DOES NATAL TERRITORY QUALITY PREDICT HUMAN DISPERSAL CHOICES? A TEST OF EMLEN'S MODEL OF FAMILY FORMATION

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DOES NATAL TERRITORY QUALITY PREDICT HUMAN DISPERSAL CHOICES? A TEST OF EMLEN'S MODEL OF FAMILY FORMATION TITLE OF DISSERTATION

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In most species with parental care, offspring disperse from the natal territory either at sexual maturity or when they are competent to survive independently. In humans and numerous avian species, dispersal from the natal family may not coincide with these developmental markers. This presents an adaptive puzzle, since delaying dispersal typically delays reproduction. Various ecological explanations for delayed dispersal in birds have been proposed and tested. Emlen (1995) suggested parallels between humans and birds with regard to the circumstances that influence family formation and dispersal timing. Work by other authors has applied Emlen's model to humans using proxy measures of "Natal Territory Quality" (NTQ). Using the Panel Study of Income Dynamics, a longitudinal survey of U.S. families, I extract direct measures of NTQ to more rigorously test Emlen's prediction that higher NTQ leads to later dispersal. I use two age-based cohorts (born in 1957 and 1967). Focusing on three dispersal events (residential dispersal, first marriage, and first reproduction), I test whether economic variables describing family of origin (NTQ) and local conditions influence dispersal age. Multiple linear regression analysis is employed to elucidate the relationships between dispersal and NTQ.

The independent variables appear to have different influences on the three dispersal events, suggesting differential salience of the independent variables for each dispersal type. Results also point to discrepancies across the two cohorts. For the older cohort, family income, father's employment status, and local unemployment rate appear to influence the timing of residential dispersal. Age at first reproduction and age at first marriage are both influenced by parents' education and household density; marriage timing is also affected by father's employment status also affecting marriage timing. For the younger cohort, father's employment status and household density affect residential dispersal timing, father's employment status, mother's education, and family income affect reproductive timing, and father's occupational prestige affects marriage timing. Females experience all dispersal events earlier than males. All results above reflect significant regression coefficients. However, according to criteria of acceptance for the models tested, the hypothesis was supported only for reproductive dispersal timing in the 1957 cohort.

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PREFACE

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1. BACKGROUND

In species with parental care, most offspring disperse from the natal territory at sexual maturity or when they are competent to survive independently. However, in a relatively small number of species, dispersal does not coincide with these developmental markers (Brown, 1987; Emlen & Vehrencamp, 1983). Instead, offspring remain on the natal territory, competing for resources and sometimes helping raise other young. One or more ecological factors are undoubtedly involved in delaying dispersal in these species. Much research suggests that, in species that exhibit delayed dispersal, variables that contribute to the quality of the natal territory are an important influence on the timing of dispersal. This dissertation tests the hypothesis that individuals from higher quality natal territories should be more discriminating in their dispersal choices.

1.1. Sociality

Not all animal species engage in social behavior. Therefore, before considering factors that influence an animal's departure from its natal social group, I will briefly discuss theories about why animals would live in groups at all. Sociality is thought to be highly dependent on ecological circumstances. Like all evolved behavioral adaptations, sociality results when its fitness benefits outweigh its costs. Sociality may provide benefits including increased protection from predators, decreased competition for resources, lower resource acquisition costs, and help from kin or others in raising offspring (Alexander, 1974; Bertram, 1978; Griesser & Ekman, 2004; Hamilton, 1964; Pusey & Packer, 1987; Silk, 1987; Trivers, 1974; Wrangham & Rubenstein, 1986). However, many of these benefits have corresponding costs, such as increased competition from conspecifics for mates and other resources and increased conspicuousness to predators. Thus, living with others is most likely when individuals in a group have shared interests (i.e., they receive mutual benefits that outweigh the costs), whether these are economic (resource-based), reproductive, social, or genetic. Those most likely to have overlapping interests are genetic kin, for reasons outlined below.

Inclusive Fitness

Evolutionary theory predicts that helping others at a cost to oneself will be rare, since it decreases the probability that one's own alleles will be represented in the next generation, thus eliminating any alleles that influence such helping behavior. Hamilton's (1964) theory of kin selection goes a long way toward explaining helping between genetic kin: The more closely related two individuals are, the more likely they are to share alleles due to common descent. Inclusive fitness refers to an individual's overall evolutionary fitness, comprising fitness obtained by the individual (through the spread of its genes, via direct descendents, in subsequent generations) and fitness gained through helping others who share those genes (kin-selection). Thus helping kin facilitates the transmission of copies of one's own alleles, via that relative's body, into the next generation. Direct empirical support for this, in terms of measuring actual genetic representation in future generations, is generally hard to come by, especially in organisms (such as humans and other primates) with long life spans, extended maturation, and few offspring. However, due to their shorter life-spans and the relative ease of following lineages over many generations, birds present an ideal set of conditions for investigating kin selection. Increasing availability of technology for harvesting avian DNA permits closer analysis of actual genetic relatedness of breeders, helpers, and recipients; consequently more direct measures of reproductive success are possible. In species where non-dispersing individuals aid in rearing the young ("cooperative breeders"), much research has described cases where non-breeders preferentially help kin (e.g., Emlen & Wrege, 1988; Marzluff & Balda, 1990; Pusey & Packer, 1994; Rabenold, 1990).

In order to explain any situation in which one individual takes the cost of helping another it is important to distinguish among different classes of hypothesized fitness benefits that are expected to outweigh these costs. Brown (1987) outlines the differences between direct and indirect inclusive fitness benefits. In general, direct benefits are those affecting descendent kin, i.e., when the actor's gametes are involved in producing the recipient (e.g., parents' behavior that affects fitness of biological offspring; grandparents' actions toward grandchildren, etc.). Indirect benefits affect non-descendent kin, that is, those who are not a direct product of the actor's gametes (e.g., siblings to siblings). The relevance of this distinction is further clarified below in the section on family dynamics (Section 1.3.).

Given the potential benefits, why is sociality not universal? This may be because in many cases ecological circumstances prevent sufficient benefits to counteract the costs of sociality. For example, we do not expect sociality where solitary foraging has a higher payoff due to patterns of resource distribution (Alexander, 1974; Bearder, 1987; Waser, 1988; Waser & Jones, 1983). Thus, where sociality does occur, we expect it to have been shaped by selection to meet local ecological challenges.

1.2. Dispersal

In animals, "dispersal" is often defined by an individual's departure from its natal territory while "philopatry" refers to the phenomenon of remaining on the natal territory. In his review of evidence for the effects of mating system on dispersal patterns, Greenwood (1980) follows Howard's (1960) definition of dispersal as the movement from the natal location to a location where reproduction occurs or could occur. Greenwood and many other authors differentiate between natal dispersal, which refers to the initial departure from the point of origin, and breeding dispersal, which includes any subsequent transfers to new breeding sites by already-reproductive individuals. Here I am only concerned with natal dispersal, in that I only deal with the initial dispersal events in for the individuals in my sample. I do however consider dispersal from the natal territory separately from breeding.

In species where some individuals remain on the natal territory one sex tends to be more philopatric than the other. In most mammals, including most primates, males are the dispersing sex, while in birds it is usually females who leave. Since philopatry appears to be non-random with regard to sex, there ought to be an explanation for dispersal by one sex versus the other. One explanation for this sex-bias is inbreeding avoidance. Theories about why one sex disperses rather than the other, or rather than both, usually describe potential benefits to the philopatric or dispersing sex. For example, Greenwood (1980) suggests that mating system influences the direction of the sex bias. Male-biased dispersal is associated with polygynous mating systems, while female-biased dispersal tends to be the norm in monogamous species. For example, in territorial polygynous species, where there are resources to defend and male mating success depends on resource defense, males may benefit from philopatry (Greenwood, 1980). This "resource defense polygyny" is a common feature of avian social systems. With few exceptions, primates exhibit female philopatry and male dispersal. In their review of primate dispersal patterns, Pusey and Packer (1987) detail possible explanations for the common patterns as well as the exceptions.

In any case, these theories attest to the possibility that what constitutes natal territory quality (NTQ) could vary by sex, as could the difficulty of finding an acceptable territory elsewhere.

Studies of human dispersal suggest that in humans the patterns of dispersal are more complicated (e.g., Marlowe, 2004), but in two societies described herein, females are more likely to leave the area in which they were born (Clarke & Low, 1992; Low & Clarke, 1991; Towner, 2001). Further, Koenig (1989) argues that females that in the United States are not philopatric. On the other hand, Turke (1988) and Flinn (1989) both describe female helpers in human families.

1.3. The Evolutionary Dynamics of Family Groups

Emlen (1994;1995;1996;1997) defines families as groupings in which offspring continue to interact with their parents after they have reached sexual maturity. Thus, family formation is often characterized by delayed dispersal from the natal territory. Family groups are a relatively rare type of social arrangement (Brown, 1987; Emlen, 1997), a fact that invites investigation of circumstances that favor it when it does occur.

1.3.1. Delayed Dispersal

Many studies show that the evolution of family formation likely rests on the phenomenon of delayed dispersal, while cooperative breeding (Section 1.3.2.) requires a separate explanation beyond those proposed for delayed dispersal. For example, work on enhanced parental investment (in various species, including humans) and embodied capital (in humans) investigates factors that would favor delayed dispersal, regardless of helping by delayers. These models emphasize the effect of parental investment on parental as well as offspring fitness. Animal studies set the stage for human behavioral ecologists to answer the same questions about humans (Blurton Jones & Marlowe, 2002; Borgerhoff Mulder, 2000; Kaplan & Lancaster, 2000; Kaplan et al., 2000; Towner, 2000). In Sections 1.3.3 to 1.3.5. I further disentangle the phenomena of delayed dispersal and cooperative breeding, since these are sometimes confounded in the literature on family formation.

Dispersal is the norm among animals: if parents interact with their offspring post-natally at all, the offspring are usually expelled from the natal territory upon reaching sexual maturity, when the young become reproductive competitors for the parents' territory or resources (Bertram, 1978; Greenwood, 1980; Koenig et al., 1992; Koenig, 1989; Langen, 2000; Pusey & Packer, 1987; for reviews of the evolution of dispersal, see Greenwood & Harvey, 1982; Johnson & Gaines, 1990). In contrast, only three percent of bird and mammal species form families (Emlen, 1995; 1997; Gardner et al., 2003). And, as mentioned above, not all animals that delay dispersal engage in helping behavior (Greenwood, 1980; Koenig et al., 1992). For example, in observed populations of Siberian jays (*Perisoreus infaustus*) (Ekman et al., 1994; Ekman et al., 2000), Texas green jays (*Cyanocorax yncas*) (Gayou, 1986), and Australian black-backed magpies (*Gymnorhina tibicen*) (Veltman, 1989), undispersed, sexually mature young do not assist with offspring care. This demonstrates the temporally dynamic nature of the balance between costs and benefits: clearly, the balance shifts as young reach maturity and as individuals are faced with shifting ecological opportunities.

Since an individual's reproductive success usually depends on the timely establishment of its own breeding situation, remaining on the natal territory may be costly. When offspring remain on their natal territory, whether they are birds, insects, or mammals, they are almost always sacrificing their own reproduction; thus, delayed dispersal is usually associated with delayed reproduction.

1.3.2. Cooperative Breeding

"Cooperative breeding" refers to a particular type of family-based social system in which individuals other than the genetic parents assist with care of dependent offspring. As described above, when offspring remain with their parents into adulthood they are often helping their parents raise subsequent offspring; over 90% of bird and non-primate mammals in which young delay dispersal also exhibit helping behavior (Emlen 1995). These "helpers" are almost always philopatric young from the previous breeding season. When helping behavior occurs it is directed almost exclusively toward genetic relatives of the helper (Emlen & Wrege, 1988; Marzluff & Balda, 1990; Pusey & Packer, 1994; Rabenold, 1990).

Based on evidence from studies of cooperatively breeding birds, including his research on white-fronted bee-eaters (*Merops bullockoides*), Emlen's (1995) evolutionary theory of the family comprises 15 predictions about the structure, dynamics, and stability of kin groups. The research presented here derives from this "generalized economic model of family formation" (Emlen, 1991; 1994; 1995). The economic component of this model emphasizes the assumed inevitability of competition for resources (Malthus, 1914 [1798]) and the benefits that must accrue to those who delay dispersal. Following inclusive fitness theory, the kin-centered component of cooperative breeding is expected to be universal across species (Hamilton, 1964). By emphasizing the interaction of genetic kin, Emlen's model facilitates cross-species comparison of the conditions that favor family formation.

In birds cooperative breeding is often called "helping-at-the-nest". Doing so means that helpers divert energy they could (all else being equal) be investing in their own offspring. Theory suggests that this reproductive sacrifice is counteracted by several classes of benefits. These may include general benefits of sociality, experience in caring for offspring, inclusive fitness benefits, increased parental investment in the non-dispersing individual, time for additional growth and development, and foraging experience; these will be discussed in more detail below. It should be noted that the latter three do not require cooperative breeding in order to be beneficial: They are also potential benefits of simply delaying dispersal (Ekman et al., 2000; Heinsohn, 1991; Langen, 2000; Pusey & Packer, 1987).

The “Ecological Constraints” model and the “Benefits of Philopatry” model, both originally generated by studies of cooperatively breeding birds, present adaptive explanations of the benefits gained by philopatric individuals in exchange for forfeiting immediate reproduction.

1.3.3. Ecological Constraints

According to Emlen’s model and others, one factor that influences delayed dispersal and the associated delay in breeding is the presence of more mature offspring than there are acceptable opportunities for successful reproduction. As a consequence, some offspring must wait for acceptable reproductive vacancies and then compete for access to them. Families form when waiting at home augments fitness more than other options do (Emlen, 1995). The latter argument suggests that external constraints determine whether an individual remains. While extrinsic factors are important in the evolution of delayed dispersal, researchers including Emlen point out that it is overly simplistic to let the argument rest at that. Below I present alternative (and sometimes complementary) ideas about other factors thought to influence delayed dispersal (see Sections 1.3.4. and 1.3.5.).

The “Ecological Constraints” model (also called “extrinsic constraints” or in specific cases, “habitat saturation”) proposes that a lack of breeding opportunities keeps birds on their natal territory; this may be attributable to lack of available territories (“habitat saturation”) (Selander, 1964; Woolfenden & Fitzpatrick, 1984), lack of available mates (Marzluff & Balda, 1990; Pruett-Jones & Lewis, 1990; Walters et al., 1992), or to the probability of failure due to inexperience (Brown, 1969; Emlen, 1992, 1994; Heinsohn, 1991; Selander, 1964; Verbeek, 1973). Habitat saturation does seem to be a factor in some species, for example Florida scrub jays (*Aphelocoma coerulescens*) (Woolfenden & Fitzpatrick (1978, 1984) and Seychelles warblers (*Acrocephalus sechellensis*) (Komdeur, 1992). The role of ecological factors is discussed further in section 1.3.5.

1.3.4. Benefits of Philopatry

According to the "Benefits of Philopatry" (Stacey & Ligon, 1991) (or "intrinsic benefits") model, there are cases where benefits of remaining explain delayed dispersal better than do limitations on available territories (Emlen, 1994,1995; Heinsohn, 1991; Heinsohn et al., 1990; Langen, 2000; Stacey & Ligon, 1987). In cases where non-dispersing birds help care for dependent offspring, the most obvious benefit is inclusive fitness through helping kin. Indeed, as mentioned previously, cooperative breeders almost always direct help towards their closest genetic relatives (e.g., Emlen & Wrege, 1988; Woolfenden & Fitzpatrick, 1978, 1984). Further, in one study, Heinsohn's (1991) evidence suggests that in white-winged choughs, parents' reproductive success depends on the aid of non-breeding kin.

Other benefits to delayers may include energy saved via prolonged dependence on care providers, and acquisition of skills required for independent foraging (Ekman et al., 1994; Ekman et al., 2000). That is, dispersal constraints (Section 1.3.3) may include ecological competence – if an animal is sexually mature, but unable to forage independently, dispersing will be costly.

In an example of the potential costs of staying, Heinsohn (1991) presents a case where extended care of the young (by helpers) may be costly to the young themselves in that independent reproduction is constrained by lack of foraging experience. In the obligately cooperatively breeding white-winged chough (*Corcorax melanorhamphos*), too much time spent begging for food appears to limit the amount of time spent acquiring foraging skills necessary for independence (see Section 1.3.5.). On the other hand, this extra time may have its benefits. Ekman et al. (1994) and Ekman et al. (2000) clearly delineate cases where retained offspring benefit directly from delayed dispersal; this benefit is manifested as enhanced winter survival in Siberian jays due to parental tolerance at feeding sites. In a playback experiment with Siberian jays, Griesser and Ekman (2004) describe alarm-calling by female parents toward retained offspring but not toward non-kin, which appears to provide an advantage in predator avoidance. The fact that undispersed Siberian jays do not "help-at-the-nest" reinforces the likelihood that direct benefits accrue to offspring, at least in this species.

In some species, other important benefits of philopatry may include better opportunities to obtain breeding territories near the natal area or even the opportunity to inherit the natal territory itself (Brown 1987; Ekman et al., 2001b; Emlen, 1984; Stacey & Koenig, 1990; Solomon & French, 1995; Woolfenden & Fitzpatrick, 1978). Finally, as discussed above, group-living itself may enhance survival (Emlen, 1995; Alexander, 1974).

1.3.5. Skills Hypothesis and Life History Hypothesis

Additional direct benefits of philopatry are suggested by the "skills hypothesis" and the "life history" hypothesis. The *skills hypothesis* contends that insufficient foraging skill at dispersal would reduce lifetime reproductive success (Brown, 1987). It is difficult to test empirically the hypothesis that the need for greater foraging skill selects for prolonged juvenile dependence (which would, in many cases, require helpers). In the first place, one would need to distinguish between requirements for further growth and for actual cognitive skills. However, much work in birds and humans attempts to clarify this point (e.g., humans: Kaplan et al., 2000; Blurton Jones & Marlowe, 2002; Bock, 2002). Heinsohn (1991) suggests that in species where parenting is very costly, for example where a difficult foraging niche requires extensive learning by juveniles, help from others might be favored. In order to parent successfully, an individual needs both foraging skill and sufficient resource availability. Thus, foraging skill requires long dependence, which is costly to parents; receiving assistance from others may offset these costs, allowing young to disperse, perhaps earlier than would otherwise be possible, thus freeing the parents to create another brood while simultaneously creating the next batch of helpers.

The *life history hypothesis* considers similar issues. Ecological constraints, while apparently important in the evolution of delayed dispersal, are not sufficient to explain all of the variation across species. Extrinsic limitations do not account for the fact that some delayed dispersers do not breed cooperatively, and that some are more obligately cooperative than others. Behavioral ecologists have been unsuccessful at finding a single ecological factor common to all cooperative breeders. Instead, the life history hypothesis (Arnold & Owens, 1998; Brown, 1987; Hatchwell & Komdeur, 2000) argues that the life history traits of a particular species ought to be considered along with the ecological context.

Arnold & Owens (1998) examine adult mortality and clutch size across taxonomic families. Their results show that, within families, lower mortality predicts a greater number of cooperatively breeding species. Lower mortality results in higher population density in a given area, and they suggest that this crowding, rather than a more generalized idea of habitat saturation, favors cooperative breeding. This creates a sort of feedback, in which more surviving individuals mean fewer available territories; consequently, more help is required, mortality might decrease further while dependence increases, and delayed maturation is maintained. While Arnold & Owens identify cooperative breeding behavior as the defining characteristic, it seems to me that they actually test the hypothesis that mortality will influence delayed dispersal, not necessarily cooperative breeding.

Arnold & Owens (1999) extend their model to include ecology as well as mortality. According to their analysis of variation in the frequency of cooperative breeding (CB) within and across taxonomic groups, phylogeny does influence the probability of CB. Since life history traits seem to be maintained within lineages, certain lineages may be predisposed to CB. However, this is mediated by ecological variation: Whether or not a particular species exhibits CB may depend on factors such as climate and sedentariness. Thus, phylogeny may predispose a species to CB, but life history interacts with ecological circumstances, increasing or decreasing the likelihood of cooperative breeding. As part of an argument against relying on a phylogenetic explanation, Hatchwell and Komdeur (2000) emphasize the facultative nature of cooperative breeding. They continue the approach of Arnold and Owens (1999), arguing that the idea of "ecological constraints" can be extended to include life history as well as ecological factors that influence the likelihood of delayed dispersal and cooperative breeding.

Heinsohn and Cockburn (1994) show indirectly that life history and ecological factors influence the likelihood of helping. Young white-winged choughs (aged one year or less) are more likely to help when groups are small than in larger groups. The fact that helping only occurs in certain conditions suggests that helping is likely only performed by young birds when it is critical; otherwise (i.e., in large groups), birds at this age do not accept the cost. The cost of helping is also demonstrated physiologically in the loss of body mass in young birds that incubate other birds. When we consider that these helpers were once dependent young themselves, we see the complex matrix of costs and benefits that must comprise any set of decision rules concerning dispersal.

Gardner et al. (2003) and Gardner et al. (2004) use life history to explain an exception to the above ideas on the relationship between ecological constraints and delayed dispersal (Arnold &

Owens, 1998), and another example of group-living without helping. When speckled warblers (*Chthonicola sagittata*) are confronted with a lack of available territories, they do not delay dispersal, nor do they float until they can acquire a territory; instead they often move into and are tolerated on territories of existing breeding pairs. These immigrant subordinate males never provision but may occasionally father offspring. Gardner and colleagues point to two variables that might explain why this pattern differs from expected: low density of individuals and large territories. These larger territories appear to decouple habitat saturation from population density, which might contribute to tolerance by dominant males of subordinate, unrelated males. Thus ecology and life history both contribute to group-living, even when this is not manifested as delayed dispersal.

1.3.6. Compatibility of Competing Theories of Delayed Dispersal

While much discussion has focused on which is the correct causal factor, several important reviews have emphasized the complementarity of the concepts of intrinsic benefits and extrinsic constraints. These superficially contrasting explanations for cooperative breeding and for delayed dispersal in general are not necessarily in opposition, but each may be more or less applicable in particular cases (Emlen, 1994; Heinsohn et al., 1990; Koenig et al., 1992). For example, it is possible that habitat constraints will favor waiting before attempting to breed. However, whether or not parents then facilitate delayed dispersal, by provisioning or otherwise tolerating the young, depends on current costs to parents (Ekman et al., 1994; Ekman et al., 2000).

In any case, according to the Delayed Dispersal Threshold Model (DDTM) proposed by Koenig, et al. (1992), the choice between remaining at the natal territory and dispersing should be influenced by a trade-off between the costs and/or benefits of staying and the costs and/or benefits of dispersing. The existence of “ecological constraints” or “habitat saturation” may be required for delayed dispersal to occur, but this is not a sufficient explanation. Koenig et al. (1992) model this trade-off using a gradient that resembles the Polygyny Threshold Model (PTM) (Orians, 1969; Verner, 1964; Verner & Willson, 1966), in which fitness outcomes of various dispersal strategies are balanced against quality of available territories. However, measuring the variables relevant to these trade-offs is complicated by the fact that, inevitably, researchers tend to use different and not necessarily compatible measures.

In sum, there are at least three hypothesized scenarios to describe the probable factors contributing to delayed dispersal. These may not be mutually exclusive, and the comparative evidence suggests that different taxonomic groups, or even different species, may require different explanations, depending on their ecology and life-history. The simplest scenario is that conditions of “habitat saturation” result in a dearth of breeding territories relative to potential breeders. Individuals who are unable to breed thus settle for inclusive fitness through helping kin. This scenario does not account for non-dispersers who do not help. Nor does it explain cases where individuals disperse, despite saturation, to either float or queue on strangers’ territories (Ekman et al., 2001b; Gardner et al., 2003, 2004; Kokko & Sutherland, 1998). A second scenario allows for the influence of habitat saturation or other constraints on successful individual breeding, but suggests that delayed dispersal confers direct benefits on the delayer, usually through prolonged parental care or tolerance of the delayer; these benefits may come from the opportunity for further physical development or from increased experience, or a combination. Helping may follow, probably favored due to indirect, inclusive fitness benefits. Finally, life history variables such as low adult mortality may set the stage for ecological constraints. This may in turn lead to further constraints due to the life-history factors.

1.4. Application of Emlen's Model to Humans

Since resource quality appears to influence the likelihood that kin remain on the same territory, and since families are defined by the presence of mature offspring on a parental territory, Emlen's second prediction is that families that control high-quality resources will be more stable than those with lower quality resources. In other words, where more or better resources are available the association among kin will be more temporally constant and families will not fission as frequently. If variation in natal territory quality (NTQ) affects the fitness benefits of remaining on that territory, then the acceptability of a reproductive opportunity will vary in parallel with natal territory quality. That is, for dispersal to occur, greater benefits must be gained by leaving than would be accrued by staying. This assumption informs the hypothesis tested here: Individuals from low-quality natal territories will have more to gain by dispersing than will individuals from high-quality natal territories, while higher quality territories will offer more incentive to stay home. Accordingly, individuals from higher-quality territories should be more discriminating when making dispersal choices, and this is expected to result in prolonged residence on the natal territory where families control high-quality resources. Parts of these predictions have been tested in several avian species (Emlen, 1995; Ekman et al., 2001b; Komdeur, 1992; Hannon et al., 1985; Stacey & Ligon, 1991; Woolfenden & Fitzpatrick, 1978; Zack & Rabenold, 1989).

The latter prediction has not yet been systematically applied to human dispersal and mating behavior using direct measures of relevant variables. This project uses Emlen's avian behavioral ecological model to generate and test hypotheses about the effects of natal territory quality on the timing and circumstances of dispersal in humans. The specific hypotheses and tests are outlined in Section 1.6. First I introduce and review research on human behavioral ecology (HBE) and outline its relevance to my research. I outline the behavioral ecological approach to understanding animal behavior in general, and then describe the value of behavioral ecological models for answering questions about human behavioral adaptations. This is followed by a review of the existing literature on dispersal timing in humans.

1.4.1. The Behavioral Ecological Approach and Human Behavioral Ecology

Thus far, I have described work in non-human animals and mentioned work in humans that assumes that ecological circumstances generate selection pressures that have an impact on behavior as well as on anatomy and physiology. The field of behavioral ecology generates and tests models about the distribution of particular behavioral adaptations, most often focusing on a particular species or group of species as a model for a particular class of behaviors. Similar adaptations may then be compared across taxa. As long as one is willing to conduct the relevant hypothesis tests, there is no *a priori* reason to wall off humans from behavioral ecological investigations. Indeed the approach, which has proved to be a fruitful source of hypotheses about the evolution of behavior, has already been productively applied to a number of domains of human behavior. For example, there is a large literature on the behavioral ecology of human foraging activity across cultures (e.g., Bird & Bliege Bird, 1997 Bliege Bird et al., 2002; Blurton Jones & Marlowe, 2002; Hawkes et al., 1982; Hawkes, 1991, Hill and Hurtado, 1996; Kaplan & Hill, 1992; Kaplan et al., 1997; Marlowe, 2003; Smith, 1988; also reviewed in Winterhalder & Smith, 2000). Much of this work draws heavily on optimal foraging theory (OFT), which originally modeled avian patterns of allocation of foraging energy (Krebs et al., 1977; Stephens & Krebs, 1986). Likewise the polygyny threshold model (PTM), originally developed to explain the distribution of avian mating systems (Orians, 1969; Verner, 1964; Verner & Willson, 1966), has sparked several useful analyses of human mating dynamics.

For example, Borgerhoff Mulder (1990) investigated multiple marriages among the Kipsigis, a group of agropastoralists in Kenya. She found that the size of the breeding opportunity offered by a male (in terms of land) and the number of existing wives of a male each independently and significantly predicted which males were preferred by females as mates: female preference appears to favor larger breeding opportunities and fewer co-wives. However, since the wives seem to consider the number of current wives separately from the amount of land available to them, it is possible that the costs incurred from mating polygynously are not offset by a large piece of land. This research employed another test of the PTM model by measuring reproductive outcomes for these females. The data suggest that in fact, females are not adequately compensated for the costs: females' number of surviving offspring is reduced where females have more co-wives. This is a classic application of behavioral ecological theory to the human case, and it is also suggestive of the effects of resources on reproductive success and how this might affect behavior.

1.4.1.1. Behavioral Ecology and the Comparative Method

As illustrated above, behavioral ecology lends itself to comparisons across species, provided the species in question share generalized behavior patterns (such as social structure) that vary in parallel. Since ecological circumstances are expected to have a direct impact on family formation in humans as well as birds (see Section 1.3), a behavioral ecological approach can be useful in the case of human family dynamics.

Patterns of human and avian social behavior have several things in common: most bird species are territorial, and many are social and at least socially monogamous (that is, they remain with one partner for one to many seasons, but may engage in extra-pair copulations). Some of these species form families (as defined by Emlen). Clearly, humans across cultures also fulfill Emlen's definition of families as groups of related individuals interacting after sexual maturity. These similarities suggest that the human ancestral environment possessed some special features that favored familial groups, features that were not similarly influential in the evolution of most other mammalian species. A behavioral ecological hypothesis would conjecture that parallel ecological circumstances were likely involved in the evolution of these characteristics in both birds and humans. For example, the quality of the territory or home in which an individual was raised may affect reproductive strategy in both cases. Further, like humans, the young in many bird species seem to benefit greatly from extended parental care (Section 1.3). Of course the set of decision rules in humans is more complicated, and the actual resources that contribute to territory quality are different between the two taxa. Also, human developmental requirements are much more complicated than those of birds (see Section 1.4.2.1.). Nonetheless, comparing birds and humans may shed light on the nature of the relevant environmental circumstances.

1.4.2. Life History

Assuming that behavioral decisions (conscious or unconscious) rest on a trade-off between the relative costs and benefits of alternatives, and that organisms are designed to maximize their own fitness, human life history decisions (conscious or unconscious, and presumably sensitive to context) must rest on such trade-offs (Stearns, 1992; Williams, 1966). First, with a limited amount of resource, and thus limited energy to invest in life's activities, individuals must balance their investment in somatic effort versus reproductive effort. In the most general sense, reproductive effort is described as being divided between mating effort and parenting effort. Further divisions are also often used. The point is that with limited available resources, an individual's reproductive success depends on how these resources are allocated. Somatic effort, or investment in growth, preserves and increases resources the individual can later expend in reproduction. Conversely, reproduction itself will reduce the resources available for future reproduction. At some point, it becomes more beneficial to deplete some of these reserves in order to actually reproduce. The optimal moment at which the transition to reproduction should be made, and whether animals (including humans) actually operate in this manner, are ongoing questions among behavioral ecologists and other evolutionary theorists (Hill & Hurtado, 1996; Kaplan & Lancaster, 2000; Krebs & Davies, 1997; Low, 1978; Trivers, 1972; Turke, 1988; Williams, 1966). Since my research tests hypotheses about the factors that influence the decision to divert energy toward reproduction, a discussion of general theories of human transitions to reproduction is necessary here.

1.4.2.1. Delayed Maturation

In previous sections I describe cases where delayed dispersal in birds appears to have specific benefits to the delayers. These "benefits of philopatry" may come by way of direct or indirect benefits, as described above. For example, extended juvenile dependence may be one of these benefits (Ekman et al., 1999; Heinsohn, 1991). It is often suggested that this lengthened maturation period may have co-evolved with delayed dispersal such that prolonged juvenile dependence is required for survival and successful reproduction and parenting. As in other animals, the most general benefits of delayed maturation in humans are hypothesized to be increased growth and development and/or increased time for learning skills. It is difficult to test empirically how or whether these are the selective factors and the relative importance of each alternative, and there is much discussion about how to model their influence (Birds: Brown, 1987; Ekman and Rosander, 1992; Ekman et al., 2000; Heinsohn, 1991. Humans: Bird & Bliege Bird, 2002; Bliege Bird & Bird, 2002; Bock, 2002; Borgerhoff Mulder, 1991; Blurton Jones and Marlowe, 2002; Kaplan et al., 1995; Kaplan et al., 2000). Most researchers agree that delayed maturation is the result of a complex set of co-evolved traits.

Recall that delayed dispersal may also affect parents' inclusive fitness through several channels, including enhanced fitness of the delayer and help with raising later-born young, which not only reduces parenting costs but frees parental energy to be invested in increasing brood size. Several life history variables are thought to contribute to prolonged offspring dependence in birds, including high costs of parental care and low adult mortality. Both of these are also thought to be important in the evolution of human life history.

There are some parallels in the HBE literature, especially where researchers investigate whether the delayed maturation exhibited by humans reflects the necessity of a long learning period. Kaplan and colleagues approach human life history with an emphasis on the importance of learning in the evolution of human delayed maturation (Kaplan et al., 1995; Kaplan & Lancaster, 2000; Kaplan et al., 2000; Lancaster & Kaplan, 2000). Kaplan & Lancaster (2000) model the relationship between foraging strategy (how do people get their food?), intelligence (does the diet require extensive learning in order to survive independently, or is the ability to survive limited only by growth and other physiological development?) and longevity (is the long human lifespan a function of the need to invest a lot of time learning or growing?). As described above, life-history theory contends that reproductive strategy is influenced by selective factors favoring early or later reproduction, depending on things like resource availability and mortality (Stearns, 1992).

Kaplan and colleagues base their idea of Embodied Capital (EC) on an individual's trade-off between investment in survival and accumulation of resources (EC) versus investment in reproduction. They describe a dynamic between ecological constraints and NTQ in which ecological factors influence the potential quality of a natal territory, but in which a really good natal territory can offset these constraints.

Blurton Jones and Marlowe (2002) review three common explanations for delayed maturation and apply theory to specific features of Hadza foraging behavior. First, they test the "practice theory" hypothesis, which argues that acquiring the skills needed for survival requires a long learning period. Second, they describe the theory that delayed maturation does not require an explanation, since it is commensurate with the long human life span; this relationship between life span and length of juvenile dependence is also seen in other mammals. Third, they examine Kaplan et al.'s (2000) model, described above, that combines elements of the first two. On several tests of important subsistence tasks they found no practice-based difference in skills. Their results did not support the "practice theory", and they suggest that, even though age-dependent increases in size and strength may improve skills, more is needed to explain the exceptionally long maturation period observed in humans, even compared to other long-lived apes.

1.4.2.2. Reproductive Strategies and Reproductive Decisions

In humans, dispersal may be viewed as a process, rather than a single event; reproduction may be viewed as one component or outcome of this process. I have established that delaying dispersal usually means forgoing reproduction. In most animals, dispersal from the natal home is the beginning of the path toward reproduction; therefore dispersal timing must be considered in this context. As in the literature on non-human animals, much research in human behavioral ecology has been devoted to reproductive strategies and decisions. Humans, to a much greater degree than other mammals, live in varied ecological environments. Each environment presents its own set of ecological variables; therefore any analysis of delayed dispersal and reproductive choices must be considered in its own context (Blurton Jones & Marlowe, 2002; Clarke & Low, 1992; Low & Clarke, 1991; Kaplan et al., 2000).

In any case, mate choice may be viewed as part of the dispersal process. The hypothesis being tested in this dissertation relates directly to mate choice in that it implicitly concerns the conditions under which an individual will choose to disperse. One of these "conditions", when dispersal is tied to reproduction, is the quality of the mate. In addition, an understanding of the critical mate-choice criteria may be applied to other life-history choices that require weighing several contextually and temporally dynamic variables. To illustrate this point, Luttbeg et al. (2001) investigated mate choice in sticklebacks using state-dependent analysis of several stages of mate choice. Rather than look at the relevant variables simultaneously, they divided the choosing process into several parts and looked at all variables at each of these points in order to determine whether some might be more important at different stages of choosing (that is, when deciding *whether* to consider a mate and then when actually *choosing* it).

A similar approach can illuminate the complexities of human dispersal: I propose several stages, or types, of dispersal, none of which necessarily occurs in a particular order. Each of these may have its own set of triggering factors. The analysis presented in this dissertation approaches dispersal as a process, in which the independent variables may differently affect the outcomes of each type of dispersal. That is, in humans, leaving home, giving birth, and forming a long-term partnership are often separate events, occurring in varied sequences, whereas in birds these events usually occur in a consistent sequence. Although in many cases first birth is not independent from first marriage, it also serves as an important marker in discussions of human reproductive development and life history and in the sociological literature on adult outcomes. Therefore I consider marriage and birth separately. This conception of dispersal events is presented in detail in Section 2.1.

1.5. Studies of Human Dispersal

1.5.1. Behavioral Ecological Approaches

Much research has investigated human dispersal behavior, including when, why, where, and how far individuals go. However, most work focuses on geographical variables, such as dispersal distance and destination, or on whether or not dispersal occurs, rather than on dispersal timing. Here I review research that emphasizes motivation for and timing of dispersal.

A few archival studies of human dispersal and reproduction patterns have used behavioral ecological models derived from animal studies. Using demographic data from 19th century Sweden, a land-based economy where inheritance was based on sex and birth order, Low and Clarke (1991) evaluated the effects in four parishes of land-ownership and occupational status on male reproductive behavior. Consistent with studies of avian dispersal (Stacey & Ligon, 1991; Emlen, 1994), Low and Clarke began with the assumption that local variation in resource availability contributes to dispersal patterns. They suggest that dispersal is influenced by the differential ability of individuals (males in particular, in this case) to gain access to local resources. Low and Clarke investigated the relationship between the probability of dispersal (defined as terminating residence in the natal parish) and several family economic variables. Of these, both father's class and natal parish had a significant effect on the probability of male dispersal. This relationship is complex: Neither natal parish nor father's class fits an ordinal pattern, since the economies and resources varied across parishes. Their overall results suggest that resources including father's status did affect men's reproduction in three of four parishes. Further, birth order, which affected the likelihood of access to family resources, also played a role: males with greater access to resources (via being born earlier and being from a wealthy family) were less likely to disperse, more likely to marry, and had more children. Illegitimate males and males from the lower economic classes were more likely to leave the parish, though this trend was not significant. Though Low and Clarke analyzed the likelihood of dispersal rather than dispersal timing, these results hint at the pattern suggested by Emlen, in which having fewer opportunities for access to resources (lower class status) appears to alter the benefit/cost balance of staying versus dispersing. Taken as a whole, males who did have access to resources were more likely to remain in the natal parish. In conclusion, Low & Clarke point out that the wide variation in environments occupied by humans means that any study of human dispersal patterns must consider context-specific ecological variables.

For the same population studied by Low and Clarke (1991), Clarke and Low (1992) examined the conditions associated with dispersal. Clarke and Low's paper is informed by Greenwood's (1980) argument that in species with resource defense competition among males, philopatry will benefit males, and females will more likely be the dispersing sex (see Section 1.2). In 19th-century Sweden, people mated monogamously but male competition for resources was high. Clarke and Low's prediction that females would be more likely to disperse was supported across age intervals (until age 35) and across the four parishes included in their analysis. They also predicted that both local (parish-level) resource availability and individual access to resources would affect the probability of dispersal by individual males. They found that while age-based male dispersal patterns differed by parish (as did female patterns), in general, the probability of male dispersal was inversely related to local resource availability.

Regarding the relationship between individual access to resources and likelihood of dispersal, they found that later-born males in larger families, who were thus less likely to inherit, were more likely to disperse compared to earlier-born males or males from smaller families. Other independent variables were father's socioeconomic class, which yielded significant but complex results such that males whose fathers were land-owning farmers had lower probability of dispersal compared to all other classes, and birth status (legitimate or not), which did not significantly predict dispersal probability in this analysis.

Also using 19th-century Swedish parish records, Clarke (1993) investigated the effects of resource access on the timing of women's marriage and dispersal from the natal parish, considering marriage and dispersal separately. Clarke found that the probability of dispersal was significantly influenced by sex, age, birth order, birth cohort, father's occupation, natal parish, and marital status. Marriage age was related to resource access: Women with more resources married earlier. Access to resources appears to be a limiting factor in the probability that a woman would marry at all: Many women dispersed before marriage, especially since women were less likely to inherit resources. Clarke concludes that a female leaving her natal parish may have been motivated by several incentives, none of which is necessarily mutually exclusive: a) income for the woman herself, b) access to a wider marriage market, and c) acquisition of resources that might increase her probability of marrying. This latter illustrates Kaplan & Lancaster's concept of investment in embodied capital (EC) in order to facilitate future reproduction.

In Clarke's sample, the likelihood that a woman would disperse from her natal parish decreased as her access to resources increased; this result corresponds to the hypothesis proposed in my study. When marriage is considered a component of dispersal, however, her results contradict my prediction: What I would call a higher-quality natal territory results in earlier marriage. The Swedish studies suggest a de-coupling of marriage and physical dispersal such that as resources increase, the probability of early marriage increases, while the probability of leaving one's area of origin decreases. This may be consistent with Emlen's proposals concerning access to resources and dispersal, but highlights the role of resource consolidation in human dispersal behavior. This illustrates the complexity of the relationship between resources and reproduction in humans. Low and Clarke's measures do not include dispersal timing, but instead use dispersal probability. In sum, the pattern appears to be that higher NTQ leads to earlier marriage and lower probability of leaving the natal area.

Towner (2001) examined the relationship among several life history and dispersal variables in 18th century Massachusetts, (USA). Unlike the Swedish records, Towner's data allow consideration of dispersal timing. Using historical records and census data from Oakham, MA, she investigated age at dispersal from Oakham in relationship to sex, father's wealth, and father's social status. Contrary to expectation, her results showed no significant effect of father's wealth on dispersal age. However, father's social status did influence dispersal age: middle-status individuals dispersed later than high- or low-status individuals. Finally, as in the Swedish studies, females were more likely to disperse, and low status females were more likely to do so than were high-status females. This curvilinear relationship between father's status and dispersal age further illustrates the complex relationship between NTQ and dispersal in humans, but points to resources at home as an incentive to remain nearby. Towner's results replicate the pattern described above: those from wealthier families tend to marry earlier, but are less likely to disperse from the natal parish.

Davis & Daly (1997) used the Canadian General Social Survey (CGSS) to investigate Emlen's 15 predictions about family formation. For their test of Emlen's second prediction (Section 1.4.) they apply frequency of contact as a measure of family stability. Their measure of natal territory quality is the current income (four income groups, subsequently divided into two) of six age-sex classes of respondents, aged 15-44. While Davis and Daly did not directly measure dispersal, they explored the relationship between their income variable and the likelihood and frequency of contact with several classes of relatives; contact frequency is their proxy measure of dispersal. They found that, as is shown elsewhere (e.g., Eggebeen & Hogan, 1990), higher-income families are more likely to remain in contact than lower-income families. However in Davis and Daly's study, when there is contact, it is more frequent in lower-income families. Thus, lower income was associated with one of two outcomes: having no contact with the natal family, or having daily contact. Their results cannot be neatly compared to Emlen's second prediction: the fact that likelihood of contact was lower for lower-income respondents suggests that dispersal is more clear-cut for this economic group. The lower probability of any contact suggests that a lower-quality natal territory decreases the potential benefits of philopatry. However, the frequency of contact seen in the lower-income group points to a more complex dynamic, perhaps involving two alternate strategic responses (no contact or daily contact) to low NTQ. Irrespective of these outcomes, their measures of dispersal did not consider dispersal timing, nor did their measure of NTQ reflect the actual childhood conditions of the respondents. In contrast, in this study I test Emlen's prediction using more direct measures of both dispersal and NTQ.

In an example of using behavioral ecological models of the relationship between life history strategies and environmental conditions (e.g., Emlen & Oring, 1977), Hill et al. (1994)

investigated relationships among childhood adversity, attachment security and adult relationships. They based their predictions on earlier evolutionarily informed work that suggests that variation in childhood rearing conditions is associated with variation in adult reproductive strategies (e.g., Belsky et al., 1991; Draper & Belsky, 1990; Draper & Harpending, 1982). Using interview and questionnaire instruments to measure aspects of early environment and adult relationships and attachment security, they found that individuals who experienced disruptive events during childhood were more likely to display nonsecure attachment styles than were individuals who experienced less childhood adversity. Attachment style in turn was associated with adult relationship timing and stability. Numerous HBE studies on family composition and early family relationships have indirectly investigated some components of the relationship between NTQ (measured as early experience) and measures of timing and circumstances of adult relationships and sexual behavior (e.g., Cashdan, 1996; Grainger, 2004; Hoier, 2003; Kaplan et al., 1995; Quinlan, 2001 & 2003).

1.5.2. Other Approaches

Traditional social scientists have addressed similar questions (e.g., Acock & Kiecolt, 1982; Aquilino & Supple, 1991; Richardson et al., 1986; Whyte, 1990; Young, 1974). For example, Young (1974) used survey data to measure the factors that contribute to leaving home in Melbourne, Australia. Whyte (1990) conducted a large survey on dating and marriage behavior in the Detroit area, using 18- to 75-year-old females who were married or had been married at least once. Whyte proposed that social class, traditionalism, and parental ties and controls would explain variation in dating, mating, and marriage behavior. He developed a Popularity Scale comprising the following intercorrelated variables: number of dating partners, number of steady boyfriends, and number of marriage proposals rejected. Females of higher social class and higher education tended to be more "popular", as did females who started dating later and married later. The timing of first sexual experience and marriage were positively correlated with social class (higher social class was associated with later sex and marriage); there was a similar but weak association between timing of dating and social class. Whyte also divided sexual intimacy into three categories: whether first sexual experience was before marriage, whether the subject lived with a mate without marriage, and whether the subject had any pre-marital pregnancies. He found some interesting trends, but no major or consistent effects, concluding that these three aspects of sexual intimacy are not under the same influences.

While it does look at variables parallel to previously mentioned research (e.g., Clarke, 1993; Towner, 2001), if Whyte's research were based on *a priori*, evolutionarily-informed hypotheses, it might demand a different approach and the results might yield a different picture of the complexities of dispersal. Interestingly, Whyte's results do appear to support Emlen's second prediction. However, Towner's (2001) and Clarke's (1993) results reflect a more complex relationship between NTQ and dispersal timing. This could be attributed to the fact that both Towner and Clarke used archival data from societies where a) the population was more homogeneous than Whyte's, and b) NTQ was much more directly tied to land-ownership and other material resources. My research also uses a large, modern population, which presents similar complications, but my results should be more interpretable since is I use an explicit, testable hypothesis.

A different body of research uses the PSID and other panel studies to answer questions about childhood circumstances and adult outcomes (South & Crowder, Brooks-Gunn et al., 1993; South & Crowder, 1998, 1999; Sucoff & Upchurch, 1998). Several of these use measures of neighborhood quality as independent variables to predict outcomes such as out-of-wedlock birth. For their predictors they use variables that parallel my conceptualization of natal territory quality. This literature is not informed by evolutionary models, but nevertheless parallels HBE studies in methods, variables, and outcomes.

1.6. Hypotheses

Using a longitudinal study of dynamic income processes in U.S. families (the Panel Study of Income Dynamics), this dissertation attempts to test whether Emlen's predicted relationship between NTQ and dispersal is manifested in humans. Applying Emlen's predictions to humans requires some generalization of concepts, but my central hypothesis is that, depending on their natal territory quality, individuals should be more or less discriminating in their choices regarding reproductive opportunities. That is, where there is competition for limited resources, and resources are unevenly distributed, individuals from wealthy families should be more reluctant than individuals from poorer families to disperse from the natal territory because individuals from low-quality natal territories will have more to gain by dispersing than will individuals from high-quality natal territories. This will result in prolonged philopatry where families control high-quality resources. Thus the degree of choosiness in terms of *timing* of dispersal should differ between individuals from low-quality and high-quality natal territories. The independent and dependent variables are thus natal territory quality (NTQ) and age at dispersal, respectively. In order to further tap the idea of "choosiness" I also include measures of local conditions. Where local conditions are favorable, dispersal should occur earlier. I also predict an interaction between NTQ and local conditions, since an individual's decision to disperse should take into account both conditions at home and extrinsic conditions.

Ecologically speaking, the natal territory of any animal contains several social and economic variables that may contribute to dispersal timing. For the purposes of this study, human natal territory quality is divisible into five components: a) economic circumstances b) living conditions, c) parents' occupation, d) parents' education, and e) family composition.

Specifically, I expect choosiness to be manifested as delayed dispersal. I investigate three dispersal components: a) physical dispersal from family of origin b) marriage (mateship) and c) reproduction, measured as age at the specific dispersal event (i.e., age at leaving the natal family, age at marriage, and age at first childbirth). According to my hypothesis, those who come from higher quality natal territories should disperse at a later age. Local conditions may exert an opposing influence: Where external conditions are poor, dispersal should be delayed. I also explore whether this population exhibits a sex bias in any dispersal components, in the form of a comparison of age at dispersal in females versus males. More specific measures related to these variables are discussed in the Methods chapter (Chapter 2).

1.7. Broader Implications

The research presented here is unique because it attempts to test an *a priori* evolutionary hypothesis about issues social scientists have studied for decades. While Davis and Daly (1997) attempted to apply Emlen's ideas to humans, they did not use a direct measure of natal territory quality, nor did they directly measure dispersal itself. This study measures the relationship between natal territory quality itself and measures of choosiness about dispersal. Previous studies using historical data have also asked similar questions. However, these focused more on leaving a geographic area, while the present study looks instead at categories of dispersal from one's family of origin. Also, I use a diverse, contemporary population: Any significant relationships in my data set that support my hypothesis would be more difficult to detect, thus such results might be a valuable addition to the information we already have.

With its implications for our understanding of family formation, this study should reveal some unexamined underlying influences on family stability in humans. Until now, much work on specific issues of family stability has considered these processes without a theoretical model from which to test hypotheses. By considering evolved psychological responses that influence the way a particular home situation will affect young adults' dispersal choices, we may be better able to address and prevent the problems sometimes associated with early dispersal and decreased family stability. The study is not intended to argue that there is a particular formula of family composition that makes a higher-quality natal territory. For example, the analyses of the PSID data are set up so that a participant who grew up in the care of someone other than her biological family may still have had a "high-quality natal territory". At the same time, the PSID allows measurement of the degree to which participants are genetically related to the people with whom they were raised, since genetic relatedness, as a rule, does have an effect on the quality of a family situation (Daly & Wilson, 1988). Ideally this research will increase understanding of the interaction between sociocultural and biological influences on family stability.

2. METHOD

2.1. The Panel Study of Income Dynamics

The Panel Study of Income Dynamics (hereafter, PSID) is a longitudinal study of a large representative sample of the U.S. population, initiated in 1968 with about 5,000 families. The database includes detailed information about financial, social, health, educational, and family circumstances, and thus captures several economic, demographic and sociological dimensions over time. The PSID tracks all followable individuals who leave original sample families, thus the sample includes these individuals and their subsequently formed families. Data have been collected since 1968 and most Family and Individual data through 2001 are available. As of 2001 the PSID included over 7,000 families and more than 60,000 individuals.

PSID data are available at no charge via the World Wide Web as downloadable files formatted for analysis by several statistical packages. I use several types of PSID files (Section 2.1.3.) which, when combined, include all variables needed for this study. Before downloading, researchers can select customized subsets that are limited to relevant variables and/or participant characteristics, creating manageable files that are tailored to a given research topic. Subsets are merged using unique identifiers in order to create complete sets of variables for each participant.

2.1.1. PSID Sample Population Details

Core Samples: The PSID began in 1968 with TWO independent samples. The *SRC Sample,* a cross-sectional equal-probability sample of U.S families (using the lower 48 states), was conducted by the Survey Research Center (SRC) at the University of Michigan's Institute for Social Research (ISR). The second core sample (the *SEO Sample)* was a low-income sample of U.S. families from the Survey of Economic Opportunity (SEO), conducted by the Office of Economic Opportunity of the U.S. census. The SEO Sample was confined to Standard

Metropolitan Statistical Areas (SMSA's) (defined by the U.S. Census) in the North and non-SMSA's in the Southern region (Hill, 1991; PSID Online User's Guide).

Other Samples: A *Latino sample* of 2000 families was included from 1990-1995, comprising families who immigrated to the U.S. from Mexico, Puerto Rico, and Cuba. This sample was eliminated in 1995 due to its limited representation of actual immigrant populations. Instead, a sample of post-1968 Asian and Latino immigrants (the *Immigrant Sample*), was created in 1997. These immigrant families, who were not naturalized but had resided in the U.S. for at least 2 years, are meant to better represent the actual post-1968 U.S. immigrant population than did the original Latino sample. Though these samples do include some retrospective data, much information on these participants is not necessarily compatible with the data from the original core samples. Thus, neither the 1990-1995 Latino sub-sample nor the Immigrant sample is considered in my analysis; cases from these samples are eliminated by ID number.

The original core sample was reduced to accommodate these new (Immigrant) families. Most of the reduction was from the SEO (low-income) sample; the SEO families were brought back into the study when funding became available, but were not part of the core and were not weighted. Therefore, as of 1997, the core sample consisted of the original SRC sample, part of the SEO sample, and the Immigrant sample.

2.1.2. PSID Data Collection: Timing and Procedures

From 1968 to 1996, core families were interviewed annually. Each annual interview is referred to as a "Wave". Waves are numbered from 1 (1968) to 34 (2001). When possible, all individuals who moved out of these families were also followed. From 1997 onward, interviews occurred biennially. So that the intervals are consistent across my sample, the cohorts in this study are only considered through 1997. From 1968 to 1972, the PSID conducted face-to-face paper-and-pencil interviews. From 1973 onward, most interviews were conducted over the telephone. In 1993, the PSID began using Computer Assisted Telephone Interviews (CATI). By 1999, all interviews used computer-based instruments.

2.1.3. PSID File Structure

2.1.3.1. Main Data Sets

The PSID includes two main types of data sets (*Family* and *Individual*) and several supplemental sets (Table 1). The *Family* data set follows all PSID families beginning in 1968. Data are collected on the "head", "wife", and other household members (including family and non-family). A clear explanation of what "head" means is necessary here. Each Family Unit (FU) has one head, who is loosely defined as the individual who has primary financial responsibility for the FU. However, if a FU had both a husband and a wife, early waves always recorded the male as Head to maintain comparability with Census criteria. To keep the "Head" category consistent, if a female is the primary resource provider, she is Head only if no adult male (16 years or older; husband or boyfriend) is present. If there is an adult male in the FU, he is the Head, and she is the Wife, unless the male is incapacitated, in which case the female is defined as Head (and the male as "Wife".) Changes in heads of FU's are documented in each wave.

The *Individual* data set follows individuals within PSID households, as well as any individual who leaves (known as "splitting off") a PSID household and starts her own household, or "family". For the individual file, more specific data are collected on that individual than would have been in her original family file, where most information concerns the head and wife. Also, a new "family" enters the Family data set for each individual who splits off and remains followable. Thus all individuals in the *Individual* data set are connected to the *Family* data set via their original family.

Table 1. PSID data sets used in this dissertation.

Cohort	**PSID Data Set**	**Variables**	**Years**
1957	PR II	Individual Information/ Age at Splitoff	1968-1997
	PR I	Family (NTQ) Information	1968-1993
	Retrospective Occupation-Industry	Parents' Occupation	1968-1980
	Childhood and Adoption History	Age at First Birth	1968-1997
	Marriage History	Age at First Marriage	1968-1997
1967	PR II	Individual Information/ Age at Splitoff	1968-1997
	PR I	Family (NTQ) Information	1968-1993
	Retrospective Occupation-Industry	Parents' Occupation	1968-1980
	Childhood and Adoption History	Age at First Birth	1968-1997
	Marriage History	Age at First Marriage	1968-1997
	Relationship History	Family Composition	1968-1985

There are two versions of each of the main data sets. Public Release I (PR I) includes family data from 1994 to 2001 and individual data from 1968-2001. PR I was formerly called "Early Release" because the set included data from more recent years, thus reliability was lower than in "Final Release" data (below) because the "early release" data had not yet been thoroughly processed. When I created my data files, Public Release II (formerly "Final Release") only contained family data through 1993, and included revisions based on up-to-date information and computed variables. Due to improved technology, the data in PR I files are currently as reliable as those in PR II; furthermore, the PR I individual files are available for all years through 2001 (PSID Online Data Center). Since PR I includes later waves, I use the PR I data for the dependent variables in order to increase the likelihood that dispersal data will be present for most cases in my populations. I continue to use PR II, as well, especially for Family data from 1968 to 1993 (unavailable in PR I), and for variables that are not available in PR I.

For this study I used data through 1993 because, at the time I began working with these files, these were the years for which the most complete family data were available.

2.1.3.2. Supplemental Data Sets

This project also uses several supplemental data sets (Table 1). Most PSID supplemental data sets consolidate and present a small number of variables relevant to a very specific topic, facilitating immediate access to a particular type of information. Each supplement includes an individual ID for each case for merging with the main files. The **Family History** files include the *Marriage History* (MH) file, the *Childhood and Adoption History* (CAH) file, and the *Parent Identification* file (PIF). The MH file contains information on date, number, and order of marriage(s) for both partners in any married pair. The CAH file contains records for all child-parent dyads (one record per event) and identifies whether each is adoptive or biological; however, adoptive and biological children were not distinguished in all years in the main data sets. Finally, the PIF file uses identifiers to link parents and offspring, allowing quick access to this information without using the entire data set. The *Relationship File* (RELHIS) augments the Family History Files by including records of *all* dyadic relationships between family members from a given original PSID household (i.e., not only parent-child relationships are described) from 1968 to 1985. See Section 2.3 for more detail on supplemental data sets.

I also use the *Retrospective Occupation-Industry Files* (OCCIND), which contain 3-digit 1970 U.S. Census codes for occupations and industries of all PSID heads and wives. I use these occupation codes in conjunction with standard measures of occupational prestige, in order to measure a status component of natal territory quality.

All supplemental data sets are cross-linked with the main data sets, so a row of variables for one individual's data file can be created using his or her records from several or all of the sets.

2.1.4. Methodological Issues

2.1.4.1. Advantages of the PSID

Annual administration of the PSID ensures that almost all information in the data set is current at the time of each survey. Thus, since data are temporally calibrated with the events themselves, error due to memory effects is minimal. Consequently, measures of family income, housing quality, education, etc. are highly accurate. Further, since the specific variables employed are for the most part consistent over time, data are also comparable across years and respondents (exceptions are described in Section 2.2). Annual data collection also means that these empirical measures of NTQ are available longitudinally. Therefore income trajectories and other temporal variations in NTQ can be assessed and incorporated into measures of NTQ.

2.1.4.2. Limitations of the PSID

While the PSID offers a thorough and comprehensive source of data on the measures required for my study, there are some cases where gaps in the data may make data analysis more complicated. For example, temporal gaps in the data occur for questions that were not asked during every wave of administration. This includes variables that were only included for several years, and questions that were dropped in one wave, then resumed in a later wave. Gaps also occur if a sample member was not available (referred to as "non-response") during one or more years. Changes in sample structure (see PSID Sample Details, above) also affect the structure of the study populations, as does attrition and entry into the sample after 1968. Changes in variable names do occur, but these are easy to detect and incorporate. Finally, changes in data collection techniques (described above: PSID Data Collection) must be accounted for when creating data files. Several of these limitations proved to be more significant than was initially expected.

2.2. Participants and Sample Structure for This Study

I use two equivalent sample populations, each of which is an age-based cohort using year of birth as the selection criterion (Table 2). Thus there is an "older" cohort (Cohort I) and a "younger" cohort (Cohort II). Individuals in Cohort I were born in 1957, eleven years prior to 1968, while Cohort II were born one year (1967) before the PSID commenced. This ten-year span between cohorts allows consideration of individuals for whom dispersal is recent or imminent in 1993 (the younger cohort) and of those who are likely to be completely dispersed in 1993 (the older cohort).

Table 2. Sample populations.

Cohort	Age in 1968	Age in1993	Age in 1997
1957	11	36	40
1967	1	26	30

Note: 1993 is the last year for which FAMILY (dependent variable) and age at residential dispersal data are available. 1997 is the last year for which age at first marriage and age at first birth are available.

The 1967 cohort includes details on NTQ over the entire childhood (since data are collected from age 1 or 2). Detection of dispersal is more likely for the 1957 cohort since these individuals will be older at the last year of data availability. This creates a methodological problem, since ages for which data are available are not equivalent across early and late cohorts. That is, data on NTQ are limited for the older cohort, while data on Dispersal are limited for the younger cohort. Therefore, I analyze the cohorts separately based on which PSID waves are available for each cohort. For example, for the 1957 cohort, I only have NTQ (Family) data beginning at age 11 (1968). To check for effects of these different endpoints (Table 2), I also analyzed the 1957 cohort data after truncating dispersal timing at age 30, then compared the results of the two 1957 analyses to each other and compared the restricted 1957 cohort to the 1967 cohort (Section 3.2.).

Including individuals at different stages of dispersal allows delineation of the specific processes involved at each dispersal stage. That is, data for the older cohort will point to conditions at the moment of dispersal, while those for the younger cohort will address the conditions leading up to dispersal. Further, looking at two time periods exposes more about the generalizability of the hypothesis, since the results are not specific to a particular historical moment.

Twins (or other multiple-birth siblings), or siblings born in the same calendar year, would not be statistically independent cases, since the same predictor values would be used for more than one outcome. Therefore I do not use more than one individual from the same family in any given cohort. PSID indentification includes a family number and a person number. In cases where the same family number occurs more than once in the same data set, I removed the second individual.

The data subsets are downloaded as ASCII data (*.dat) files with corresponding SPSS syntax files, then converted to SPSS data files using these syntax files. With each data set, there is an option to download a corresponding codebook. Individualized codebooks can also be created independently of the data sets. SPSS, Microsoft Excel, and SAS were used for data management.

2.3. Conceptual Introduction to Variables

In birds, the measurable "quality" of the natal territory is relatively straightforward, and limited to the relevant limiting resources for a given species. Size of territory, available nesting sites, and food availability are important factors for avian NTQ; all reflect what might be called "economic" factors. Conversely, NTQ in humans is more difficult to define, especially since less tangible factors, such as emotional support or other social conditions, may be important. To operationalize human NTQ, I use measures that integrate logical parallels with the avian literature and measures from the social sciences.

Throughout the literature in traditional social sciences (e.g., sociology, economics, psychology) and in human behavioral ecology there are several general categories of childhood conditions that are thought to contribute to adult outcomes. Since I do not have reliable measures of the emotional or psychological states of my sample individuals, I use indirect measures that I believe tap both material and psychological conditions.

2.3.1. Conceptual Independent Variable: Natal Territory Quality + Local Conditions

In this section I parse the idea of natal territory quality and local conditions into their measureable components and relate each to its theoretical roots in the avian literature and Emlen's model in particular. In Section 2.3.3. I describe how I operationalized each component using the data available in the PSID.

For the purposes of this study, **human natal territory** comprises five components:

a) economic circumstances
b) living conditions
c) parents' occupational prestige
d) parents' education
e) family composition

Local conditions external to the home comprise employment opportunities (unemployment rate in the county of residence) and city size.

Economic Circumstances

I use variables that evaluate the immediate economic environment, including circumstances within the natal home and local conditions external to the home. Both of these contribute to NTQ in animals. First, direct measures of economic circumstances, such as family income and the head's employment status, address the amount of material resource a family has to work with.

Living conditions

Living conditions indicate something about an individual's level of comfort in her surroundings. For this element of NTQ, I use the ratio of actual number of rooms in the family unit to the number of rooms "required" based on the size and composition of the FU. I use this this measure of household density as a proxy for the quality of personal space as a resource. That is, how crowded is the living space? Are there more people in the space than the space can sustain? Further, overcrowding in the home would result in increased competition for "space", a resource in itself, and might also contribute to psychological stress. Thus, a *lower* ratio in this case reflects a higher density of individuals in a household, and thus *lower* NTQ. A higher ratio reflects more "personal space".

Parents Occupational Prestige

Occupational prestige measures a family's status (via its head) relative to other families. The PSID tracks occupations using U.S. Census occupation codes, and these are translated into a corresponding prestige value for each occupation (Siegel, 1971). The prestige values are a standardized ranking of U.S. occupations (see Section 2.3.2.3.). As a measure of status, a father's occupational prestige may reflect the ability of the family to obtain and control resources, much as social dominance does in animals (and humans). Also, parental status is usually transferred to offspring, which provides advantages in itself.

Parents Education

The educational level of the parents has been shown to affect the family's quality of life directly, in terms of higher income levels, and indirectly, in terms of status. Further, children's educational attainment is correlated with that of their parents. Many studies use mother's education as a separate measure of socioeconomic status, and it has also been shown to predict the likelihood of out of wedlock births (Acock & Kiecolt, 1989; Lancaster & Kaplan, 2000; Sucoff & Upchurch, 1998).

Family Composition

I use detailed information about the relationships among individuals within a family unit to create a measure of how closely related an individual is to the people she lives with. This brings this study directly in line with kin selection theory (Hamilton, 1964), since this theory rests on the "coefficient of relatedness" (**r**), or the proportion of genetic material the individual is likely to share with various kin. Flinn & England (1995) documented a difference in levels of stress hormones depending on family structure, and Quinlan (2003) showed that differences in childhood family structure were associated with differences in timing of female reproductive development Measures of family composition are also used in the sociological literature (e.g., Acock & Kiecolt, 1989). Since altruistic behavior is expected to be most common among kin (see Section 1.1.1), and selfish behavior at a minimum, knowing the number and type of kin an individual lived with should provide a useful proxy measure of the quality of interactions the individual would have experienced while growing up. That is, higher r reflects higher NTQ.

Local Conditions

According to the hypothesis outlined in Section 1.5, conditions of the immediate surroundings can be viewed as "local opportunity". Measures that reflect the economic circumstances in the community also reveal something about the ability of the local environment to sustain the individuals residing there. This is related to the concept of "*carrying capacity*", the number of individuals that a given habitat can sustain given the resources available in that area. County unemployment rate is an inverse proxy measure of local opportunity: A higher proportion of unemployed individuals implies fewer opportunities in the immediate environment. The size of the nearest city may also reflect local opportunity: a larger city nearby may act as a magnet for any individual to leave earlier, and its influence may be modified by NTQ. A smaller city may mean fewer opportunities away from the natal territory, and thus be associated with a longer dispersal delay.

2.3.2. Conceptual Dependent Variable: Dispersal Timing

Dispersal is defined as a transition in state, from "undispersed" to "dispersed", comprising three components, none of which is dependent upon the other for its occurrence. These are:

a) residential dispersal from family of origin (leaving home)

b) reproductive dispersal (birth of first child)

c) mating dispersal (first marriage)

Dispersal timing is measured as: a) age (in years) at dispersal from family of origin ("split-off" in PSID), b) age at birth of first child and c) age at first marriage. These life events are not assumed to occur in a particular order, nor is it expected that every individual will experience each of these events. See Section 2.3.4. for more details on the structure of these data sets.

2.4. Selection of Independent Variables

I chose measures of NTQ and local conditions based on several criteria. First, I attempted to use measures that have been used elsewhere in the sociological and behavioral ecological literature. In some cases these measures were not available in the PSID, or were not usable for the structure of my hypothesis. In such cases I chose PSID variables that I determined to be reasonable proxies for NTQ in birds. The following studies, combined with avian studies discussed in Section 1.3, provided the basis for my predictions.

Family income and parents' education are used frequently as measures of socioeconomic status or family resources, and have been shown to be important in studies of effects of childhood circumstances on various adult outcomes (e.g., Acock & Kiecolt, 1989; Axinn & Thornton, 1992; Buck & Scott, 1993; South & Crowder, 1999; South, 2001; Quinlan, 2003). Mother's education is used as a proxy for family SES in many studies (e.g., Haveman & Wolfe, 1995; Sucoff & Upchurch, 1998). Buck & Scott (1993) also use short-term changes in family income over time, which parallels my measure of income trajectory over the four years prior to dispersal. Occupational status is another measure of family circumstances as well, for example in Clarke, 1993, Low & Clarke, 1991 and Towner, 2001. Parental employment has also been shown to affect adult outcomes (Haveman & Wolfe, 1995; Sucoff & Upchurch, 1998).

Analysis of the effects of family structure on adult outcomes appears throughout the sociology, behavioral ecology, and evolutionary psychology literature (e.g., Belsky et al., 1991; Draper & Belsky, 1990; Draper & Harpending, 1982; Flinn, 1988; Flinn & England, 1995; Haveman & Wolfe, 1995; Hill et al., 1994; Quinlan, 2003). It is commonly invoked in studies of the timing of first reproduction, particularly in cases of teenage or out-of-wedlock births (that is, female reproductive development).

Effects of neighborhood characteristics life-course variables are documented in many studies, which influenced my choice of county unemployment rate and city size as measures of local conditions (Buck & Scott, 1993; South & Crowder, 1998, 1999; Sucoff & Upchurch, 1998).

2.5. Measures Used in This Study

Using the PSID data to test my hypothesis required extensive data management. First, I used multiple PSID sources of data to obtain all of the relevant variables, resulting in the creation of several data sets; these had to be merged at several stages. Next, the PSID coding of the variables had to be deciphered to ensure that the variable in question was actually measuring the relevant phenomenon. Then exceptions to the coding were identified, and temporal gaps in the PSID's collection of the variables were taken into account. All of these contributed to my choice of independent variables. I changed most variable names from numbers to terms that directly describe what the variable measures. After the distributions of each variable were examined carefully, I used the PSID variables to generate new variables that could be used together to measure NTQ.

2.5.1. General Data Structure

In general, I began with data from all available years, up to year of dispersal. Table 3 lists all variables used in my analysis; Appendix A provides additional detail on variable categories and transformations. In linear regression, using each year (1968-1993) for each NTQ variable would have made analysis quite cumbersome, first because there would have been too many variables relative to the sample size, second because variables are often not defined consistently over all waves and for some years some variables were not available at all, and finally because using the same variable over many years leads to potential overdetermination. To avoid these problems, for each NTQ variable I used the values for the four years before an individual physically left home ("split off"). Thus if an individual left home at age 19, I use the values for that individual's family when they were aged 15 to 18. Although I had to analyze each dispersal variable separately, I based all NTQ values on the age at residential dispersal ("splitoff"). I used the splitoff age, rather than age of reproduction or marriage, as a baseline because the four years before a person gave birth or married may have been years that she was already physically dispersed. This would be problematic for analysis because in such cases the family values for that year would be the value for the individual's own, adult household (her "splitoff family"), and not her family of origin. Thus the values for years before actually leaving home are the best measures of NTQ. Transformations specific to each variable are described below.

Table 3. Basic List of Variables Used

Dependent	**Name**	**Cohort**
	Age at Residential Dispersal	1967
	Age at First Birth	1967
	Age at First Marriage	1967
	Log Age at Residential Dispersal	1957
	Log Age at First Birth	1957
	Log Age at First Marriage	1957
Demographic	**Name**	**Cohort**
	Sex of individual	Both
	Race of Individual	Both
	Region	Both
Independent		
NTQ	Mean Log Adjusted Family Income	Both
NTQ	Log Adjusted Family Income Trajectory	
NTQ	Head's employment status	Both
NTQ	Personal Space (household density)	Both
NTQ	Head's Educational Attainment	Both
NTQ	Wife's Educational Attainment	Both
NTQ	Head's Occupational Prestige	Both
NTQ	Family composition	Both
Local Conditions	County Unemployment (%)	Both
Local COnditions	Size of Nearest City	Both

As described in Section 2.2.2., it was necessary to create a separate working data set for each of the three dependent variables: age at residential dispersal, age at first reproduction, and age at first marriage. The way I structured and transformed the NTQ variables was tailored to the specific range of dispersal ages for each dispersal type. Thus, each separate working data set is identical to the others with the exception of transformations that took into account the earliest dispersal age for each type (Section 2.3. and Table 4). Since there were data for so many years, the data sets would have been unwieldy if I had included each of the NTQ variables for all dispersal types in one data set.

Table 4. Dispersal age ranges and years.

COHORT	Dispersal type	Actual Dispersal Ages	Actual Dispersal Years
1957	Residential	16 – 36	1973-1993
	Reproductive	15 – 35	1972-1992
	Marriage	15 – 38	1972-1995
1967	Residential	15 – 30	1982-1997
	Reproductive	14 – 30	1981-1997
	Marriage	15 – 30	1982-1997

Specifically, I began with a main set of transformed variables based on age at residential dispersal ("splitoff" age). To construct these sets I used the value from the four years prior to residential dispersal (Dispersal year minus one (D-1), D-2, D-3, D-4), which of course may differ among subjects. I used the values for the residential dispersal set to create equivalent D-1 to D-4 variables for all relevant NTQ variables. If some first births (or marriages) occurred before the first splitoff age, I added coding to incorporate those cases into the D-1 to D-4 data. For each of the three dispersal data sets within each cohort, I removed all variables from the other two dispersal types (i.e., the "age at first marriage" subset does not have the "splitoff age" NTQ variables). This facilitates analysis since there are fewer variables, and it lowers the probability of using incorrect versions of variables in analysis. Thus, in the "age at first birth" subset, the reference point for "dispersal" when calculating D-1 to D-4 is either splitoff age (in most cases) or age at first birth, whichever came first for a given individual.

2.5.2. Demographic Measures

These potential confounds are included in some analyses to investigate their influence on the observed patterns.

1. Sex of respondent. In the PSID, male = 1 and female = 2; for analysis I transformed the variable so that M=0 and F=1.

2. Race of Respondent. I use the race of the head of the individual's family in 1968. Various inconsistencies in the data set make this the best way to estimate an individual's race. First, there was not a reliable variable available for the individual's race. Second, although the early waves (before 1980) did not distinguish among biological and other kinds of parents, the race of the mother would be the next best correlate to the individual's race; however mother's race was not available for the earliest waves. The head's race is available for all years, and since there is likely some correlation between the head's and the individual's race, regardless of the ambiguity, I chose this as a proxy for individual race. Also, regardless of the individual's race, the head's race may nonetheless play a role in NTQ, through its effect on family status and personal identity (e.g., Conley, 2004).

PSID race categories changed over time. I began by collapsing race variables (for all years) into three equivalent categories: black, white, and other. At the same time, I created an equivalent variable using only two categories: black and white. After exploratory analysis of frequencies and differences I determined that eliminating the "other" category made more sense than using it or than combining it with either other category. The proportion of cases in the "other" category in 1968 was 0.032 (3.2 percent).

3. Geographic Region

I applied this regional variable to family income adjusted for inflation. See Section 2.3.3.2. for details. This variable, available for all years, includes four categories: Northeast, North Central, South, and West. For some years, the PSID included two other categories: AK/HI and Foreign Country. For this study, I excluded cases who were living outside the U.S. and combined "AK/HI" with the West category. Percentage of the entire data set (four cohorts combined) in the AK/HI category, over the years 1968 to 1993, ranged from 0.00 to 0.3. This category was not used in 1968 and 1969. The PSID codebook does not give details about the four region categories for these two years. However, the U.S. Bureau of Labor Statistics (BLS) uses the same region categories for its analyses, and the PSID based all of their categories on these. Thus it is safe to assume that 1968 and 1969 were equivalent to other years. For all other years, regions included the following states (from PSID Codebook):

> NORTHEAST: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont
>
> NORTH CENTRAL: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, Wisconsin
>
> SOUTH: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, Washington DC, West Virginia
>
> WEST: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

2.5.3. Independent Variable: Natal Territory Quality

2.5.3.1. Economic Circumstances

1. Total family unit income, adjusted for inflation: The original continuous PSID variable includes five income variables: taxable income of head and wife; taxable income of other family unit members (OFUMs); transfer income of head and wife; transfer income of other OFUMs; Social Security income. I adjusted the PSID variable for inflation using the All Urban Consumers version of the Consumer Price Index (CPI) of the U.S. Bureau of Labor Statistics (BLS Guide to Available CPI Data). For better precision I incorporated regional categories since the PSID and the CPI use the same regional designations (see Section 2.3.2.). The Urban format represents 87% of U.S. consumers; it is the only format available for this adjustment (BLS Guide to Available CPI Data).

For both cohorts, I used log transformation of the D-1 to D-4 adjusted income variables. In order to reduce the number of variables in my analyses, I used two transformations of D-1 to D-4: the mean of the four years and the trajectory over the four years. The latter was created using the SLOPE command in Microsoft excel.

2. Head's Employment Status: The PSID categories for this variable change over time, therefore I re-coded it to make categories equivalent over all years. I then created the D-1 to D-4 versions of head's employment status, then reduced it to two categories: 1 = unemployed; 2 = employed. Thus all analyses of head's employment status use this dichotomous coding.

3. County Unemployment Rate: In the PSID this variable uses seven categories to reflect the percentage unemployed in the county of residence for a given year. Since the intervals between categories were approximately equal, I decided to treat this variable as a continuous variable. Again, I used D-1 to D-4 for each cohort and for each dispersal type within the cohorts. I compared the log transformed and the normal versions of the four unemployment values and determined that the normal version was acceptable for both cohorts. As with adjusted income, I created two new variables: the mean and the trajectory of D-1 and D-4.

4. Size of Largest City in County of Residence: This categorical variable begins with six categories for the size of SMSA (Standard Metropolitan Statistical Area) in the county. I first reverse-coded the categories so that larger numbers corresponded with larger cities. Next I created the D-1 to D-4 variables as described above. For analysis I reduced the number of categories to two: 0 = <100K; 1 = >=100K. Finally, I created the mean of this variable over the four years prior to dispersal.

2.5.3.2. Living Conditions

Household Density ("Personal Space") is computed using the ratio of the actual number of rooms in the household to the rooms required. The number of required rooms is determined by a standardized PSID variable based on family composition (Table 5). I used this ratio to create the D-1 to D-4 variables for household density, and used the mean of these four variables for analysis. The untransformed version of the room ratios approximates normality so I did not use the log transformed version. For clarity of interpretation, I call this variable "Personal Space"; as the ratio increases, personal space increases, and this higher values for this variable indicate better NTQ.

Table 5. PSID Criteria for "Required Rooms" (from PSID Codebook).

Base: 2 rooms for Head + Wife pair or single Head
- +1: Each single person > 18 years old
- +1: Each married couple older than Head/Wife
- +1: Each same-sex PAIR of children < 18 yo
- +1: Each pair of < 10 year old, regardless of sex, if this reduced the room requirement.

2.5.3.3. Parents' Occupational Status

Occupational Prestige for the head and wife of each family were based on the PSID's occupation classification variables from their 1968-1980 Retrospective Occupation-Industry (OCCIND) files and from the family data files from 1981 to 1993. Using U.S. Census three-digit 1970 occupation codes (U.S. Bureau of the Census, 1971), the OCCIND supplement comprises separate data files for each wave of the PSID from 1968 to 1980. Earlier versions of these variables used different classification systems (one-digit; two-digit) over the years, thus the OCCIND supplement updates all previously recorded occupation codes to the three-digit format. For all waves after 1980, the PSID used these three-digit codes, so the values from the family files for later years can be combined with those from the updated OCCIND supplement for a complete set of identically coded occupation data.

I used the standard occupational prestige classifications developed by Hodge, Siegel, and Rossi (Siegel, 1971); these correspond to the 1970 three-digit Census codes (U.S. Bureau of the Census, 1971). The codes are available from the General Social Survery (GSS) website (http://www.icpsr.umich.edu:8080/GSS/homepage.htm). Appendix F of the GSS codebook includes a link to the prestige codes and their corresponding occupations (http://webapp.icpsr.umich.edu/GSS/rnd1998/appendix/occu1970.htm). I converted the codes to Microsoft Excel format, then used the Microsoft Excel VLOOKUP command to convert the occupation codes for each individual, from each year of my data sets, into their corresponding prestige code. These values were then integrated back into the main data sets. While the prestige codes are ordinal rather than interval data, and thus technically not appropriate for use in linear regression, the large number of categories (possible values from 1-100) places the coding within generally accepted practice for treating ordinal variables as having equal intervals (Garson, 2004).

I created D-1 to D-4 versions of the occupational prestige data, and compared untransformed versions to log transformed. For the 1957 cohort, I used the untransformed version of head's occupational prestige, and for the 1967 cohort I used the log transformed version. I also created means and trajectories of D-1 to D-4 for each cohort. While data for both head and wife were available, the wife data were not available consistently; thus I used only the head data in my analysis.

2.5.3.4. Parents' Education

Two issues contribute to the difficulty of obtaining a consistent measure of parents' education:

A. *Categories change over time, and in later years the variable converts to continuous.* The values representing different education levels in PSID variables for parents' education are not consistent over the entire study. In order to create a variable that is comparable over the entire study period, I began with the education summary variables for each year and re-coded them to create equivalent values for different education levels. Table 6 presents PSID categories by year and corresponding re-coded categories.

Table 6. Intermediate Parents' Education Attainment: Intermediate categories used in exploratory analysis, PSID v. Present Study;

Nominal Category	**PSID Categories 1968-1984**	**PSID Categories 1985-1990**	**PSID Categories 1991-1993 (# grades)**	**Intermediate Categories**	**Dichotmous Categories: Present Study**
Less than HS	1-3	1-3	0-11	1	1: < BA
HS or GED	4	4	12	2	2: BA or greater
Some college	5*-6	5*-6	13-15	3	
BA	7	7	16	4	
> BA	8	8	17	5	
Can't read			0**		

Note: Categories 4 + 5 were later combined. See Appendix A for final categories. *5=12 grades + non-academic training; ** in wife's edu, 0 = no wife

I used these categories in the initial exploratory analysis. Due to insufficient numbers of cases in Category 5, I collapsed categories 4 and 5. I later collapsed the data into binary categories for use in linear regression: 1 = less than BA degree and 2 = BA or higher degree.

B. *These questions were not updated for every family for every year of the study.* For most years, the values for head's and wife's education were carried over from the previous year, unless the household acquired a new head or wife since the previous interview. Thus, if there was *not* a new head/wife, and the head/wife obtained more education between interviews, this fact would not appear. This is in part dealt with in values from the 1985 wave, when these questions were re-asked of all sample members. However, many cases, especially from the older (1957) cohort, dispersed prior to 1985.

Thus I decided that it would be most reliable to use parents' education for just one year. I chose the year before dispersal, since there was not a great deal of change in parents' education, both in terms of frequencies across the sample and changes across individual cases.

2.5.3.5. Family Composition

I used the Relationship (RELHIS) supplement (see Section 2.1.3.2.) and the Guide to Relationship History files (PSID Online Data Center) to generate an "average coefficient of relatedness" for each individual for each year from 1979 to 1985. As described in section 2.1.3.2., the RELHIS supplement includes codes for relationships between each individual and all other individuals in her household for all waves from 1968 to 1985, with the years 1982 to 1985 providing the most detail. There are several levels of coding: three-, five- and eight-digit codes provide increasing amount of detail. Each level has two subsets based on two different sources: The 1985 updated marital and fertility histories (HIS) records and the "relationship-to-head" (RTH) variables. The most detailed information is contained in the eight-digit codes and the most consistent information is from the 1985 marital and fertility histories, which were updated to compensate for the lack of detail prior to 1982. Thus I used the eight-digit HIS codes. A separate "coresidence" variable indicates whether a given dyad lived in the same dwelling in a given year. I used only dyads who resided in the same family unit for the year in question.

Several steps were necessary to allow merging of these data with the main data. First, I determined the "coefficient of relatedness" or r-value for each relationship code. For example, the PSID code for "full sister" is 52, which has a corresponding r-value of 0.50. Appendix B lists all relationships that occurred in my sample and their corresponding r-values.

Next I used the VLOOKUP command in Microsoft Excel to generate a variable that gave me the corresponding r-values for each relationship dyad in my data set. I used SAS to generate an average r-value for each individual for each year. Thus, for example, a series of seven dyads (seven family members) for person X in 1980 would result in a single, average value for that year. Finally I merged these new variables to the main data set. I then created means and trajectories for the set of average r values, using the same techniques as I used for the other NTQ variables.

I carried out this project for the 1967 cohort only. While data are available from 1968 to 1985, prior to 1983 the PSID did not distinguish among biological, step, and adoptive parents, nor did it make parallel distinctions in other relationships. Though the 1985 retrospective data collection reduced this limitation, the data for the 1957 cohort where still incomplete. The most complete data, even using the "HIS" versions of the variables, begins in 1980. Thus, since most of the 1957 cohort had already dispersed by 1980, and all were 23 years old at that time, the information I do have for their childhood or adolescent relationships is essentially useless in terms of computing meaningful degrees of relatedness.

2.5.4. Independent Variable: Local Conditions

1. County Unemployment Rate: In the PSID this variable uses seven categories to reflect the percentage unemployed in the county of residence for a given year. Since the intervals between categories were approximately equal, I decided to treat this variable as a continuous variable. Again, I used D-1 to D-4 for each cohort and for each dispersal type within the cohorts. I compared the log transformed and the normal versions of the four unemployment values and determined that the normal version was acceptable for both cohorts. As with adjusted income, I created two new variables: the mean and the trajectory of D-1 and D-4.

2. Size of Largest City in County of Residence: This categorical variable begins with six categories for the size of SMSA (Standard Metropolitan Statistical Area) in the county. I first reverse-coded the categories so that larger numbers corresponded with larger cities. Next I created the D-1 to D-4 variables as described above. For analysis I reduced the number of categories to two: 0 = <100K; 1 = >=100K. Finally, I created the mean of this variable over the four years prior to dispersal.

Table 7 lists all NTQ and local conditions variables and their expected relationship to dispersal timing.

Table 7. Independent Variables and Expected Outcomes.

Independent Variable	**Relationship to Hypothesis**	**Expected Outcome**
Adjusted Family Income: Mean	Higher value = higher NTQ	Higher income = later dispersal
Adjusted Family Income: Trajectory	Higher value = higher NTQ	Increasing income over time = later dispersal
Head's (Father's) employment status	Higher value = higher NTQ	Employed father = later dispersal
Personal Space (Rooms/Required)	Higher value = higher NTQ	Less personal space = smaller ratio = earlier dispersal
Head's (Father's) Educational Attainment	Higher value = higher NTQ	More education = later dispersal
Wife's (Mother's) Educational Attainment	Higher value = higher NTQ	More education = later dispersal
Head's (Father's) Occupational Prestige	Higher value = higher NTQ	Higher status = later dispersal
Family composition – Average r	Higher value = higher NTQ	More genetic kin in household = later dispersal
County Unemployment (%)	Higher value = poorer local opportunity	Higher unemployment = later dispersal
Size of Nearest City	Higher value = better local opportunity	Bigger city = earlier dispersal

2.5.5. Dependent Variable: Dispersal Timing

As described in Section 2.2.4.2., information on residential dispersal, reproduction, and marriage comes from three different supplemental data sets. I merged the data from the CAH and MH data sets with the main individual data set, which includes residential dispersal information. This leaves some ambiguity for individuals who are missing values for one or more of the dispersal variables. For example, an individual might appear in the main data file with an age at residential dispersal, but not have a value for age at first birth. This could be because she never gave birth within the study period, or it could be because her first birth was not recorded in the CAH files due to PSID methods. Thus there is a possibility that some individuals in the main data set will appear to have never given birth (or married), when in fact this is due to artifacts of the data collection procedure. Therefore, within each cohort I analyzed the three dispersal variables separately, using a separate data set for each type of dispersal.

2.5.5.1. Age at Residential Dispersal (Physical Dispersal from Family of Origin)

I obtained age at residential dispersal from the main individual data set. I used the "year of splitoff" variable, which corresponds to the year that an individual departed from her original PSID family. The "relationship to head" (RTH) variable is available for each year; it can be used to check the splitoff year variable by indicating whether a person was the "head" of a family in that year. I used the splitoff and RTH variables with Microsoft Excel coding to assure that the correct splitoff year was used, since cases could have more than one such age, for example if families split apart before actual dispersal. After determining correct year of dispersal I calculated age at splitoff by subtracting year of birth from year of splitoff.

2.5.5.2. Age at First Reproduction

This variable comes from the Childhood and Adoption History (CAH) data set (see Section 2.1.3.2.). I used the same procedure described above, subtracting the individual's year of birth from the year of her first reproduction to obtain her age at first birth.

2.5.5.3. Age at First Marriage

This variable comes from the Marriage History (MH) data set (see Section 2.1.3.2.). I used the same procedure described above, calculating age at first marriage by subtracting individual's year of birth from year of first marriage.

2.6. Analysis

2.6.1. Preliminary Analyses

Preliminary analyses included checking frequency tables and distribution plots of all independent variables and generating bivariate correlations on variables that were repeated over several years. Where distributions did not approximate normality I used several strategies. First I log transformed the variables. I also looked at individual outliers to see whether there values were consistent with the rest of their data. In cases where the values for the variable in question were greater than or equal to three standard deviations from the mean, and in cases where there appeared to be some error in data collection, I made the decision to either remove that case from analyses using that variable or to eliminate the case from the sample. This only applied in a very small percentage of cases. See section 2.3 for details on variable transformations.

2.6.2. Linear Regression

Multiple linear regression was used to detect significant relationships among the NTQ variables and each dependent variable. Each dependent variable was considered separately with all relevant predictor variables. All analyses were repeated for the 1957 cohort and the 1967 cohort, with the exception that the Family Composition variable (average coefficient of relatedness for each case) was only used with the 1967 cohort. See section 2.3 for descriptions of variable transformations used in linear regressions. I used the "enter" method of linear regression, which enters all independent variables to produce one model, in contrast with stepwise methods, which remove non-significant variables to produce one to several alternative models. I began with all predictor variables and demographic variables, then used significant predictors from these initial regressions to obtain significant models with only significant coefficients. Directions and size of standardized beta coefficients were used in the interpretation of these models. Tables 7 through 11 list all significant models, standardized beta coefficients, and p-values for each coefficient.

As described above, I test the hypothesis under six different conditions (two cohorts times each of three dispersal components; see Table 4). For each condition I use nine independent variables in multiple regression to test the hypothesis; each must be significant in the predicted direction in order to be considered. Therefore I must establish the probability that the number of significant variables in a given test could have been due to chance. The acceptable probability of such an error was set at < 0.05. I used the following formula to estimate the probability of *exactly* **s** successes (significant coefficients) in **t** "trials" (predictors): $(t!/s!\ [t-s]!)\ p^{s}(1-p)^{(t-s)}$. To calculate the probability of *at least* **s** successes, I iterated the formula for s, s+1, s+2…t, then summed the results of the iterations (after Gaulin & Robbins, 1991, p. 67, fn. 3).

According to this formula, with nine independent variables the probability of at least two significant outcomes is 0.071 and the probability of at least three significant outcomes is 0.008. Therefore, for each of the six main tests, support for my hypothesis at the 0.05 level requires at least *three* significant coefficients out of nine independent variables.

In cases where the above criterion is not met, but two of the nine coefficients are significant, an adjusted R^2 of 0.30 or greater for the model is considered acceptable as support for my hypothesis.

2.6.3. Proportional Hazards: Cox Regression

Because I had access to longitudinal data I attempted to use survival type analyses to measure the risk of a dispersal event happening. Unlike linear regression, proportional hazards using Cox regression allows analysis of all cases, including "censored" cases, or cases for which dispersal data are not available. Data are structured such that each individual has a value for the time at which the event occurred, or the time at which that individual was "lost to follow-up" (i.e., disappeared from the sample), whichever came first. In this case "dispersal" is the event, and age at dispersal is the "time to event". Cases that left the study before it ended or who had not dispersed by the end of the study (1993 for my purposes) were given an age that corresponded to one of those times. In addition, for Cox regression each case is given a "status" value to reflect whether the case was censored or dispersed. I prepared the data for these analyses but discovered that my data set was not ideal for these regressions.

Limitations of my data set:

a) Incomplete information for age at first birth and age at first marriage.

b) Cox regression requires complete data – any case with missing cells is excluded from the analysis. Even considering only a few data points failed to provide enough data.

c) Only able to do this analysis for the younger (1967) cohort, since data for the 1957 cohort were only available after age 11. The sample sizes for the 1967 cohort were too small to maintain the power required by Cox regression, due to b). Thus results of these analyses are not reported here.

3. RESULTS

Results of multiple linear regressions are presented by cohort. Within each cohort I describe the analyses for each dispersal type. Table 4 lists dispersal age ranges for each cohort, all relevant statistics are found in Tables 8 through 13, and Appendix C provides all regression equations. Tables 8a – 8d list statistics for all regression models reported in Sections 3.1. – 3.4. (See next page.)

Table 8a. ***1957 Cohort*****: Summary of Significant Models All Dispersal Ages**

Cohort	**Dispersal Variable**	**Model Information**	**N**	**F**	**Adjusted R^2**	**P value**	**Coefficient Table**
1957	**Age at Residential Dispersal**	General Model	195	11.343	0.208	< 0.001	9a
		Race * Income trajectory	195	12.612	0.193	< 0.001	9b
		Sex * Income	199	18.870	0.153	< 0.001	9c
		Income * Cty Unemp	198	10.819	0.199	< 0.001	9d
		Mother Edu*Father Edu	129	6.318	0.143	<0.001	9e
		Father Edu*Cty Unemp	196	18.450	0.152	<0.001	9f
		Mother Edu*Cty Unemp	131	7.523	0.167	<0.001	9g
1957	**Age at First Reproduction**	General	100	13.998	0.396	< 0.001	10a
		Father's Education	160	17.759	0.297	< 0.001	10b
		Mother's Education	100	14.487	0.353	< 0.001	10c
		Mother Edu*Father Edu	100	18.011	0.407	<0.001	10d
		Father Edu*Income	100	13.976	0.396	<0.001	10e
		Mother Edu*Income	100	14.001	0.427	<0.001	10f
1957	**Age at First Marriage**	General Model	162	5.176	0.072	0.002	10g
		Father Edu*Income	156	8.468	0.162	<0.001	10h

Note: See Appendix C for regression equations

Table 8b. ***1957 Cohort*****: Significant Models Dispersal Ages 30 and Younger**

Cohort	Dispersal Variable	Model Information	N	F	Adjusted R2	P value	Coefficient Table
1957 30	Age at Residential Dispersal	General Model	193	12.067	0.224	<0.001	11a
1957 30	Age at First Reproduction	General Model	88	13.450	0.364	<0.001	11b
1957 30	Age at First Marriage	General Model	139	6.56	0.108	<0.001	11c

Table 8c. ***1967 Cohort*: Significant Models All Dispersal Ages.**

Cohort	Dispersal Variable	Model Information	N	F	Adjusted R^2	P value	Coefficient Table
1967	**Residential Dispersal Age**	Single Model	131	8.362	0.145	< 0.001	12a
1967	**Age at First Reproduction**	Father's Employment Status	93	5.139	0.043	0.026	12b
		Mother's Education (4 Cat)	40	7.289	0.139	0.010	12c
		Mother's Education (2 Cat)	40		0.005	NS	
		Adjusted Family Income	93	7.859	0.069	0.006	12d
		Sex	106	6.500	0.050	0.012	12e
1967	**Age at First Marriage**	Single Model	72	14.016	0.268	<0.001	12f

Note: See Appendix C for regression equations

Table 8d. ***1967 Cohort*: Significant Models Dispersal Ages 18 and Older.**

Cohort	Dispersal Variable	Model Information	N	F	Adjusted R^2	P value	Coefficient Table
1967 18	**Residential Dispersal Age**	Single Model	124	8.430	0.195	<0.001	13a
1967 18	**Age at First Reproduction**	*No Significant Model*					None
1967 18	**Age at First Marriage**	*No Significant Model*					None

Note: See Appendix C for regression equations

3.1. 1957 COHORT – All Dispersal Ages

3.1.1. Age at Residential Dispersal

Multiple linear regression using the enter method resulted in significant relationships between timing of residential dispersal and sex of individual, adjusted family income, county unemployment rate, head's employment status, and family income trajectory (N=195; F=11.343; adjusted R^2=0.208; p=0.000) (Table 9a.). Including race of head in preliminary regressions affected which coefficients were significant; specifically, head's employment status and income trajectory were significant when race was included in the early models (where all variables were entered to determine significant coefficients; see Section 2.4.2). Therefore I tested an alternative model using interactions between race and each of the latter two variables. Results of these models showed a significant interaction between race and income trajectory, but not between race and head's employment status. A final model using sex, mean county unemployment, mean family income, and race*income trajectory was significant as well (N=195; F=12.612; adjusted R^2=0.193; p=0.000). Table 9b gives standardized beta coefficients and p-values for all variables. The directions of the relationships were as follows: males dispersed later; higher county unemployment was associated with later dispersal; higher family income resulted in later dispersal. Race modulated the effect of income trajectory on age at residential dispersal, increasing slope of family income was associated with earlier dispersal for both races.

Tables 9a.-9g. 1957 Significant Regression Models: Residential Dispersal.
See Table 8a. for model statistics.

Dependent Variable	Model	Variable	Standardized Beta (weight)	P
Residential Dispersal	**9a.** General Model	Sex (male=0; female=1)	-0.168	0.01
		Family income	0.237	0.002
		Family income trajectory	-0.136	0.039
		County unemployment	0.326	<0.001
		Father employment status	-0.157	0.04
	9b. Race * Income Trajectory	Sex	-0.178	0.007
		Family income	0.148	<0.001
		County unemployment	0.338	0.023
		Race * Family Income Trajectory	-0.132	0.047
	9c. Sex * Income	County unemployment	0.360	<0.001
		Sex * Income	-0.175	0.008
	9d. Income * Cty Unemp	Sex	-0.169	0.01
		Family income	0.178	0.022
		Family income trajectory	-0.139	0.036
		Father’s employment status	-0.160	0.038
		Income * County unemployment	0.318	<0.001
	9e. Mother Edu*Father Edu	Sex	-0.200	0.017
		Family income trajectory	-0.176	0.036
		Income * County unemployment	0.208	0.014
		Mother edu * Father edu	0.170	0.041
	9f. Mother’s Edu*Cty Unemp	Family income	0.242	0.007
		Family income trajectory	-0.219	0.008
		Father’s employment status	-0.226	0.011
		Mother’s edu * County unemployment	0.275	0.001
	9g. Father’s Edu*Cty Unemp	Sex	-0.209	<0.001
		Father’s edu * County unemployment	0.278	0.002

I also investigated interactions between sex and mean family income and sex and county unemployment. A significant model resulted when county unemployment and sex*income were included (N=199; F=18.870; adj. R^2=0.153; p<0.001) (Table 9c); consistent with previous results, males left home later and higher county unemployment delayed dispersal; further, these results suggest that the relationship between leaving home and family income is different for males than for females. In a regression using family income and sex*unemployment, only 3.7 percent of the variance was explained and the interaction coefficient was NS. Thus the interaction between sex and income is important while that between sex and county unemployment is not.

I also investigated the interaction between family income and county unemployment rate (Table 9d.). In multiple regression, age at residential dispersal was significantly related to sex, family income, family income trajectory, head's employment status, and the interaction between income and county unemployment (N=198; F=10.819; adj. R^2=0.199; p<0.001). In this model, males leave home earlier, and individuals whose fathers are employed leave earlier. Higher income is associated with later dispersal, while income that increases over time is associated with earlier dispersal. The significant interaction indicates that family income has an effect on how unemployment influences dispersal age.

Although parents' education did not appear to influence age at residential dispersal in the main effects models, further analysis suggested that the educational attainment of one parent modulates the effects of the other parents' education (Table 9e). The interaction between mother's and father's education is significant, but only when mean family income and father's employment status are removed from the model (N=129; F=6.318; adj. R^2=0.143; p<0.001).

A model including the interaction between mother's education and county unemployment rate was significant when sex was excluded and the other original main effects (mean family income, income trajectory, and father's employment status) were included (N=131; F=7.523; adj. R^2=0.167; p<0.001)(Table 9f). The beta weight for the interaction was 0.275, compared to a weight of 0.326 for county unemployment in the main effects model.

The interaction of father's education and county unemployment rate was also significant, but only when combined with respondent's sex (N=196; F=18.450; adj. R^2=0.152; p<0.001; Table 9g).

A model including the interaction between mother's education and county unemployment rate was also significant when sex was excluded and the other original main effects (mean family income, income trajectory, and father's employment status) were included (N=131; F=7.523; adj. R^2=0.167; p<0.001) (Table 9f). The beta weight for the interaction was 0.275, compared to a weight of 0.326 for county unemployment in the main effects model.

3.1.2. Age at First Reproduction

Multiple linear regression using the enter method resulted in several significant models for timing of first reproduction (Tables 10a, 10b, and 10c). **General Model:** When both father's and mother's educational attainment were included, both were significant, as were sex, household density (rooms/required), and size of nearest city (N=100; F=13.998; adj. R^2=0.396; p<0.001). **Father's Education Model:** Using father's education and not that of the mother, significant predictors of age at leaving home were sex, father's education, household density, and size of nearest city (N=160; F=17.759; adj. R^2=0.297; p<0.001). **Mother's Education Model:** Finally, considering mother's education without that of the father resulted in significant coefficients for sex, mother's education, household density, and size of nearest city (N=100; F=14.487; adj. R^2=0.353; p<0.00).

Tables 10a.-10h. 1957 Significant Regression Models: Age at First Reproduction and First Marriage.
See Table 8a. for model statistics.

Dependent Variable	Model	Variable	Standardized Beta (weight)	p
First Reproduction	**10a**. General	Sex (male=0; female=1)	-0.196	0.017
		Father's education	0.236	0.006
		Mother's education	0.23	0.006
		Personal space	0.347	<0.001
		Size of nearest city	0.233	0.004
	10b. Father's Education	Sex	-0.296	<0.001
		Father's education	0.305	<0.001
		Personal space	0.259	<0.001
		Size of nearest city	0.179	0.009
	10c. Mother's Education	Sex	-0.184	0.031
		Mother's education	0.278	0.001
		Personal space	0.409	<0.001
		Size of nearest city	0.214	0.011
	10d. Mother's Edu*Father's Edu	Sex	-0.190	0.020
		Personal space	0.348	<0.001
		Size of nearest city	0.244	0.003
		Mother's edu*Father's edu	0.376	<0.001
	10e. Mother Edu*Income	Sex	-0.195	0.018
		Father's education	0.232	0.007
		Personal space	0.338	<0.001
		Size of nearest city	0.227	0.005
		Mother's edu*Family income	0.234	0.006
	10f. Father Edu*Income	Sex	-0.197	0.017
		Mother's education	0.229	0.006
		Personal space	0.338	<0.001
		Size of nearest city	0.228	0.005
		Father's edu*Family income	0.238	0.006

Dependent Variable	**Model**	**Variable**	**Standardized Beta (weight)**	**P**
First Marriage	**10g.** General Model	Race	0.244	0.007
		Family Income	0.274	0.007
		Father’s employment status	-0.259	0.003
	10h. Father’s Edu*Income	Race	0.272	0.003
		Family income	0.304	0.002
		Father’s employment status	-0.362	<0.001
		Father’s education*Family income	0.277	0.001

The directions of significant relationships were the same for all models. Females tended to reproduce earlier than males. Higher educational status of either parent was associated with later reproduction, as was lower household density (higher ratio of rooms/required). Living near a larger city is also associated with later dispersal.

I investigated an interaction between mother's and father's educational attainments; this interaction is significant when it replaces each of these variables and is combined with the other significant main effects variables (see Table 10a). For the interaction model, N=100; F=18.011; adj. $R^2=0.407$; $p<0.001$ (Table 10d). Thus effects of one parent's education mediate the effects of the other's education on age at first birth.

Family income was not significant in the main effects models for age at first reproduction (Tables 10a-10c), but significant interactions between family income and parents' education suggest that the effects of parents' education is mediated by family income. Recall that parents' education was an important covariate in all models. Interactions between mother's education and family income and father's education and family income were significant when combined with the main effects model (Tables 10e and 10f).

In a model (B, below), that includes the interaction between father's education and family income plus all independent variables from the main effects model presented in Table 10a, the outcome is essentially the same as the main effects model (A, below) (N=100; F=13.976; adj. $R^2=0.396$; $p<0.001$) (Table 10f). For both the main effects model and the interaction model, adjusted $R^2=0.396$.

Equation A, Main Effects only (Table 10a):
agebirth = -0.73*sex + 0.117*dad edu + 0.120*mom edu + 0.198*density + 0.089*city + 3.139

Equation B, interaction: family income*father's education replaces father's education (Table 10f):
agebirth = -0.73*sex + 0.011*(dad edu*family income) + 0.119*mom edu + 0.193*density + 0.087*city + 3.034

Equation C, interaction: family income*mother's education replaces mother's education (Table 10e):
agebirth = -0.73*sex + 0.011*(mom edu*family income) + 0.115*dad edu + 0.193*density + 0.087*city + 2.913.

Equation D, interactions of family income and mother's education and family income and father's education
agebirth = -0.73*sex + 0.010*(dad edu*family income) + 0.011*(mom edu*family income) + 0.190*density + 0.085*city + 2.928

In the equivalent model using the interaction between mother's education and family income (C, above), results are similar to the above models (N=100; F=14.001; adj. R^2=0.427; p<0.001)(Table 10e). For further comparison, I include both parents' education x income interaction terms in the same model (N=100, F=13.84, adj. R^2=0.393, and p<0.001) (D, above).

In sum, all models that used interactions between either parents' educational attainment and family income were significant, and did not appear to vary from the original main effects model that did not include family income. The main difference between the original model and the interaction models is that the unstandardized coefficients were much smaller for the interactions.

I also investigated an interaction between county unemployment rate and each parent's education. From the results of these regressions I concluded that the original main effects model (Table 10a) better explains the variance in age at first reproduction than does any model with either of these interactions.

3.1.3. Age at First Marriage

Multiple linear regression using the enter method resulted in significant relationships between timing of first marriage and race, adjusted family income, and father's employment status ($N=162$; $F=5.176$; adj. $R^2=0.072$; $p=0.002$) (Table 10g). Individuals tended to marry earlier if the heads of their families were employed, while they tended to marry later with increasing family income. Whites tended to marry earlier than blacks.

Although parents' education was not significant in the main effects model for age at first marriage, further analysis revealed a significant interaction between father's education and family income. When this interaction was considered with the significant variables from the main effects model (Table 10h), both the interaction and the family income variable were significant, along with the other two original variables (race and father's employment status) ($N=156$; $F=8.468$; adj. $R^2=0.162$; $p<0.001$). Other interactions were not significant.

3.2. 1957 COHORT – Dispersal Ages 30 and Younger

3.2.1. Age at Residential Dispersal

Restricting this cohort to individuals who left home at age 30 or earlier removed only two cases from the analysis. Linear regression using the forced entry method revealed significant relationships between the timing of residential dispersal and respondent's sex, mean family income, county unemployment rate, and father's employment status ($N=193$; $F=12.067$; adj. $R^2=0.208$; $p<0.001$) (Table 11a). These results closely parallel those found for this cohort when all residential dispersal ages were considered (see Section 3.1.1; Table 9a). Including variables that were significant for the 1967 cohort but not for the complete 1957 cohort (race and personal space) resulted in non-significant models and coefficients.

3.2.2. Age at First Reproduction

Restricting this cohort to individuals who reproduced at age 30 or younger removed 12 cases from the analysis. Results of linear regression using the truncated 1957 cohort parallel the results of the original cohort (see Section 3.1.2; Table 10a): respondent's sex, mother's education, personal space, and size of nearest city were all significantly related to age at reproductive dispersal (N=88; F=13.450; adj. R^2=0.364; p<0.001) (Table 11b). In contrast to the original cohort, father's education did not significantly contribute to reproductive timing. Adding variables that were significant in for the 1967 cohort revealed a significant relationship between family income and age at first reproduction, but only when the above variables (excepting sex) were not in the model.

3.2.3. Age at First Marriage

Restricting this cohort to individuals who married at or before age 30 removed 23 cases. Linear regression revealed significant relationships between age at first marriage and race, family income, and father's employment status (N=139; F=6.56; adj. R^2=0.108; p<0.001; Table 11c). These results parallel those found for the complete 1957 cohort (see Table 10g). While still low, adjusted R^2 for the truncated cohort's model was 0.108, compared to the adjusted R^2 for the complete cohort (0.072).

Tables 11a.-11c. 1957 Cohort Dispersal Ages 30 and Younger: Significant Regression Models

Dependent Variable	Model	Variable	Standardized Beta (weight)	p
Age at Residential Dispersal	**11a.** 1957 Truncated	Sex	-0.149	0.023
		Family income	0.251	0.001
		Family income trajectory	-0.156	0.019
		County unemployment	0.340	<0.001
		Father's employment status	-0.154	0.043
Age at First Reproduction	**11b.** 1957 Truncated	Sex	-0.213	0.019
		Mother's education	0.270	0.003
		Personal space	0.399	<0.001
		Size of nearest city	0.218	0.013
Age at First Marriage	**11c.** 1957 Truncated	Race	0.227	0.016
		Family income	0.413	<0.001
		Father's employment status	-0.301	0.001

3.3. 1967 COHORT – All Dispersal Ages

Table 8c lists statistics for all regression models reported in Section 3.2.

3.3.1. Age at Residential Dispersal

Linear regression using the forced entry method resulted in significant relationships between timing of residential dispersal and race, father's employment status, and household density (N=131; F=8.362; adj. R^2=0.145; $p<0.001$) (Table 12a). Lower household density was associated with later dispersal from home, while individuals whose family heads were employed tended to leave earlier. Whites tended to leave home at an earlier age than did blacks.

Tables 12a.-12e. 1967 Significant Regression Models: All Dispersal Ages.
See Table 8b. for model statistics.

Dependent Variable	Model	Variable	Standardized Beta (weight)	p
Residential Dispersal	**12a.** General Model	Race	0.271	0.003
		Father's employment status	-0.209	0.016
		Personal space	0.382	< 0.001
First Reproduction	**12b.** Father's Employment Status	Father's employment status	0.231	0.026
	12c. Adjusted Family Income	Adjusted family income	0.282	0.006
	12d. Sex	Sex (male=0; female=1)	-0.243	0.012
First Marriage	**12e.** General Model	Sex	-0.338	0.001
		Father's occupational prestige	0.426	<0.001

3.3.2. Age at First Reproduction

The 1967 cohort also resulted in several different models for age at first reproduction (Tables 12b-12d). Using the enter method of linear regression, three different variables were significantly associated with reproductive dispersal, but only when considered on their own. Individuals from families where the head was employed reproduced later (N=93; F=5.139; adj. R^2=0.043; p=0.026) (Table 12b). Higher family income was associated with later reproduction as well (N=93; F=7.859; adj. R^2=0.069; p= 0.006) (Table 12c). Finally, sex was also significant in a univariate regression (N=106; F=6.5; adj. R^2=0.050; p= 0.012) (Table 12d). Regressions using all possible combinations of these variables were not significant.

3.3.3. Age at First Marriage

Multiple linear regression using the enter method resulted in significant relationships between age at first marriage and sex and father's occupational prestige (N=72; F=14.016; adj. R^2=0.268; p<0.001) (Table 12e). Females married later, and higher occupational prestige of the household head was associated with later marriage.

3.4. 1967 COHORT Using Family Composition – Dispersal Ages 18 and Older

As described in Section 2.3.3.5., the structure of the RELHIS data is such that I cannot consider cases that dispersed before 1985. Analyses described here thus consider only individuals who dispersed in 1985 or later. These regressions parallel those described above with the addition of two variables: The mean of the seven years (1979-1985) of average degree of relatedness (r), and the trajectory of average r over this time period. Table 8c lists statistics for all regression models reported in Section 3.3.

3.4.1. Age at Residential Dispersal – 18 and Over

Multiple linear regression resulted in significant relationships between age at residential dispersal and race, county unemployment, father's employment status, and household density (N=124; F=8.430; adj. R^2=0.195; p<0.001) (Table 13). This is consistent with the results in Section 3.2.1, with the additional influence of county unemployment: Higher county unemployment is associated with earlier dispersal. The family composition variables do not have an influence for individuals who disperse after age 17.

Table 13. 1967 Significant Regression Models: Dispersal Ages 18 and Over.
See Table 8c for model statistics.

Dependent Variable	Model	Variable	Standardized Beta (weight)	p
Residential Dispersal	**13a.** Single Model	Race	0.217	0.020
		County unemployment rate	-0.287	0.001
		Father's employment status	-0.245	0.005
		Household density	0.301	0.001
First Reproduction	*No sig model*			
First Marriage	*No sig model*			

3.4.2. Age at First Reproduction – 18 and Over

Analyses of the influences on age at first birth in those whose first birth occurred between ages 18 and 31 did not reveal any clear relationships. Multiple regressions resulted in some significant coefficients, including sex, father's education, and mother's education, but none of the models themselves was significant. The family composition variables were eliminated in the first stages. Sample sizes for both the reproduction and marriage data sets, especially in the

1967 cohort, were smaller than those for residential dispersal. This may have contributed to the lack of significant results.

3.4.3. Age at First Marriage – 18 and Over

Analyses of the influences on age at first marriage in those whose first birth occurred between ages 18 and 31 did not reveal any clear relationships. Multiple regressions resulted in some significant coefficients, family income trajectory and father's occupational prestige; individual's sex approached significance. However, none of the models themselves was significant, nor were any variables significant when considered alone in linear regression. The family composition variables were eliminated in the first stages.

3.5. Overall Support for Hypothesis

According to the criteria established in Section 2.6.2., a claim that my hypothesis was supported required a model with at least three of nine significant predictors. Alternatively, if a model had two significant predictors but an adjusted R^2 of at least 0.30, I also considered this acceptable as support for my hypothesis. Only reproductive dispersal in the 1957 cohort fulfilled the first criterion, with three significant predictors and an adjusted R^2 of 0.396 in the main effects model. Reproductive dispersal in the truncated (at age 30) 1957 cohort fulfilled the alternative criterion, with two significant predictors and an adjusted R^2 of 0.364. None of the other cohorts provided support for the hypothesis using either of the above criteria.

4. Discussion

Emlen's model of avian family formation predicts that individuals from higher quality natal territories will be more selective in their dispersal choices than will individuals from lower quality natal territories. This dissertation tested this prediction in humans, using measures of childhood circumstances that were designed to approximate human "natal territory quality" (NTQ). I hypothesized that dispersal timing would differ depending on the quality of an individual's natal territory, and that a higher quality natal territory would result in delayed dispersal. I also predicted that delayed dispersal would result from poorer local conditions.

I conceptualized natal territory as comprising five components: Economic Circumstances, Living Conditions, Parents' Occupational Prestige, Parents' Education, and Family Composition. Local conditions included county unemployment rate and the size of the nearest city. Within each component I used one or more variables to measure the effect of each component and local conditions on the timing of three types of dispersal event: Age at Residential Dispersal, Age at First Reproduction, and Age at First Marriage.

The initial discussion of the results is organized by dispersal type, then by cohort within each dispersal type. The discrepancy among cohorts in terms of significant NTQ variables makes this approach more practical than discussing each type of dispersal as a unified whole. As a reference for this chapter, Table 14 provides all significant predictors for each dispersal type, including the direction of relationships.

Table 14. All Significant Predictor Variables and Directions of Relationships.

Dispersal Type	Predictor	1957 Cohort	1957 30- Cohort	1967 Cohort	1967 18 + Cohort
Residential	Sex	(-)	(-)	NS	NS
	Family income	(+)	(+)	NS	NS
	Income trajectory	(-)	(-)	NS	NS
	County unemp	(+)	(+)	NS	(-)
	Father emp status	(-)	(-)	(-)	(-)
	Household Density	NS	NS	(+)	(+)
	Race of head	NS	NS	(+)	(+)
	Sex*Income	(-)	N/A	N/A	N/A
	Race*Income traj	(-)	N/A	N/A	N/A
	Income*County unemp	(+)	N/A	N/A	N/A
	Father's edu*Mother's edu	(+)	N/A	N/A	N/A
	Mother's edu*County unemp	(+)	N/A	N/A	N/A
	Father's edu*County unemp	(+)	N/A	N/A	N/A
Reproductive	Sex	(-)	(-)	(-)	NS
	Family income	NS	NS	(+)	NS
	Father's education	(+)	NS	(+)	NS
	Mother's education	(+)	(+)	NS	NS
	Rooms/required	(+)	(+)	NS	NS
	Nearest city size	(+)	(+)	NS	NS
	Father emp status	NS	NS	(+)	NS
	Father's edu*Mother's edu	(+)	N/A	N/A	N/A
	Mother's edu*Family income	(+)	N/A	N/A	N/A
	Father's edu*Family income	(+)	N/A	N/A	N/A
Marriage	Family income	(+)	(+)	NS	NS
	Race	(+)	(+)	NS	NS
	Father emp status	(-)	(-)	NS	NS
	Sex	NS	NS	(-)	NS
	Father occupational prestige	NS	NS	(+)	NS
	Father's edu*Family income	(+)	N/A	N/A	N/A

4.1. Age at Residential Dispersal

4.1.1. 1957 Cohort

Regardless of sex, the effect of the natal family's income trajectory on residential dispersal is different for blacks and whites. There is a difference for females versus males in the influence of family's income, and income itself mediates the influence of county unemployment rate on residential dispersal timing. The latter is interesting because it integrates conditions in the natal territory with extrinsic factors. The interaction of income and county unemployment rate is consistent with integrative theories on delayed dispersal (Section 1.3.5.): benefits of philopatry (income) and local conditions (employment opportunities) appear to jointly influence the decision to disperse.

While parents' educational attainment also appears to modulate the effects of county unemployment rate on age at residential dispersal, the effects of education are seen only in the context of this interaction. Thus it is possible that parents with more education provide an advantage in dealing with poor local conditions. Historically, individual educational attainment is correlated with parental education and it may also be the case that higher individual education gives an advantage in a poor employment environment.

The directions (positive or negative) of the influences of each predictor variable were consistent across all residential dispersal models for the 1957 cohort (Table 8a; Section 3.1.1.). Females dispersed earlier than males, which provides evidence for female-biased dispersal in humans (Section 1.2.), though both sexes do ultimately disperse. Higher family income was associated with later dispersal, which directly supports the proposed hypothesis that higher quality natal territory predicts delayed dispersal. Higher county unemployment was also associated with later dispersal, which suggests that, as hypothesized, poorer local conditions act to keep individuals at home longer. That is, in this population the trade-off between the benefits of leaving home and the costs of staying appears to favor staying, again indicating parallels to delayed dispersal in other animals. On the other hand, the results suggest that individuals whose family income decreased over time also dispersed later, and those whose fathers were unemployed dispersed later. The latter two outcomes suggest that poorer conditions at home, under some circumstances, may also lead to delayed dispersal.

4.1.2. 1967 Cohort: All dispersal ages.

As in the 1957 cohort, individuals whose fathers were unemployed in the years leading up to dispersal left home later. However, unlike those born in 1957, residential dispersal in the 1967 cohort was influenced by race and by household density. For this population, blacks left home later than whites, and individuals from less crowded homes left later. Lower household density may be interpreted as a proxy for higher NTQ, not only in terms of the ability of the family to support itself but also in terms of competition for these resources. Thus the later dispersal associated with lower household density supports the hypothesis that higher NTQ is related to later residential dispersal. Future studies might include a more comprehensive analysis of race; however, since the race variable is itself a proxy for the individual's actual race (Section 2.3.2.) perhaps its apparent influence is less reliable in this study.

4.1.3. 1967 Cohort: Dispersal Ages 18 and Older

A sub-sample of individuals who dispersed after age 17 was considered separately due to limitations in the family composition data. Contrary to expectation, the average coefficient of relatedness did not significantly affect dispersal age, and this variable was excluded from all models. As in the full 1967 cohort, in this sub-sample whites left home earlier than did blacks. Consistent with all previous results, individuals with unemployed fathers dispersed later. This suggests that NTQ components ought to be subdivided into those that, when better, *delay* dispersal, and those that, when better, *accelerate* dispersal.

In contrast with all other outcomes in this dissertation, in this truncated group of slightly-later dispersers, individuals dispersed earlier where county unemployment was higher. Thus, lower likelihood of employment in the surrounding area seems to have been a cue that staying at home longer was not the best option. While the usefulness of the results for this sub-sample might be limited, it is interesting to observe that the reaction to local conditions appears to be different when considering only individuals who left home at the more “traditional” cut-off point of 18 years old.

4.2. Age at First Reproduction

4.2.1. 1957 Cohort

Except for sex and household density, a different set of predictors were significantly associated with age at first birth compared to age at residential dispersal. Family income did not influence reproductive timing. In line with the findings for residential dispersal, females reproduced earlier and lower household density was associated with later reproduction. However, compared to residential dispersal parents’ educational attainment played a greater role in the timing of reproductive dispersal, as did the population size of the nearest city. Both mother's and father's education appear to be associated with later dispersal, supporting the hypothesis that higher NTQ is associated with later dispersal. The latter hypothesis gains further support from the fact that those whose homes were less crowded in the years before they left also gave birth later.

Greater city size was associated with later reproduction across all analyses in which this variable was significant. This suggests that better opportunities close to home might delay reproduction. The size of the nearest city may reflect local conditions such that a larger city nearby provides greater opportunities for success at independence. Recall that in the case of residential dispersal, another measure of local conditions (county unemployment rate) suggested that *poorer* extrinsic conditions might keep a person at home. In the case of city size, it appears instead that what might be *better* local opportunity delays reproduction. The latter could be explained simply by the fact that if there are more opportunities (e.g., careers in the city), people might be more likely to put off having children. Unfortunately data to test this are not available here.

The interaction of mother's and father's educational attainments suggests that when it comes to age at reproductive dispersal, these two elements of NTQ can mediate each other's effects. This might mean that a higher educational level for one parent may compensate for a lower level in the other.

The models that include interactions between parents' education and family income suggest that while family income on its own does not significantly effect age at first reproduction in this cohort, income does moderate the effects of parents' education. Since parents' education is a significant predictor in main effects models as well, these interactions might mean that in terms of the quality of the natal territory, higher parental education can make up for lower income.

Overall it appears that, compared with residential dispersal, less material measures of NTQ in the years before leaving home are better predictors of the timing of reproductive dispersal in the 1957 cohort. The factors that do affect reproductive timing may have more to do with what Kaplan and Lancaster (2000) describe as “Embodied Capital” than with perceived resource availability. Recall that according to life history theory, individuals of any species must allocate limited resources between somatic effort and reproductive effort in order to maximize reproductive success, and decisions about when to divert investment from continued growth toward mating or parenting effort are determined by trade-offs (Section 1.4.2). Ecological variation in the benefits of different allocation strategies result in individual differences in the relationship between investments and outcomes. Kaplan and Lancaster use the term “Embodied Capital” (EC) to refer to resources garnered through somatic effort in humans; these include skills and knowledge in addition to physiological attributes such as strength, immune competence, and coordination. According to this model, once an individual is sexually mature, further investment in EC should reflect the likelihood that such an investment will pay off in reproductive success. In terms of my research, this relates to the timing of reproductive dispersal. Where one can expect less benefit from investment in one’s own EC, we would expect an earlier switch to reproduction, while greater expected return on EC investment would lead to delayed dispersal and continued investment in EC. Returning to my results for reproductive dispersal, influences of parental characteristics such as education may reflect parents’ investment in their own EC, and this may influence their offspring’s perception of the value of similar investment. Thus children parents with higher education might be more likely to take more time to build their own embodied capital, and this might be manifested as delayed reproduction.

4.2.2. 1967 Cohort: All Dispersal Ages

There were no significant multiple linear regression models for age at first reproduction for this cohort. However, several variables were significant when considered singly, and two of these were not significant for the 1957 cohort. Consistent with all results herein, males reproduced later than females. Higher mother's education was again significantly associated with later reproduction, reinforcing support for the positive effect of this component of NTQ on dispersal timing. Further, as in the 1957 residential dispersal outcome, higher family income in the years leading up to residential dispersal was related to later reproduction. For this cohort, head's employment status was also significant. In contrast with residential dispersal outcomes for all cohorts, if a person's father was employed in the years leading up to residential dispersal, she or he reproduced later. This seems more in accordance with the expectation that higher NTQ would lead to delayed dispersal. In other words, if your father is providing resources, you leave home later and begin having children later. Cohort-level differences in significant predictors for age at first reproduction may be due to differences in sample size, the fact that the 1967 cohort is truncated as far as maximum dispersal ages, or due to secular trends that may effect the factors that influence the dispersal process.

4.2.3. 1967 Cohort: Dispersal Ages 18 and Older

There were no significant results for this sub-sample. This may be attributable in part to low sample sizes once this cohort was truncated. Another factor may be the loss of variance associated with removing younger dispersers. For example, the sample size when mother's education is included is reduced to only 36 cases. In the complete 1967 cohort, wife's education appeared to have some influence on age at first birth.

4.3. Age at First Marriage

4.3.1. 1957 Cohort

Race appears to influence marriage age for this cohort, with whites marrying earlier than blacks. This may be a manifestation of a pattern discussed in the sociological literature, in which whites are more likely than blacks to marry at all (e.g., Bennett et al., 1989). Higher family income is associated with later marriage, consistent with results for residential and reproductive dispersal and with my hypothesis. As is the case with residential dispersal, having an employed father appears to lead to earlier marriage, perhaps attributable to the need for sufficient resources to embark on a marriage. That is, if your father is unemployed, you might have to wait longer before you are in a position to marry. This is another example of a potential non-linear relationship between family resources and dispersal timing. Marriage might be considered a separate class of dispersal, since it usually requires some kind of stockpile of resources. It is also possible that leaving home requires a certain amount of resource in hand, such that an employed father would make an early departure more feasible. Compared to marriage, reproduction may be under the influence of different forces in that its occurrence is often less dependent on resource acquisition (Section 4.2.1.). Interestingly, sex was not a significant predictor of age at marriage.

The significant interaction between father's education and family income suggests that the effect of family income on age at first marriage is mediated by father's educational attainment. In the inverse of the interaction results for reproductive dispersal, it appears that higher family income can make up for a less educated father.

4.3.2. 1967 Cohort: All Dispersal Ages

Marriage and NTQ appear to have a different dynamic for this younger cohort. Sex does play a role, with males marrying later than females, but race is not a significant factor. Head's occupational prestige is the only other significant predictor of dispersal age. That is, fathers with more prestigious occupations tend to have children who marry later. On the surface this goes along with the hypothesis that better childhood circumstances lead to later dispersal. It may seem to contradict my earlier suggestion that better conditions at home might allow a person to marry earlier than would otherwise be possible. However, occupational prestige might reflect more directly the potential for inheritance not only of economic resources, but also of status. That is, if a parent's occupation is based on training or education, it is not as likely to change as are e.g. income and employment status. And as is the case with education, higher status parents might contribute to higher status of offspring. Thus these results might complement, rather than contradict, those reported for other dispersal types.

4.3.3. 1967 Cohort: Dispersal Ages 18 and Older

There were no significant results for this sub-sample. The same factors suggested for age at reproduction may also apply here (Section 4.2.3.)

4.4. Comparison Between 1967 Cohort and Truncated 1957 Cohort

Comparisons among the complete 1957 cohort, the 1957 cohort truncated at age 30, and the 1967 cohort revealed more similarity between the truncated and complete versions of the 1957 cohort than between the truncated 1957 cohort and the 1967 cohort (Section 3.2). Thus it is likely that historical forces are important in the differences across the 1957 and 1967 cohorts. Overall changes over the past half-century in timing of dispersal in the U.S. may be at play here

(Buck & Scott, 1993; South, 2001). Smaller sample size in the 1967 cohort may also have contributed to inter-cohort differences.

4.5. General Discussion

According to the criterion established in Section 2.6.2., a claim that my hypothesis was supported required a model with at least three of nine significant predictors. Alternatively, if a model had two significant predictors but an adjusted R^2 of at least 0.30, I also considered this acceptable as support for my hypothesis. Only reproductive dispersal in both the complete and the truncated 1957 cohort fulfilled these criteria. However, if one considers models with adjusted R^2 of at least 0.20 (well within the acceptable range in the social sciences), several other models lend support to my hypothesis (see Tables 8a-8c; 9a; 10f; 11a). These models include residential dispersal timing for both versions of the 1957 cohort, as well as marriage timing for the 1967 complete cohort. For this reason I argue that although my dissertation did not provide conclusive evidence for the application of Emlen's second hypothesis to the human case, it does suggest that these measures do account for some of the variance seen in patterns of human dispersal timing.

In sum, the following variables were significantly associated with timing of dispersal in one or more of the six cohort/dispersal-type conditions: mean family income, personal space, parents' education, father's status (occupation), and county unemployment rate. Each of these was significant in the predicted direction. The variables that most clearly parallel the avian case are those that measure something about family material resources and physical conditions: family income and personal space. Conditions external to the natal territory, while not specifically addressed in Emlen's second prediction, are implied in any discussion of delayed dispersal; county unemployment rate might be a good proxy for the quality of territories available to a dispersing bird, and the size of the nearest city might reflect something about population density or local opportunity. The latter, however, is more a reflection of human population distribution and economics than of avian ecology. Family composition ought to approximate some characteristics of the factors that influence avian dispersal. However, my measure was perhaps overly ambitious. It also left out some key considerations, such as birth order of siblings and differentiation among the kinds of kin that contributed to a given the values I obtained for a given person. Some of my variables are less directly parallel to the avian situation. Father's occupational status, parents' educational attainment, and father's employment status were attempts to incorporate additional measures that parallel the literature in human dispersal. Parents' education, probably a uniquely human characteristic, appears to be an important predictor of age at first reproduction, but father's occupational status was significant only for marriage timing in the younger cohort. Note that it could be the case that parents' education in humans does parallel parental skill in birds, a factor that is argued to play a role in avian development and in theories concerning the benefits of delayed dispersal. More specific discussion of the implications of outcomes regarding each of these variables can be found above in the sections pertaining to each cohort/dispersal-type condition.

Overall, residential dispersal may appear to be the most closely connected to the ideas proposed by Emlen, since studies of delayed dispersal in animals are based on actual departure from the natal territory. However, in my sample, the hypothesis was not supported for this dispersal variable. Since avian residential dispersal does seem intimately tied to reproduction, one could argue that reproductive timing in humans is the better proxy for avian dispersal. In fact, the results presented here do support a relationship between NTQ and reproductive dispersal for this population. While leaving home is the most direct correlate to avian dispersal, in birds as in humans physical dispersal is not always directly linked to reproduction. For example, floating and queuing are two alternate strategies for dispersing birds in some species (Gardner et al. 2003, 2004; Kokko & Sutherland, 1998). Since the information on reproduction and marriage in my data set came from separate, limited PSID data files, these data may have been less complete than those for residential dispersal. Partnership formation and reproduction should be explored more thoroughly in future work using data that thoroughly document these events. Further, it would be useful to probe the complexities of the process of human residential dispersal.

Family composition data held promise as a route to measuring the genetic relationships among household members. I am not aware of any other research that ties family structure to dispersal using coefficients of relatedness. However, in both sociology and human behavioral ecology there has been much research on the effects of family structure on adult outcomes, especially in terms of female reproductive development (Belsky et al., 1991; Draper & Belsky, 1990; Draper & Harpending, 1982). Results differ across these studies, making firm conclusions difficult. One pattern that seems to be emerging in the HBE literature is that while "father-absence" was earlier thought to influence the timing of female sexual behavior, the actual effects of family structure are more complicated (Grainger, 2004; Hoier, 2003; Quinlan, 2003).

The archival studies of human dispersal (Section 1.5.1.) usually measure dispersal as departure from a larger community, unlike my data which measures dispersal from the family residence. It is possible that the two are parallel; for example, in the 18th century a parish might have played the role of an extended network of kin and non-kin, whereas today it appears that these webs of connection are shrinking.

Davis & Daly's (1997) conclusions about their results refer to the importance of "intragroup solidarity", reciprocal altruism, and other social factors. These ideas point to the question of whether the important level of analysis is dispersal from the natal family or dispersal from a larger community. My study attempted to look more closely at direct measures of natal territory in order to parallel the ecological variables we look at in animals. Also, my analysis was related to the timing of dispersal, not the maintenance of contact following dispersal. Finally, this research contributes more direct measures of both family background and its effect on dispersal timing. In spite of my findings in support of an effect of NTQ on choosiness about dispersal, the issues raised by Davis & Daly remain and must be further explored in order to understand the complexity of how human social systems form and how they are maintained.

4.6. Suggestions for Further Research

The premise of the research reported here was that individuals from higher-quality natal territories would be choosier about dispersing. In this dissertation I investigated choosiness as manifested in dispersal timing, relating it to delayed dispersal in animals, especially birds. A useful and complementary study would look at the conditions into which people disperse, that is, "Dispersal Territory Quality". This would be measured using variables such as income and occupation at each stage of dispersal.

Future studies would also benefit from data on inheritance, which may interact with the effects that some family variables have on dispersal ages. It might also facilitate comparison to birds, since human inheritance is a clear, measurable phenomenon. There are hints that the potential for inheritance might differ for males and females in my sample (e.g., Section 4.1.1). This project does not include inheritance, but other studies of human dispersal do (e.g., Towner, 2001; Low & Clarke, 1991). Results of some of these studies suggest that inheritance might be a benefit of philopatry in humans. The relationship between sex and inheritance in humans should also be measurable. In addition to sex biases in inheritance, birth order effects are also likely.

4.7. Conclusions

In general, with the exception of reproductive dispersal timing in the 1957 cohort, the hypothesis that higher quality natal territory quality should result in later dispersal was not supported in this study. However, the results suggest that with regard to some NTQ components, better conditions at home favor delayed dispersal, while for other components poorer conditions seem to encourage delayed dispersal. This highlights the complicated relationship in humans between early experience and adult outcomes. Table 7 is based on expectations that parallel Emlen's prediction about avian family formation, and on findings in the human literature on the effects of childhood dispersal on dispersal and adult outcomes . This dissertation reinforces the findings of researchers such as Davis & Daly (1997) and Towner (2001), in that the formulation of the predictions for this research may be too simplistic. Lancaster and Kaplan (2000) suggest that what I call natal territory interacts with ecological constraints such that even with limited external opportunities, a really good natal territory might offset such extrinsic constraints. The relationships among my measures of childhood circumstances reveal the fact that some circumstances that might be construed as favorable might in fact lead to earlier dispersal. My results provide further evidence that the integrative theories about delayed dispersal in other animals (Sections 1.3.5 & 1.3.6.) apply in humans as well.

The specific factors that affect dispersal timing in humans were not expected to correspond exactly to the relevant factors in birds and other animals, but instead were meant to expand the conception of NTQ to model human dispersal processes. Although I was not able to confirm overall that higher natal territory quality results in delayed dispersal in humans, this dissertation confirms that important parallels do exist between the factors that contribute to family formation in birds and the factors influencing dispersal processes in humans.

APPENDIX A

Variables and Codes

	VARIABLE	NAME	FORMAT	YEARS	CAT	CATEGORIES	recodes
D	Age at residential dispersal	splitagef	continuous	once	n/a		
D	Age at first reproduction	agebirth	continuous	once			
D	Age at first marriage	agemarr	continuous	once			
C	Sex of individual	indsex	binomial	once	2	1=male 2=female	0=male 1=female
C	Race	race268	binomial	once	2	1=white 2=black	
C	Region 1-4 (use in adj income)	reg1s		D-1 - D-4		1=NE 2=NC 3=S 4=W/AK/HI	
I	County unemployment rate	unemp1s	Ordinal	D-1 - D-4	6	1=UNDER 2%	1=1+2
	log unemp	unm1sln?		D-1 - D-4		2=2-3.9%	2=3
	mean unemp	unmean		once		3=4-5.9%	3=4
	mean log unem 1-4	unmeanl?		once		4=6-8.9%	4=5
	slope of unemp 4-1	unmtraj		once		5=9-10%	5=6
						6=10.1-12%	6=7
						7>=12	
						9=NA	
I	Adjusted family income (CPI)		Continuous	D-1 - D-4			
	log adjusted income	adjinc	Continuous	D-1 - D-4			
	mean log adj income	adjmean	Continuous	once			
	Family income trajectory	inctraj	Continuous	once			

	VARIABLE	NAME	FORMAT	YEARS	CAT	CATEGORIES	recodes
I	Head’s employment status	hdemp1s	cat	D-1 - D-4	2	1=none 2=some	0/1
	Mean employment status	emp2mean emp0mean					
I	Head’s education	hded1s	Cat	(D-1)	4	1=<HS	1=<HS
I	Wife’s education	wfed1s		(D-1)		2=HS/GED 3=some college 4=BA 5>BA	2=HS/GED 3=some coll 4=4+5
I	Head’s education: Dichotomous	hded1s2	cat		2	1=<BA (1-3)	
I	Wife’s education: Dichotomous	wfed1s2				2=>=BA (4)	
I	Size of nearest city (population)	smsa1sr	cat	D-1 - D-4	6	6=500K OR MORE 5=100K-499,999K 4=5OK-99,999K 3=25-49,999K 2=10-24,999K 1=UNDER 10K 9=NA; OUTSIDE US (system missing)	
I	Size of nearest city: Dichotomous	smsa1s2	cat	D-1 - D-4	2	1 < 100K (1-4)	
	Mean city	citymean	(cit2mean)	0/1 (1/2)		2 > = 100K	
I	Log household density	room1sln	cont	D-1 - D-4			
	Mean log density	rmmean					
						2<1	
I	Head’s occupational prestige	hdpres1s	ordinal	D-1 - D-4		1-100	
	Mean head prestige	presmean					
	Head prestige trajectory	prestraj					
I	Family composition	aver79	continuous	79-85		measure = mean r by year	
	(1967 only)		(relhis files)				
	D Age 18 + over						

APPENDIX B

Relationship Codes Occurring in 1967 Cohort

PSID code	r-value	relationship	mean r
0	0	unrelated	0
2	0	wife	0
3	0	husband	0
24	0.5	nat daughter	0.5
25	0.5	nat son	0.5
26	0	adopted daught	0
27	0	adopted son	0
30	0 - 0.5	daught unclear	0.25
31	0 - 0.5	son unclear	0.25
32	0	step dau	0
33	0	step son	0
34	0	fost dau	0
35	0	fost son	0
38	0.5	natmom	0.5
39	0.5	natdad	0.5
52	0.5	nat sis	0.5
53	0.5	nat bro	0.5
54	0.25	1/2 sis	0.25
55	0.25	1/2 bro	0.25
56	0.25 - 0.5	f/h sis	0.375
57	0.25 - 0.5	f/h bro	0.375
58	0	adopted sis	0
59	0	adopted bro	0
63	0 - 0.25	grandson unclear	0.125
2402	?	ND of wife	0
2406	?	ND of sep wife	0
2412	?	ND of div wife	0
2414	?	ND of widowed wife	0
2424	0.25	ND of ND - granddau	0.25
2444	0 - .5	ND of mom uncl	0.25
2448	0	ND of fostermom	0
2456	.125 - .25	ND of f/h sis (niece)	0.1875
2512	?	NS of div wife	0
2513	?	NS of div husb	0
2514	?	NS of widowed wife	0

PSID code	**r-value**	**relationship**	**mean r**
2524	0.25	NS of Ndaugh - grandson	0.25
2544	0 - .5	NS of mom unclear	0.25
2545	0 - .5	NS of dad unclear	0.25
2546	0	NS of stepmom	0
2547	0	NS of stepdad	0
2548	0	NS of fostmom	0
2549	0	NS of foster dad	0
2556	.25 - .125	NS of natsis (f/h) (neph)	0.1875
3439	0	fosterDau of natdad	0
3449	0	fosteDau of foster dad	0
5202	0	fullsis of wife	0
5203	0	fullsis of husb	0
5238	0.25	fullsis of natmom	0.25
5239	0.25	fullsis of natdad	0.25
5302	0	fullbro of wife	0
5303	0	fullbro of husb	0
5338	0.25	fullbro of natmom	0.25
5339	0.25	fullbro of natdad	0.25
5403	0	1/2 sis of husb	0
5438	0.125	1/2 sis of natmom	0.125
5439	0.125	1/2 sis of natdad	0.125
5538	0.125	½ bro of nat mom	0.125
5602	0	f/h sis of wife	0
5603	0	f/h sis of husb	0
5613	0	f/h sis of div husb	0
5635	0	f/h sis of fostersis	0
5638	.125 - .25	f/h sis of natmom	0.1875
5639	.125 - .25	f/h sis of natdad	0.1875
5656	.25 X .25	f/h sis of f/h sis	0.125
5702	0	f/h bro of wife	0
5703	0	f/h bro of husb	0
5738	.125 - .25	f/h bro of nat mom (uncle)	0.1875
5739	.125 - .25	f/h bro of natdad (uncle)	0.1875
240072		Ndaugt of ? of gma unclear	0
242448	0	Ndaught of ND of fostmom	0
250072		Nson of ? of gma unclear	0
252449	0	nson of natdau of fostdad	0
523924	0	Fullsis of natdad of ndau	0
533925	0	fullbro of natdad of natson	0
563539	0	f/h sis of fostsis of natdad	0
563924	0	f/h sis of natdad of NDau	0
573824	0	f/h bro of natmom of ND	0

APPENDIX C

Regression Equations

Cohort	**Dependent Variable**	**Model**	**Equation**	**Table**
1957	**Residential dispersal**	General	splitage = -0.057*sex + 0.061*income – 0.089*income traj + 0.066*county unemp – 0.068*father employment + 2.347	9a
		Race*Inctraj	splitage = -0.060*sex + 0.038*income + 0.068*county unemp – 0.063 + 2.581	9b
		Sex*Income	splitage = -0.006sex*income + 0.073*county unemp + 2.964	9c
		General: female	splitage = 0.058*county unemp – 0.174*inctaj + 2.867	9d
		General: male	splitage = 0.058*income + 0.082*county unemp + 2.292	9d
		Income*County Unemployment	splitage = -0.057*sex + 0.046*income – 0.091*income traj – 0.07*father employment + 0.006*(income*unemp) + 2.566	9e
1957	**First Reproduction**	General	agebirth = -0.73*sex + 0.117*dad edu + 0.120*mom edu + 0.198*density + 0.089*city + 3.139	10a
		Father’s education	agebirth = -0.119*sex + 0.172*dad edu + 0.151*density + 0.075city + 3.222	10b
		Mother’s education	agebirth = -0.068*sex + 0.145*mom edu + 0.234*density + 0.082*city + 3.142	10c
		General: female	agebirth = 0.147*dad edu + 0.219*mom edu + 0.173*density + 3.029	10d
		General + mother’s education: male	agebirth = 0.142*density + 3.166	10d
		Father’s edu: female	agebirth = 0.221*dad edu + 0.160*density + 3.021	10e
		Mother’s edu: female	agebirth = 0.233*mom edu + 0.214*density + 3.042	10f
1957	**First Marriage**	Single Model	agemarr= 0.10*race + 0.085*income – 0.137*father employment + 2.276	10g

Cohort	**Dependent Variable**	**Model**	**Equation**	**Table**
1967 all ages	**Residential Dispersal**	Single Model	splitage = 1.407*race – 1.424*county unemp + 2.592*density + 19.781	11a
	First Reproduction	Father's Employment Status	agebirth = 2.427*father employment + 20.864	11b
		Family Income	agebirth = 1.463*income + 8.134	11d
		Sex	agebirth = -2.012*sex + 25.744	11e
	First Marriage	Single Model	agemarr = -2 .348*sex + 4.45*father occ prestige + 9.891	11f
1967 18 +	**Residential Dispersal**	Single Model	splitage = 1.001*race – 0.760*county unemp – 1.472*father employment + 1.793*density + 23.004	12a

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Bureau of Labor Statistics (BLS) Guide to available CPI data: http://www.bls.gov/cpi/cpifact8.htm

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General info: http://psidonline.isr.umich.edu/Guide/
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