	ns
Age	-0.00090	0.001	ns

Table 4. Multiple Regression of Likelihood of Being Observed in the "Aim Game"

<i>Variable</i>	<i>Parameter estimate</i>	<i>Standard error</i>	<i>p-value</i>
Agricultural calories	-0.006	0.002	0.0045
Female gender	-0.007	0.002	0.0026
Age	-0.005	0.003	0.0059

allocation profile of children (Bock 2002a, 2002b; Bock and Johnson 2002a). In addition, the results are consistent with the hypothesis that certain forms of play in this community are preparatory for adult competence in a given subsistence ecology. Predictions from the alternative hypothesis (i.e., time allocation to all forms of play activities should diminish at the same rate and should track growth and energy balance rather than subsistence ecology) were not supported. In the present study, it was shown that time allocated to play pounding diminished to zero by age 8 while time allocated to the "aim game" diminished to zero by age 12. We argue that this reflects differences in the rate of acquisition of growth- and experience-based embodied capital for farming and foraging tasks in this community.

Elsewhere, Bock (2002a) has shown that play pounding appears to have a training function in developing grain processing skills. As the time allocated to play pounding decreases, the time allocated to grain processing increases proportionately. In addition, the return rate on grain processing by girls is a significant predictor of the decreased time in play pounding and the increased time in grain processing. Because return rates for grain processing were amenable to experimental derivation, it was possible to measure the trade-offs between immediate productivity and future returns as they related to the development of age-specific ability. We found measuring these trade-offs in real time to be more challenging in foraging and herding tasks. In particular, it is difficult to measure the putative benefits of the "cow game" in terms of competence in herding and handling cattle. An important factor is the complexity of tasks related to herding. Grain processing consists of few, very well defined tasks. A successful herder needs not only tangible skills such as moving cattle from place to place, protecting them from predators, ensuring adequate water, and properly milking, but also even more difficult to measure skills such as herd management in terms of both number and quality. The lack of significant results highlights the need for more clearly defined connections between training functions of precursor activities and herding skills.

The training function of the "aim game" relative to successful hunting and fishing seems to be intuitively clearer. Still, the fact that children are more likely to practice projectile delivery when they are more likely to employ that skill in later in life does not show that this activity produces more competence in hitting a target. Blurton Jones and Marlowe (2002) demonstrate among Hadza people that large amounts of time in practice do not translate to more competence in bow and arrow shooting. Although we have not yet examined this relationship in the study community, we believe that there may be additional training functions of the "aim game" beyond projectile delivery. In a seminal paper, Smith (1982) argued that different types of play have a training function when learning by doing, or direct practice, is costly in terms of danger or other currencies. We believe

that all three forms of play discussed here in relation to specific task performance in a given subsistence ecology (i.e., play pounding, the “cow game,” and the “aim game”) fit this criterion.

In addition to the development of grain processing ability, play pounding may be favored owing to the costs of allowing young children with low levels of skill to practice with grain. In the extremely arid environment of the study community, and employing only dry farming with traditional technology, yield of grain crops is less than 200 kg/hectare. The hourly return on agricultural labor is therefore extremely low. In addition, in our experience it is extremely rare for even households with heavy reliance on farming to produce enough grain to meet their needs, and people supplement their diets with fishing and foraging. We believe that this influences people to assign a high cost to giving grain to an incompetent grain processor. Play pounding uses no resources but produces a valuable skill.

The prevalence of the “cow game” may also be related to the cost of training on live oxen. We believe that the lack of significant results relative to subsistence ecology with regard to the “cow game” may be due to the operationalization of the variable. Herding is commonly done by very small children (Bock 2002b), which leads us to believe that skills involved in moving lone cattle are developed through learning by doing practice. Inspanning oxen, however, is an extremely dangerous task performed by adults. A more appropriate test of the hypotheses might utilize the frequency of household oxen team use as a measure of subsistence ecology relevant to the hypothesized training activity. While the “aim game” is significantly more likely to be played by children from households with less reliance on agriculture, the training function may be less related to the mechanics of projectile delivery and more to the development of cognitive skills relevant to the overall tracking, pursuit, and harvesting of animal prey. Lancy (1996) found in his study of Kpelle children’s play in Liberia that fantasy play developed not only specific skills, but also larger-scale social and behavioral attributes through the enactment of scenarios and exploration of contingent solutions.

While children’s play has been observed and analyzed in a number of traditional societies (see Slaughter and Dombrowski 1989 for a review), few studies have focused on children’s play from a life-history perspective. Few studies have been designed to explore a hypothesized training function in traditional subsistence ecologies, and we know of no other study that has analyzed the functional trade-offs related to children’s activities in multiple subsistence ecologies. The present study is valuable for delineating some of the possible relationships between activities at different points in the life course. By focusing on the trade-off between immediate productivity and skill acquisition for future returns we hope to have avoided being caught in a logical circuit where work and play are

dichotomous, children play, adults work, and therefore children's play leads to adult work.

The diverse responses to subsistence ecologies in terms of children's time allocation profiles also helps focus on the ways in which trade-offs and opportunity costs are integral to understanding the evolution of the human juvenile period. As the human family system became more reliant on intergenerational wealth flows, the trade-off between immediate productivity and skill acquisition favored selection for an extended juvenile period and more time spent in acquiring skills that would have benefits later in life. While this established an overall pattern of children's developmental trajectories, there remains a great deal of plasticity. Clearly, children are highly responsive to the same factors affecting these trade-offs in extant societies.

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