THE EFFECTS OF RESOURCE COMPETITION AND DILUTION ON SIBLING RIVALRY IN RURAL DOMINICA

By

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THE EFFECTS OF RESOURCE COMPETITION AND DILUTION ON SIBLING RIVALRY IN RURAL DOMINICA

Abstract

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Sibling rivalry occurs with predictable regularity and intensity between offspring. The resource competition framework suggests that the nature of sibling rivalry depends on the characteristics of other siblings, the structure of the family, and on the nature of the insufficient resource. Each sibling may be motivated toward selfish behaviors because, excepting identical twins, individuals share more genes with themselves than with siblings. Mothers in a rural village in Dominica were interviewed about factors which influence resource distribution on both the family level and the dyadic level. These factors include alloparenting (non-parental investment), sibling relatedness, birth spacing, birth order, family size, and paternal investment. Paternal investment, a main source of resources in this village, was found to decrease sibling rivalry. Large families and families with half siblings generated increased rivalry, as expected

under resource competition. Additionally, closely spaced siblings and later born siblings (with many older siblings to redirect resources) had greater levels of rivalry. Alloparenting, relatedness within dyads, and same-sex dyads were non-significant for effects on sibling rivalry. Although not every hypothesis was supported, these findings suggest that resource competition can be a useful framework for predicting the occurrence of sibling rivalry within families.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Dedication

This thesis is dedicated to my mother, to my father, and to my grandfather.

CHAPTER ONE

INTRODUCTION

RESOURCE COMPETITION AND SIBLING RIVALRY

Studies have shown that sibling aggression is the most prevalent form of family aggression (Yu and Gamble 2008). A nationwide study of violence in families with minor children found that, per year, 53 of every 100 children act violently toward a sibling (Straus et al. 1980). Sibling tensions are so prevalent that most families downplay even acts of violence between siblings as being routine (Kettrey and Emery 2006; Caspi 2008). Sibling rivalry is problematic from an evolutionary perspective, given that an optimal alternative strategy for related individuals may be to redirect this energy toward promoting inclusive fitness (Hamilton 1964). Given that investment into one offspring limits potential investment into others, every offspring should desire a larger share of resources than parents are willing to grant (Trivers 1974). These resources may be material or non-material (e.g., time spent playing with a child).

Motivation for gaining parental resources may generate antagonistic behaviors directed to both siblings and parents, such as an older child's regression to a needier developmental stage to divert resources from younger siblings (Dunn and Kendrick 1982). This research explores the effects of several variables which may influence levels of sibling rivalry between individuals and within a family. Some variables act upon the family and include levels of paternal investment, alloparenting (investment by individuals other than the mother or father), the size of the family, and the presence of half siblings. Other variables are unique to each sibling dyad and include the

sexes, the age spacing, and the birth orders of the siblings. Effects of these variables indicate resource competition through sibling rivalry within families.

While equal distributions by parents might reduce conflicts between siblings and require less ecological information for parental decision-making (Hertwig et al. 2002), such distributions may occur only when differences between offspring are insubstantial (i.e., one child is not expected to grow up to be healthier, wealthier, or have more mating opportunities). Given the parental incentive to bias parental investment toward the children expected to return the highest reproductive pay-off (Trivers and Willard 1973; Geary and Flinn 2001), sibling rivalry is expected to fester in atmospheres with disparate investments. Alternatively, the threat of sibling rivalry may be so powerful that a "parental desire to control sibling competition helps to explain the prevalence of equal division" (Faith et al. 2008:407) of resources within a family. Research has indicated that children can recognize inequitable treatment within families (McHale and Pawletko 1992), and that siblings perceive less strain and more closeness when differential treatment is minimized (Kowal and Kramer 1997; Feinberg and Hetherington

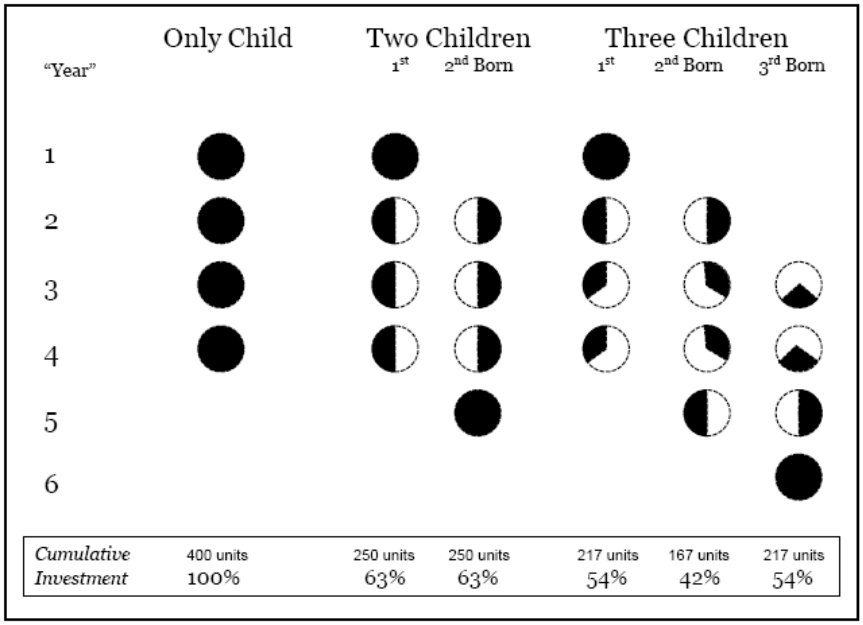


Figure 1: How equitable distribution may create inequalities between offspring. Redrawn from Hertwig et al. 2002:731, Figure 1.

2000). Indeed, sensitivity to resource allocation by children is "Darwinian common sense" (Sulloway 1995:77). It is important to note that even under completely equitable parental allocation, differences in gross allocation may accumulate (Hertwig et al. 2002).

Resource competition has led to the development of *resource dilution*, a theory in which finite resources must be distributed within a growing family. Resource dilution concerns indirect sibling rivalry, in which siblings compete merely through their presence in a family: "The oldest theory states that an increase in the number of siblings or a decrease in the spacing between them dilutes the time and material resources that parents can give to each child and that these resource dilutions hinder the outcome for each child" (Heer 1985: 28). Large families and close births correlate with negative effects for children including health risks (Maitra and Pal 2008), reductions of positive feelings toward siblings (Bowerman and Dobash 1974), and increased conflict (Caspi 2008). Laterborn children tend to be shorter in stature and experience higher mortality rates than earlier born children in developing countries (Hertwig et al. 2002). Resource dilution is often applied to educational outcomes, though Steelman and Powell caution that "although the resource dilution hypothesis frequently is used as an ad hoc explanation for the deleterious impact of sibship size on a wide range of educational phenomena, it seldom is tested directly" (1989:844).

In more impoverished families, particularly in cultures with male-oriented education, the birth of additional sons can severely limit the educational attainment of a daughter (Sudha 1997; Bauer and Gang 2001). In cultures where many sons will be in direct competition for an indivisible resource such as land, parents reduce investment in these sons but increase investment

in sons with many sisters (Borgerhoff Mulder 1998). Some studies indicate that the sex ratio of siblings may be more important for resource dilution—and therefore competition—than the number of siblings (Garg and Morduch 1998; Bommier and Lambert 2004).

Siblings can practice *differentiation* to decrease sibling rivalry. Differentiated individuals pursue radically different interests to minimize the competition for certain resources (Lalumiere et al. 1996). The more objectively similar the children, and therefore the more similar the resource bases, the more differentiated they will become. For example, one child might become interested in sports while another focuses on painting. This is necessary for closely spaced and other similar children: "Siblings who are close in age have more similar needs than if they are at different developmental stages and are likely to experience more intense competition for parental attention and other resources" (Daly et al. 2001:38). Differentiation reduces direct competition over who excels in each pursuit, and for potentially limited parental resources directed toward each subject (Feinberg and Hetherington 2000). The prevalence of sibling differentiation may suggest an adaptation which decreases resource competition and achieves higher average sibling fitness (Lalumiere et al. 1996).

Birth order, and the resource competition associated with certain birth orders, may pressure siblings to occupy specific niches within families. One study showed that the most differentiated children tend to be the firstborn and second child, even in larger families (Schachter and Stone 1988), which indicates a unique pressure on early children. Proponents of birth order research assert that "birth order sums up several variables…it is a surrogate for

differences in age, size, power, and privilege among siblings" (Sulloway 1995:76). Conversely, other researchers note:

> It is interesting that birth order, which has been so much studied, has less apparent influence on sibling affect than direction of age difference, age of subject, sex combination, or family size. Possibly we have a clue here that the conflicting findings of the birth order studies may result in part from failure to control for these other structural variables as well as dynamics of the relationship that could modify order effects.
>
> (Bowerman and Dobash 1974: 53)

Although birth order theory has been widely criticized (Ernst and Angst 1983), some studies indicate that certain siblings experience unique effects which can impact sibling rivalry. Rohde et al. (2003) found that a last-born child was much more likely to identify as a rebel and to feel less close to parents. Furthermore, middleborn children of older mothers reported less closeness, which has been explained as being "consistent with the view that mothers of low residual reproductive potential tend to increase their maternal investment in youngest children (particularly lastborns), thereby enhancing the contrast effect between middleborns and nonmiddleborns" (Rohde et al. 2003:273).

Each child is reared in a slightly different environment due to the continued presence of older siblings, the addition of younger ones, and changes in parental condition. Firstborns have less to gain from fighting than other siblings; firstborns have already experienced a period of uninterrupted parental investment and tend to be favored for additional investment. This is reflected in cross-cultural practices of primogeniture and superior dowries for firstborns (Salmon and Daly 1998). Firstborns, on average, strive more for status than younger siblings (Davis 1997). Parental favoritism toward firstborns may occur because of an increased expectancy of

survival at the time of the birth of the second child (Salmon 2003). Firstborns are unaffected by increasing numbers of siblings, but as the number of children increases between the first and last, the youngest child strives less because older children have made their choices for "niche differentiation" (Davis 1997:215).

Investment from parents can influence sibling rivalry by creating unequal or inadequate resource distributions. Lastborn children experience undiluted investment as they age and older children gain independence (Salmon 2003). Since women experience menopause, expected future reproduction is "a declining function of parental age" (Salmon and Daly 1998:300) and older mothers should be selected to invest more into offspring than younger mothers. If parents accumulate resources as they age, this increasingly benefits the sole lastborn (Hertwig et al. 2002). However, this skew does not affect resource distribution or sibling rivalry during childhood. Firstborns may benefit more than lastborns from undiluted investment because their period of exclusive parenting may have constructed a more secure attachment style at a critically early phase in the lifespan (Lalumiere et al. 1996; Hertwig et al. 2002). Middleborns lose this period of individual parental investment, which is theorized to lead to an increased reliance on non-kin rather than kin (Salmon and Daly 1998; Salmon 2003). Resources also become more diluted for later-born children as the family size increases (Hertwig et al. 2002). If sibling rivalry is based on resource competition, then middle- and later-born siblings may be expected to experience increased levels of rivalry relative to firstborn children. Generally, birth order studies produce more limited hypotheses than differentiation—which predicts that siblings will

distinguish themselves without necessarily adhering to rigid personality trajectories—but the birth order framework generates more easily testable hypotheses.

Finally, sibling rivalry can be affected by the sex of each sibling. Same-sex siblicide occurs more frequently than siblicide between a brother and a sister (Daly et al. 2001), as expected if same-sex siblings also experience higher levels of resource competition. Males and females aggress differently. Females use relational aggression (Ostrov and Keating 2004) and indirect aggression (Lagerspetz et al. 1988; Bjorkqvist 1994; Hess and Hagen 2006) such as gossiping, while males use direct aggression and physical aggression to a greater extent (Lagerspetz et al. 1988; Ostrov and Keating 2004). When interacting with males, other males use more verbal aggression than do females (Ostrov and Keating 2004). However, siblings may use less gender-typical aggression toward each other than toward peers and use more relational aggression during middle childhood (Yu and Gamble 2008).

Although brothers aggress the most severely, and with the widest variety of aggressive acts (Hoffman et al. 2005), same sex siblings are often regarded with warm feelings (Bowerman and Dobash 1974; Weiss 1981), especially within sister dyads (Cicirelli 1982; Pollet 2007). Same-sex siblings exhibit inverted levels of positive and negative feelings toward each others, while mixed-sex feelings did not show a relationship; a brother and a sister can display positivity and negativity simultaneously (Dunn and Kendrick 1981).

Siblings who fight as children can bond as adults (Cicirelli 1982; Jankowiak and Diderich 2000). Adult siblings may supply resources to facilitate inclusive fitness for the children of younger siblings (Draper and Hames 2000). Adams (1968) reported that, for one's closest-aged

sibling, adult sisters felt closest while adult brothers felt the least close and reported the most jealousy and competitiveness. Adams explained sororal closeness as resulting from similar interests in the family and children. Perhaps this closeness is also a result of the certainty of genetic relatedness of nieces and nephews and thus a desire to lend maternal support. For both sexes, maternal half siblings display more closeness and supportiveness than paternal half siblings, possibly as a result of the certainty of genetic relatedness (Pollet 2007). Even within a polygamous community which explicitly espouses equality toward all family members, full siblings feel closer than half siblings (Jankowiak and Diderich 2000). These findings underscore the centrality of the balance between self-interested competition and inclusive fitness which characterizes sibling rivalry.

HYPOTHESES DERIVED FROM RESOURCE COMPETITION LITERATURE

The resource competition framework has generated several hypotheses concerning individuals and families. For each sibling dyad, increased relatedness is expected to decrease sibling rivalry, since more closely related individuals receive increased inclusive fitness (Hamilton 1964) and so may be less driven toward competition. Half siblings should fight more than full siblings and unrelated siblings should fight the most. Pollet (2007) suggests that maternal half siblings should have better relationships than paternal half siblings due to genetic certainty. Preferential treatment toward full siblings has been recorded even in communities with cultural stigmas against such preferences (Jankowiak and Diderich 2000).

If sibling rivalry is driven by resource competition, individuals with fewer resources per child should be expected to produce conflict. Resource acquisition is positively associated with a woman's reproductive success (Quinlan 2001). If fathers are responsible for resource acquisition, paternal investment should decrease resource competition even while increasing the size of the family. Thus, large families without paternal investment should experience increased rivalry.

Alloparents often play central roles in the lives of children: for example, rural infants in Argentina are alloparented 60% of the day (Valeggia 2006) and Efe infants in the Democratic Republic of the Congo are alloparented nearly half of the time (Ivey 2000). Because the presence of alloparents increases the number of children a woman is capable of raising (Hrdy 1999) and decreases interbirth intervals (Quinlan and Quinlan 2008), the presence of relatives who act as alloparents may be associated with increased fighting as families become larger.

However, if the kin invest additional material resources into the family—as expected from fathers—their presence should be associated with decreased fighting. Direct parental investment is expected to be reduced in the presence of alloparents (Geary and Flinn 2001), suggesting that alloparents do replace some resources that are otherwise provided by parents.

Older sisters act as alloparents across many cultures (Turke 1988; Hertwig et al. 2002; Valeggia 2006). The responsibilities exacted upon the firstborn daughter can become so extensive as to reduce her fertility in comparison to other daughters, as happens within the Truk culture (Turke 1988). Children in some communities in Dominica even call the oldest sister *dada* and express special respect and affection toward this sororal alloparent into adulthood (Paugh 2008). The presence of an oldest sister, rather than an oldest brother, may be associated with a decrease in the amount of fighting within a family, since this oldest sister can regulate the behavior of her younger siblings and provide additional investment.

Alloparents should therefore decrease fighting within families if their resource investments supplement parental investment. If alloparents simply substitute for parental investment into present children and allow parents to raise additional children, resource levels would remain steady while the size of the family increased, thereby generating more resource competition and sibling rivalry.

Children close in objective characteristics, such as sex and age, should need similar resources and will therefore compete for those resources (Daly et al. 2001). Bowerman and Dobash claim that "with the exception of age, sex composition is probably the most important characteristic of the sibling structure to be taken into account in the study of sibling

relationships" (1974:51). Although sister dyads and brother dyads should both fight, sisters should prefer non-physical aggression over brothers (Lagerspetz et al. 1988; Ostrov and Keating 2004). This may be due to the presence of less physical strength in females than males (Bjorkqvist 1994). Other research suggests that sister dyads may be closer than brother dyads (Cicirelli 1982; Pollet 2007) and as a result, may fight less.

Birth order literature, although still developing, has produced plausible hypotheses. Some researchers predict that the highest levels of conflict should arise between later-born children because only the first-born child was privy to a period of undiluted parental investment (Salmon and Daly 1998; Salmon 2003). Others concur, noting that resource dilution suggests that laterborn children in growing families should receive much less investment than the first children before reaching maturity (Hertwig et al. 2002). The children closest to the middle will receive the fewest resources (Salmon and Daly 1998; Hertwig et al. 2002; Salmon 2003). Presumably, these middle children will conflict more with privileged early and laterborn children rather than other resource deprived middleborns, since perceived disparities in investment increase sibling rivalry (Kowal and Kramer 1997; Feinberg and Hetherington 2000). Especially in societies with explicit inequity such as primogeniture, "conflict theory would predict that parental favoritism increases conflict by encouraging siblings to view each other as competitors for tangible resources and parents' attention" (Hoffman et al. 2005: 1109). As families grow, the inequity between middle children and non middle children expands (Hertwig et al. 2002).

These hypotheses derived from the literature are most easily tested:

1. Paternal half siblings should fight the most, followed by maternal half siblings, then full siblings. Non-related siblings should be most conflict-prone.

2. All else being equal, large families should contain more sibling rivalry in total due to the increased number of children and the smaller portion of resources per child.
3. If alloparents have facilitated large families without additional resource investment, then an increase in alloparents should be associated with an increase in sibling rivalry.
4. Oldest daughters are likely to provide additional care to younger siblings, which should decrease rivalry within a family.
5. Paternal investment should decrease levels of rivalry due to increased resource levels per child when compared with families without paternal investment
6. Same-sex children and closely-aged children should fight the most. Sisters may fight less than brothers.
7. If birth order and resource dilution are correct, later-born children should fight more. Middle children should prefer to fight with more endowed siblings, especially in larger families.

CHAPTER TWO

RESEARCH DESIGN AND METHODOLOGY

ETHNOGRAPHIC BACKGROUND

This research was conducted in the Commonwealth of Dominica, a small island in the Caribbean Sea with an estimated population of 65,000 people (Quinlan 2001). Dominica shares cultural features with other such Caribbean islands including a French Creole dialect known as Patois (Roberts 1988; Paugh 2008). Dominica currently has one of the highest migration rates in the world (Seller 2005).

The focal village for this study, Bwa Mawego, is a village on the island's east coast with an estimated population of 700 (Quinlan 2001). Residents of Bwa Mawego, as in other villages, live in family compounds (Seller 2005). These family compounds can be either matrifocal or patrilocal, and the amount of support given by relatives can be dependent on the type of compound. Women residing in matrifocal compounds typically receive more kin support (Quinlan 2004). Women are the main providers for about half of the households (Quinlan 2004; Seller 2005). Aside from agriculture, two of the main sources of income in the village are bay oil, a plant by-product used in cosmetics and toiletries, and fishing (Quinlan 2004). Manufacturing bay oil is a time- and labor-intensive process most commonly undertaken by men, while fishing is wholly a male occupation (Quinlan 2004). Due to an increasing number of job opportunities available in the capital city, Roseau, or outside the island, men and women frequently migrate to and from the study village. This has resulted in population fluctuations and

families left without working adults, particularly men, for extended periods of time (Quinlan 2004). Absent fathers are expected to provide monetary support for their children. This contribution is viewed as evidence of their fatherly love and its importance often supersedes physical presence; affection without monetary provision is not considered proper love (Seller 2005).

Dominican women typically reproduce by the age of 20. Few men and women marry (Quinlan 2004), and to be a married—but childless—woman is considered more outlandish than to be an unmarried mother (Cracknell 1973). Families are often large in Bwa Mawego. Until recently, the sole secondary school for the island was located in the capital town, Roseau, and children from Bwa Mawego attending secondary school lived in Roseau for extended periods of time (Seller 2005). This has changed in recent decades, allowing siblings to remain together despite daily commutes. Due to the high incidence of half siblings living in the same household, sibling ties are very fluid. Half siblings interact daily and consider each other to be brother and sister (Seller 2005).

DATA COLLECTION AND ANALYSIS

The data were gathered through interviews with 32 women caring for multiple children. The number of children ranged from 2 to 15 siblings. These children were full siblings, half siblings, or in rare cases, adopted. The relationship is accordingly noted within each dyad: ascending numbers indicate closer genetic relatedness. In two families, the primary caretaker (and subject of the interview) was the maternal grandmother. All other subjects were the mothers. In one additional family, the grandmother was the primary caretaker only during the summer, with the mother otherwise present. This is reflected in the data by noting the absence the biological parents and presence of the grandmother.

Interviews began by asking the interviewee to list her current age, the sex of all children, and ages of all children. In cases where the mother was not the subject, the age of the mother was still recorded. Mothers' ages ranged from 25 to 53. Two mothers indicated deceased or infirm children. Such children were described in the dyadic data through a variable noting whether one or both children in the dyad had developmental problems. Other siblings were rarely described as fighting with these children, and their inclusion did not statistically impact the results.

After determining the family structure, mothers were asked to indicate which dyads fought via a "yes" or "no" response, and to describe the frequency of fighting (described below). The interviewer attempted to list each dyad, but in the extremely large families, mothers were less certain about dyadic fighting and the interviewer may inadvertently have introduced noise. Frequency was coded in intervals from "once a month" to "several times per day." Only direct

aggression, not relational aggression, was measured in this study. For each child who fought, the mother was asked whether the child fought non-physically (described as shouting and using insults) or physically (hitting, biting, hair pulling, or similar acts). If the mother indicated that a child used both styles in equal proportions or could not recall the preferred tactics, nothing was recorded. These data were coded with different codes representing the interaction of the younger and older children's styles.

Mothers were asked if the father was involved in childcare. Fourteen families had multiple paternities, so the subject of this question was the father of the most recent children. One family with multiple paternities, and one family without, had adopted children; these families were included in families with half siblings. The relatedness within one family was unknown. Given the high levels of sporadic direct involvement due to job opportunities which removed fathers for weeks, months, or years in succession, this factor is best interpreted as the mother's assessment of overall paternal presence and investment in the family. Finally, mothers were asked to free list all relatives who regularly contributed to child rearing. Such individuals included aunts, grandfathers, and sisters. A variable was created totaling the number of relatives who acted as alloparents; although older daughters can provide additional care for younger siblings, the variable for the presence of an eldest daughter was distinct from the variable for alloparents.

Birth order was entered as a series of binary classifications for firstborn children, middle children, and lastborn children. Adopted children and older children brought into families with previously established birth orders were not assigned to any category. Families with only two

children were eliminated for these analyses, as families with two children were only included in the study if they fought, artificially inflating the figures for firstborn and lastborn children.

All statistical tests were clustered by the family. This minimized the bias in the standard error which would otherwise aggregate from reusing families with multiple dyads. The amount of sibling rivalry within a family was calculated by adding up the number of individuals who fought. While sibling rivalry as a variable may be conceptualized as either individual children or sibling dyads, and as either the percentage of fighting within a family or aggregate number of children who fought, these alternatives to using the number of individuals did not radically alter either the significance levels or the interpretation of the trends. The percentage of sibling rivalry was calculated by dividing the number of children who fought by the total number of children within a family. Significance is set at .05, although levels between .05 and .10 are considered to be marginally significant.

CHAPTER THREE

RESULTS

The results are divided into two sections. The first section includes factors affecting all family members: (1) the total number of siblings; (2) perceptions of paternal investment; (3) the presence of half siblings; (4) the number of alloparents; and (5) the presence of an older sister who is expected to function as a caretaker. The gender of the firstborn was split evenly between families. This section uses the raw number of children who fight within a family as a primary measure of sibling rivalry and the percentage of children who fight as a secondary measure. The percentage of children who fight was calculated by dividing the number of children who fight by the number of children in the family.

The results for individual fighting examine sibling rivalry at the level of the dyad; slightly fewer than 16% of all dyads were reported to fight. The variables measure the age difference between the siblings, the biological relatedness of the dyad, the effects of sex composition, and the general effects of birth order. Fighting within dyads was coded as a dichotomous variable. Most variables described here are also outlined in Table 1.

Table 1: Descriptive statistics for the data set.

	N	%
Number of children in family		
2	3	9.38
3	7	21.88
4	4	12.50
5	8	25.00
6	2	6.25
7	3	9.38
8	3	9.38
10	1	3.13
15	1	3.13
Total	32	100
Mean=5.15625		
Standard deviation=.4754229		
Number of children who fight		
2	12	37.50
3	6	18.75
4	9	28.13
5	4	12.50
6	1	3.13
Total	32	100
Mean=3.25		
Standard deviation=.2106059		
Paternal investment		
No	8	25.00
Yes	24	75.00
Total	32	100
Relatedness within dyad		
Unrelated	41	9.07
Half siblings	141	31.19
Full siblings	270	59.73
Total	452	100

	N	%
Does this dyad fight?		
No	383	84.18
Yes	72	15.82
Total	455	100
Frequency of fighting by dyad		
Once per month	6	10.17
Once every two weeks	2	3.39
Once every week	17	28.81
Multiple times per week	5	8.47
Once per day	15	25.42
Multiple times per day	14	23.72
Total	59	100
Number of alloparents		
0	16	50.00
1	10	31.25
2	4	12.50
3	1	3.13
4	1	3.13
Total	32	100
Mean=.78125		
Standard deviation=.1781082		
Half siblings are present in family		
No	15	48.39
Yes	16	51.61
Total	31	100
Gender composition		
Both female	108	23.74
Both male	112	24.62
Older brother, younger sister	138	30.33
Older sister, younger brother	97	21.32
Total	455	100

FAMILY LEVEL VARIABLES

Paternal investment, family size, and the presence of half siblings:

Paternal investment was hypothesized to decrease sibling rivalry by introducing additional resources into a family. The presence of half siblings, conversely, should increase rivalry by presenting competition for these resources. In multiple linear regression analysis, paternal investment was positively correlated with the number of children in a family (unstandardized beta, "b" hereafter=2.375, p=.004) and marginally correlated with the presence of half siblings (b=2.302, p=.051). As the number of children in the family increased (b=.279, p=.000) and with the addition of half siblings (b=1.11, p=.003), more children fought. As shown in Table 2, when controlled for the number of children and presence of half siblings, families with paternal support contained fewer children who fought (b= -1.006, p=.031). This regression removed one possible outlier, the family with 15 children: the decision did not affect the significance of any variables.

The percentage of children who fought decreased with paternal support (b= -.3059, p=.000). However, larger families were associated with smaller percentages of fighting; to ensure that this result was not a function of the correlation of paternal investment and larger families, the size of the family was controlled. Paternal investment remained highly significant for decreasing the percentage of fighting siblings (b= -.2089, p=.005). The number of children in a family and the presence of half siblings are not associated (b=.854, p=.381), which suggests that the influence of half siblings upon the amount of sibling rivalry is not an artifact of the number of children. The number of children within a family, paternal investment, and the

presence of half siblings within a family explained over 51% of the variance in the number of children who conflicted.

Figure 2: Effect of half siblings on fighting within families with 2-8 children. Under the presence of half siblings, the number of children who fought increased within each family size.

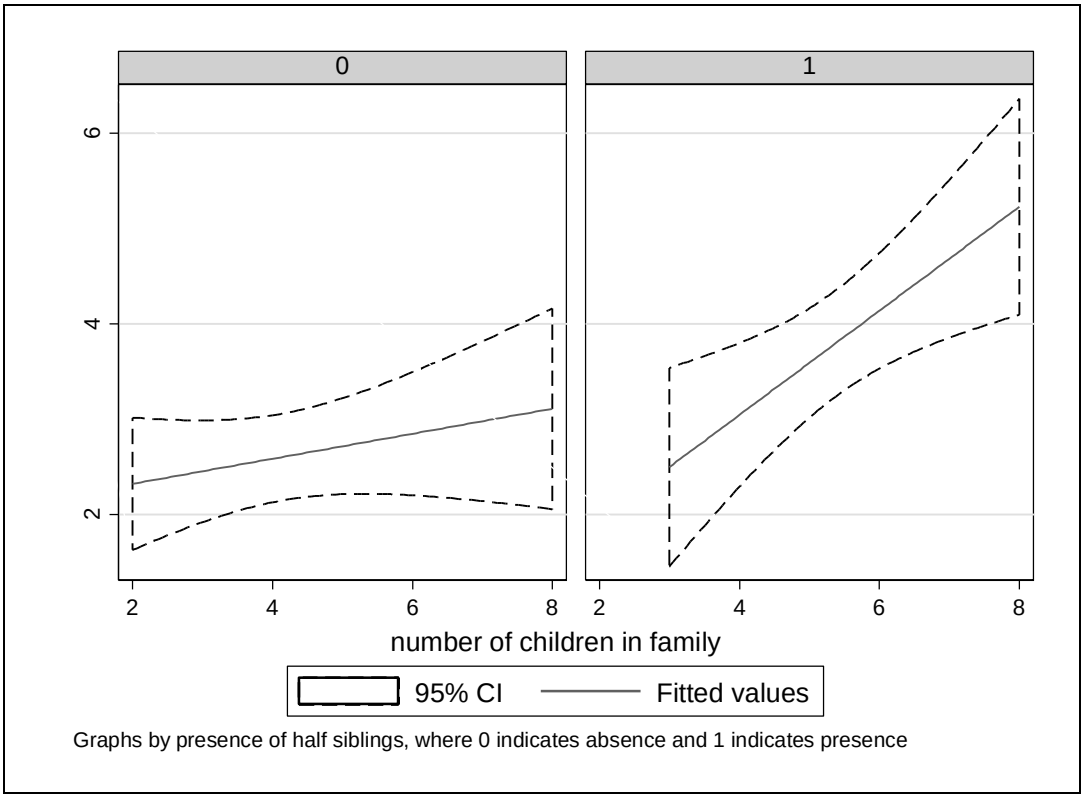
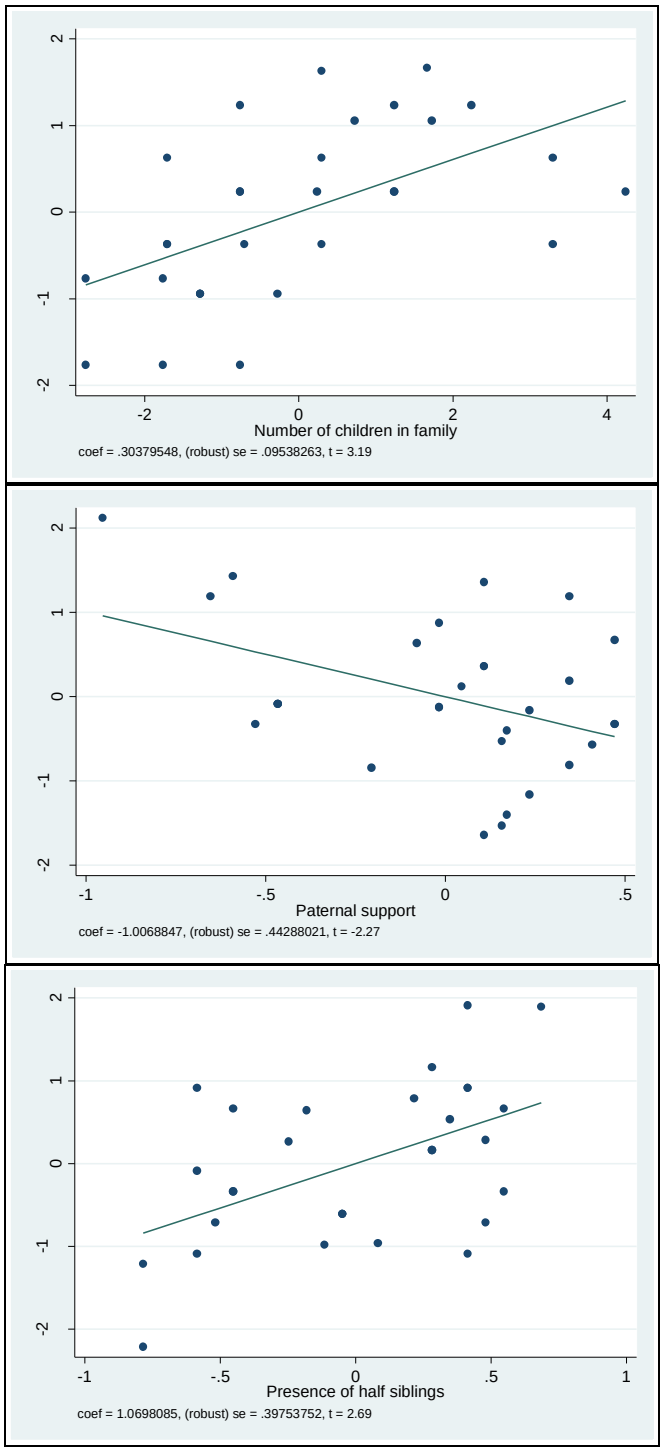


Table 2: Effects of the number of children, paternal investment, and the presence of half siblings on fighting within a family.

Linear regression				**R-squared = .5135**
	B	Lower CL	Upper CL	P-value
# children in family	.3037955	.1087161	.4988749	**.003**
Paternal investment	-1.006885	-1.912676	-.101093	**.031**
Half siblings	1.069809	.256753	1.882864	**.012**

B= unstandardized regression coefficients. CL= 95% confidence limits for *B*. *n*=30. Clustered by family.

Figure 3: Added variable plots for Table 2 showing associations for each variable while controlling for the other two variables.

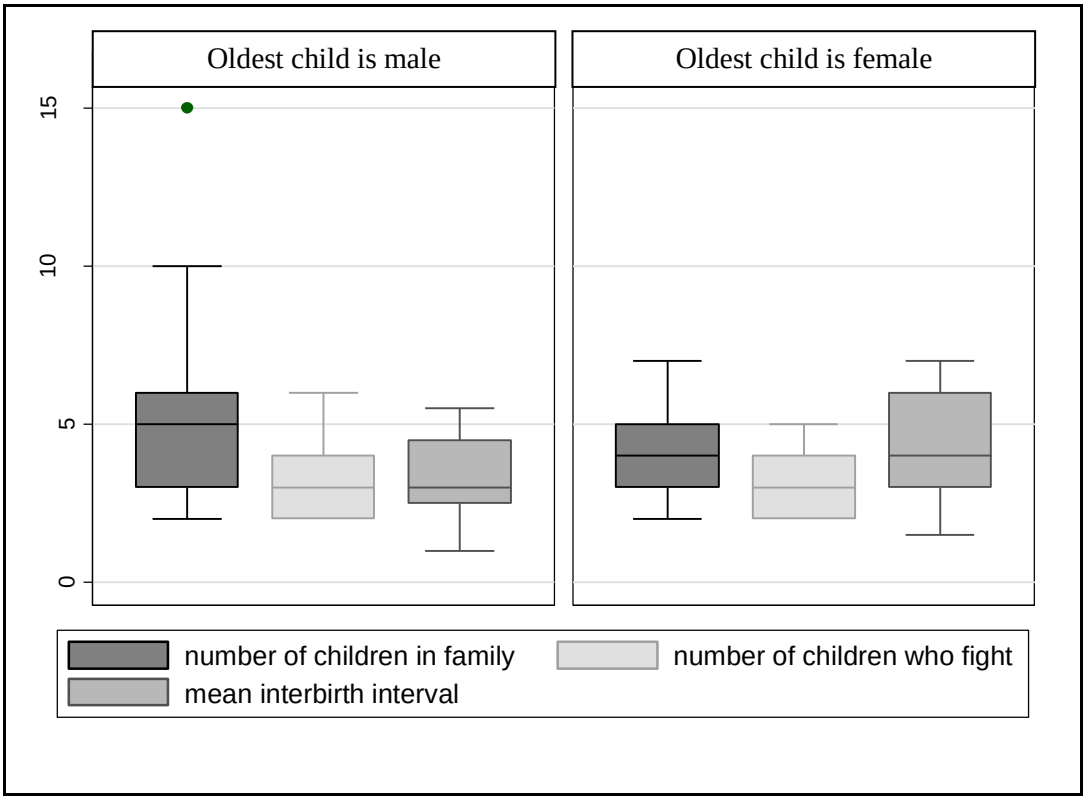


The mean interbirth interval showed a marginally negative trend with the number of siblings who fought (b= -.241, p=.053), most likely due to the shorter birth spacing which arises from the births of additional children. When controlled for the number of children, the marginal significance between the mean interbirth interval and sibling rivalry became non-significant (b= -.106, p=.288).

Alloparents:

Non-nuclear kin who assisted families with childcare (alloparents) were hypothesized to facilitate larger family sizes and to decrease rivalry only if they supplemented a family's resources. Oldest daughters, who often care for younger siblings, were hypothesized to decrease subsequent levels of rivalry within a family. The presence of a daughter as the firstborn was not correlated with a change in the level of sibling rivalry (b= -.500, p=.241). Families in which the oldest child was female had significantly higher mean interbirth intervals (b=1.246, p=.022) and fewer children when the age of the mother was controlled (b= -1.81, p=.045). Even when controlling for the number of children in the family, the presence of a firstborn daughter did not significantly correlate with a change in the levels of rivalry. The presence of an oldest daughter is correlated with at least one non-reproductive gap six years or more in reproduction (b=1.97, p=.018), although the current age of the oldest daughter was not correlated with the reproductive gap (b=.065, p=.592), suggesting that the gap is not due to reproductive assistance for grandchildren.

Figure 4: Effect of firstborn's sex on family variables. A female firstborn is associated with fewer children in a family, fewer children who fight (due to the decreased number of siblings), and longer interbirth intervals.



There was a negative correlation between the number of relatives who acted as alloparents and the number of children in a family (b= -1.23, p=.001), and a negative correlation (b= -7.14, p=.001) between the number of children in a family and the percentage of siblings who fought (i.e., larger families had a lower percentage of fighting exacerbated by artificially high percentages for two and three children and artificially low percentages for 10 or 15 children). Given this, it would be expected that greater involvement of relatives would correlate with a higher percentage of children fighting in small families. This would not be due to a direct influence of alloparenting, but would rather reflect the influence of family size on the percentage

of siblings who fight. Indeed, the number of relatives involved with the family correlated with an increase in the percentage of siblings who fought (b=.148, p=.000) but was not significantly correlated with the number of siblings who fought (b= -.135, p=.429). When controlling for the number of children in a family, the presence of alloparents was still uncorrelated with the number of siblings who fought (b=.226, p=.196). However, when recoded as a binary variable (i.e., alloparents or no alloparents) and controlling for the number of children in the family, the presence of an alloparent was associated with more children who fought (b=.887, p=.019). Thus, the presence of alloparents appears to be either unconnected to the occurrence of sibling rivalry or to be associated with increased rivalry.

Alloparents may be more likely to aid small families because paternal investment is correlated with larger families (b=2.375, p=.004). Paternal investment is negatively correlated with help from other relatives (b= -1.29, p=.005). No mother was without an alloparent or the father's help, so an alloparent may increase rivalry by not providing the same resources as the father. Alloparents appear to become involved with younger mothers (b= -2.61, p=.019), another possible explanation for their involvement with smaller families: older mothers have had opportunities to bear more children. As a family grows and ages, it may become more independent and therefore reliant on the patriarch rather than other relatives. Alloparents were not associated with a change in the mean interbirth interval (b=.191, p=.504) in this study, even when controlling for the number of children in a family. Table 3 summarizes the effects of a firstborn daughter, the number of relatives who function as alloparents, and the mother's age on

the number of children in a family. While a firstborn daughter and additional alloparents are correlated with smaller families, older mothers are correlated with larger families.

Figure 5: Effects of paternal investment and alloparents on number of children and rivalry. Despite the increase in family size associated with investment from the father rather than an alloparent, the number of siblings who fight decreases within these families.

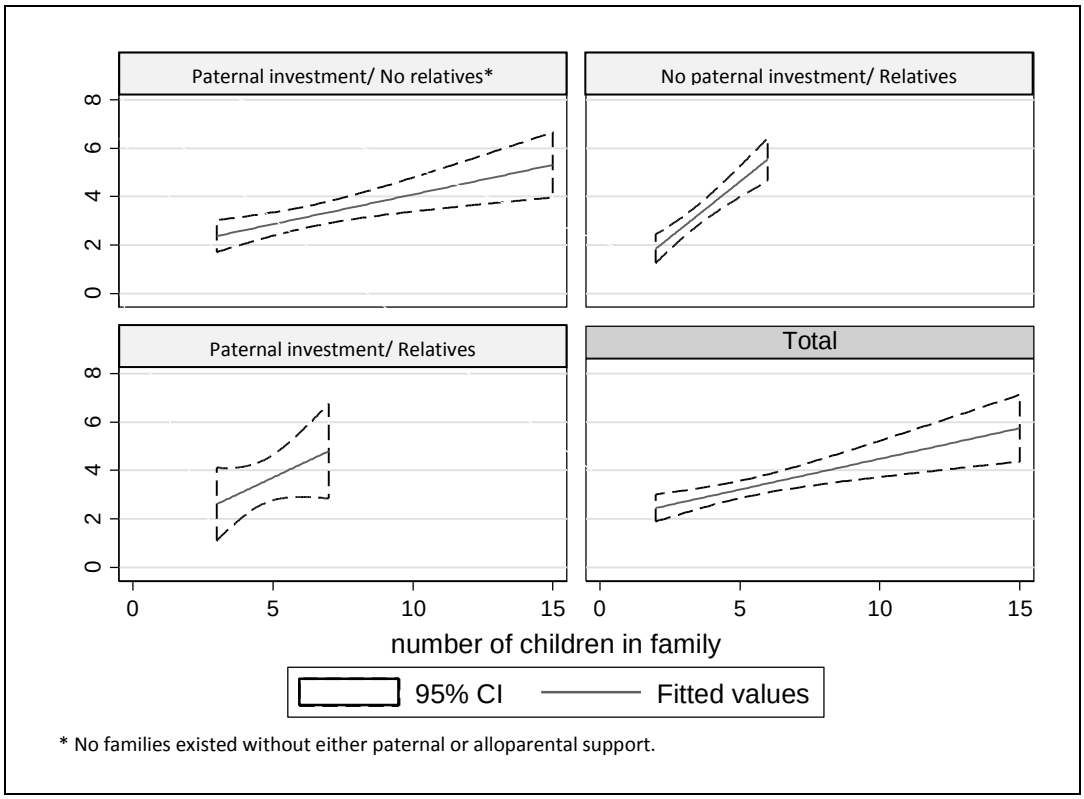
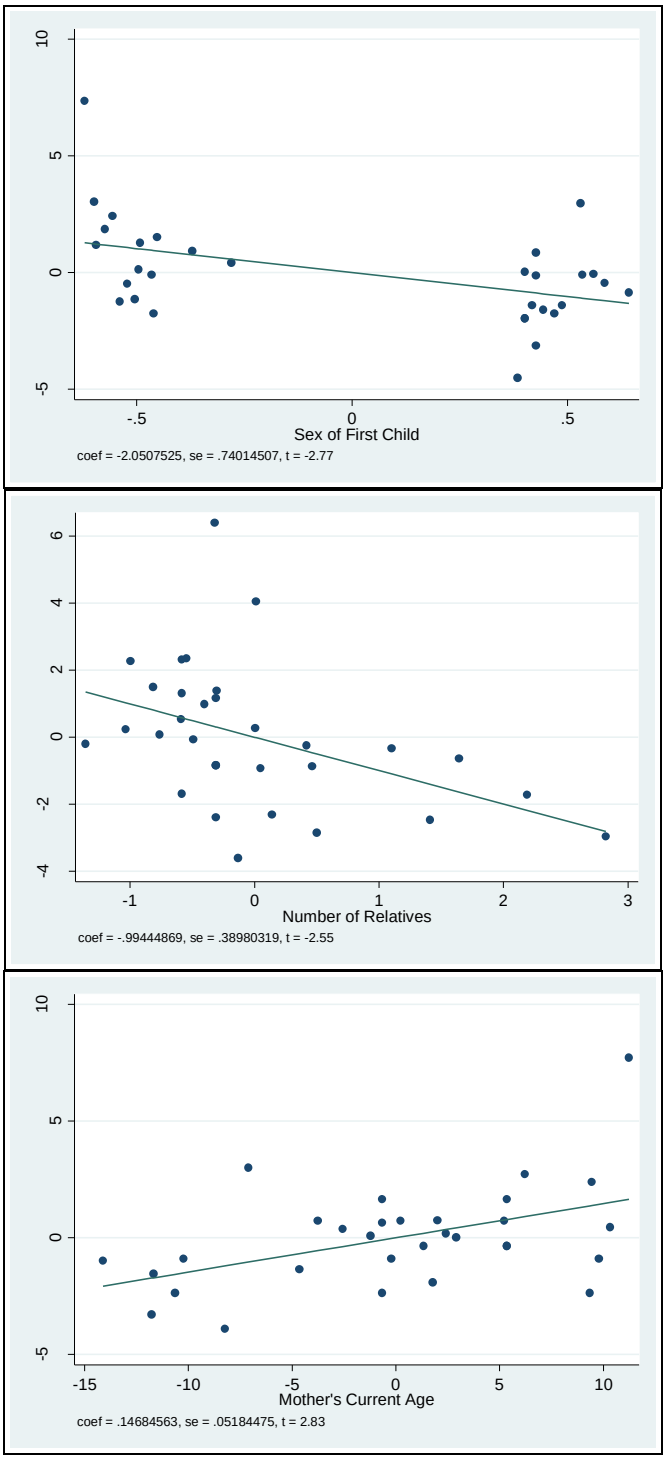


Table 3: Effects of sex of firstborn, number of alloparents, and mother's age on the number of children in the family.

Linear regression				**R-squared = .4923**
	B	Lower CL	Upper CL	P-value
Firstborn female	-2.050753	-3.684654	-.416851	**.016**
Number of alloparents	-.9944487	-1.395735	-.5931621	**.000**
Mother's current age	.1468456	.0125545	.2811368	**.033**

B= unstandardized regression coefficients. CL= 95% confidence limits for *B*. *n*=31. Clustered by family.

Figure 6: Added variable plots for Table 3 showing associations for each variable while controlling for the other two variables.



DYADIC VARIABLES

Age difference and degree of relatedness:

Siblings with large age differences were hypothesized to need different resources and experience less rivalry. Closely related siblings were hypothesized to fight less due to concerns about inclusive fitness. No sibling dyads with age differences over 14 years fought. Increased age differences in a dyad were associated with reduced fighting (b= -.300, p=.000), even when restricted to dyads with age differences of less than 15 years (b= -.289, p=.000). Table 4 summarizes these findings as well as the effects of relatedness on each dyad's likelihood of fighting. Contrary to hypotheses from resource competition, half siblings and unrelated siblings were less prone to fighting than full siblings even when the analysis was restricted to families with half siblings present (b=.855, p=.016; b=1.518, p=.001). Because mothers often give birth to consecutive children with the same father, the difference in birth order was restricted to one order difference: the relatedness between siblings birthed consecutively and siblings spaced apart significantly decreased (b= -.138, p=.012). The tendency toward full siblings fighting with half siblings remained marginally significant (b=.776, p=.075). When further restricted to siblings with consecutive births and only to families containing half siblings, more related siblings still fought more (b=1.28, p=.01).

Table 4: Effects of age difference and degree of relatedness on dyadic fighting (results without age difference restriction).

Logistic regression				**R-squared = .2178**
	B	Lower CL	Upper CL	P-value
Age difference	-.2999318	-.4386274	-.1612361	**.000**
Degree of relatedness	.6060572	-.0176442	1.229759	**.057**

B= log odds. CL= 95% confidence limits for *B*. *n*=452. Clustered by family.

Logistic regression				**R-squared = .1583**
	B	Lower CL	Upper CL	P-value
Age difference	-.2887916	-.4407555	-.1368278	**.000**
Degree of relatedness	.6076046	-.0167402	1.23195	**.056**

B= log odds. CL= 95% confidence limits for *B*. *n*=375. Clustered by family.

The second regression is restricted to dyads with an age difference less than fifteen years and demonstrates that widely spaced siblings are not skewing the results.

Sex composition:

As with similarities for age differences, the resource competition framework predicted that same-sex siblings would generate greater conflict, although sisters may fight less than brothers. Sisters were hypothesized to prefer non-physical tactics during conflicts. Contrary to predictions about the effects of similarity on sibling rivalry, same-sex dyads were not more likely to aggress than mixed-sex dyads (b= .210, p=.362). For dyads with frequency data, being sisters decreased frequency of fighting (b= -.921, p=.029). Brothers were non-significant for levels of fighting (b= .210, p=.702), which does not support other research about aggression between brothers. Mixed-sex dyads were also non-significant (b= -.601, p=.192).

As predicted from other research, sister dyads were significantly more likely (b= .441, p=.014) to use non-physical tactics than non-sister dyads. Brother dyads were significantly less likely to use non-physical tactics (b= -.344, p=.002). Being the same sex marginally increased the likelihood of both parties using the same style of aggression (b= .241, p=.087). Siblings who used non-physical tactics fought less often than siblings using mixed tactics or only physical tactics (b= -1.577, p=.008), substantiating the finding that sisters tend to use non-physical tactics and to fight less frequently.

Although sister dyads did not fight more often, dyads with lastborn females had a greater likelihood of fighting as the percentage of sisters in the family increased (b=3.24, p=.01). As research into resource competition suggests, older sisters may represent more competition for lastborn daughters than older brothers. However, lastborn brothers did not have a greater likelihood of fighting with the presence of a higher percentage of brothers (b= -1.02, p=.290).

Birth order:

Middle children and lastborn children were hypothesized to fight the most. Firstborns, having experienced a period of undiluted investment and being favored for additional investment, were hypothesized to fight the least. For this section, families with two children were eliminated because only families in which children fought were included in this research, skewing the number of firstborn and lastborn children who would fight. Although children with age differences up to 14 years fought, the separation by birth order was never more than 3 children. Dyads with lastborns were more likely to experience fighting than dyads without lastborn children (b=1.022, p=.006). Even when the age difference was restricted to eliminate

siblings who were close in age (six years apart or closer), being in a dyad with a lastborn child significantly increased the odds of fighting (b=1.423, p=.001). The association between fighting and birth order was non-significant for dyads with firstborns (b= -.246, p=.478) and dyads with two middle children (b= -.407, p=.245). When controlled for the number of children in the family and age differences between the siblings, firstborns were marginally less likely to fight (b= -.660, p=.089).

One potential confound to these results is the firstborn's age. As more children are born, the firstborn ages: mothers may underreport the occurrence of sibling rivalry among first children while concentrating on younger children. However, in families with more than three children, younger firstborns were not more likely to fight than older firstborns (b= -.061, p=.117), even though some firstborn children were still minors. Similarly, younger lastborns were not described as being more antagonistic than older lastborns (b==.002, p=.862). Even when restricted to children younger than ten, and controlled for the number of children in the family, dyads with a firstborn were significantly less likely to fight than dyads without a firstborn (b= -1.14, p=.046). The age of the mother at the birth of the last child was marginally correlated with the likelihood of the lastborn fighting (b= -.0664, p=.017), but this association disappeared when controlling for the number of siblings. As shown in table 5, being a firstborn or lastborn, the age difference within a dyad, and the number of children within a family can explain between 29% and 31% of the variance in the likelihood of a dyad fighting.

Table 5: Effects of birth order, age difference within dyad, and number of children within a family on the likelihood of a dyad fighting. Being a firstborn marginally decreases fighting, while being a lastborn significantly increases fighting.

Logistic regression				**R-squared = .2945**
	B	Lower CL	Upper CL	P-value
Age difference	-.2961477	-.4437372	-.1485581	**.000**
# children in family	-.3292826	-.4734741	-.1850912	**.000**
Firstborn in dyad	-.6606827	-1.42266	.1012949	**.089**

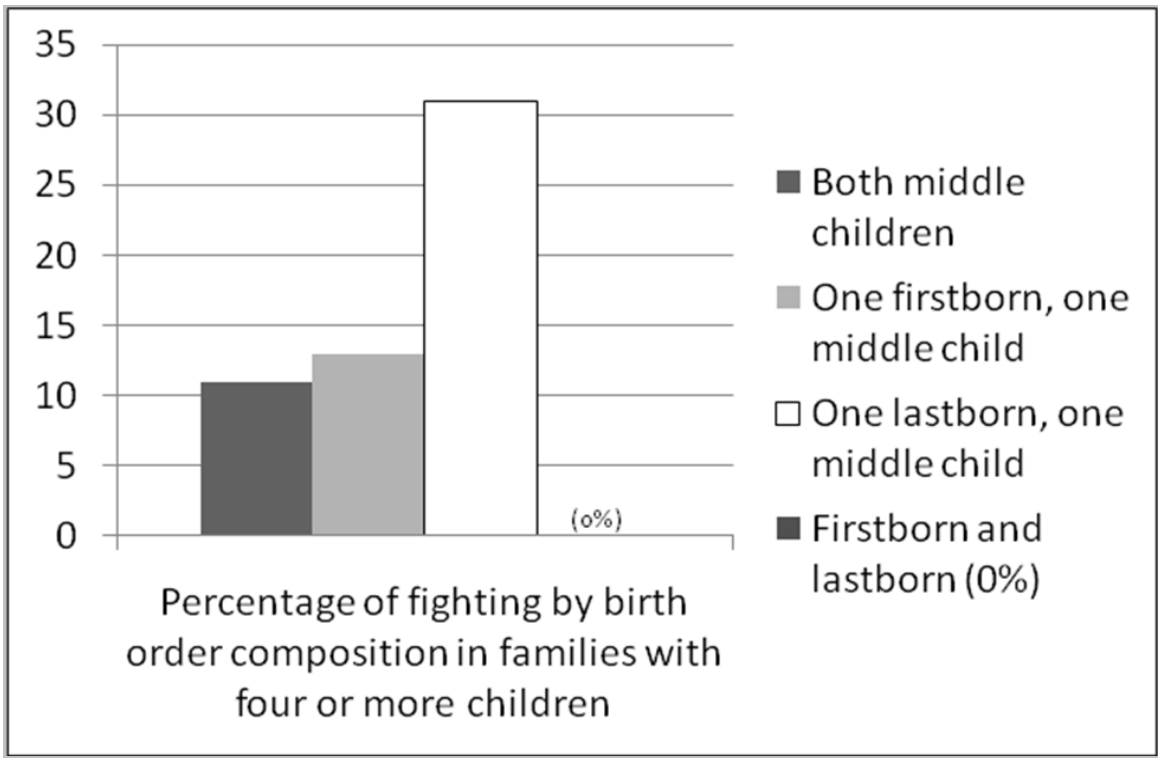
B= log odds. CL= 95% confidence limits for *B*. *n*=452. Clustered by family.

Logistic regression				**R-squared = .3168**
	B	Lower CL	Upper CL	P-value
Age difference	-.3434952	-.5019939	-.1849964	**.000**
# children in family	-.2315477	-.3374866	-.1256087	**.000**
Lastborn in dyad	1.24107	.3960083	2.086132	**.004**

B= log odds. CL= 95% confidence limits for *B*. *n*=452. Clustered by family.

In families with more than three children, middle children were more likely to fight with a lastborn (b=1.373, p=.002) than with another middle child, despite the higher number of middle children than lastborn children within any family with more than four children. Middle children were not significantly less likely to fight with firstborns than with other middle children (b=-.002, 0.995). Firstborns never fought with the youngest child in families containing more than three children.

Figure 7: Percentage of fighting dyads by birth order composition. Middle children fight in greater amounts with lastborns than with firstborns or with other middle children.



CHAPTER FOUR

DISCUSSION AND CONCLUSION

DISCUSSION

The resource competition framework explains some, but not all, aspects of these results. Large families with half siblings that lacked supplemental investment from the father generated increased levels of rivalry; later born children who were close in age tended to fight the most. However, an increased presence of alloparents—including an eldest sister—was not associated with levels of sibling competition except under certain constraints. Same-sex siblings and more closely related siblings did not conflict in greater amounts.

Sibling rivalry increased in families where inclusive fitness was threatened and where parental resources were decreased either by paternal absence or dilution. As expected from resource dilution hypotheses, the total amount of fighting increased with the number of children. With the births of additional children, the individual proportion of total resources directed toward the majority of children is reduced (e.g., Hertwig et al. 2002). Even under practices of primogeniture or other unequal divisions, the average level of resources per child will decrease. The presence of half siblings had a similar effect, indicating that children may increase the amount of fighting when less-related competition enters a family. However, dyads were more likely to fight if full siblings, contrary to Hamilton's (1964) theory of inclusive fitness. The explanation for this is unknown, although it may correspond to laxer sibling parameters in Bwa Mawego.

Paternal investment decreased fighting, possibly due to the central role of Dominican fathers in economic provision for a family (Seller 2005). Although paternal investment allowed for larger families, it reduced the number of children, and percentage of, fighting within the family. Further research into economic correlates of each family will be necessary to determine the strength of the connection between paternal involvement, resource distribution, and sibling conflict.

Help from relatives was neither associated with an increase in family size nor any positive effect on levels of sibling rivalry, contrary to other findings (Hrdy 1999; Quinlan and Quinlan 2008). Relatives appear to involve themselves with smaller, less independent families in which the mother is younger. Additional child care did not decrease the levels of rivalry, suggesting that reductions in sibling rivalry may be dependent upon emotional support within the nuclear family (e.g., Kowal and Kramer 1997; Hoffman et al. 1995) but not from external sources. The non-association of increasing levels of alloparenting with sibling rivalry may result from the failure to distinguish families residing with the father's kin from families residing with the mother's kin. Previous research within the community shows disparate levels of investment from kin dependent upon residence patterns (Quinlan 2004).

Although alloparenting research suggests that maternal support should increase family size and decrease interbirth intervals, the presence of an eldest sister was correlated with decreases in family size, higher interbirth intervals, and a gap of six years or more in reproduction. This is not due to a maternal suspension of reproduction when oldest daughters become reproductively active: although the presence of an oldest daughter is correlated with at

least one reproductive gap, the current age of the oldest daughter was not correlated with the gap, nor did the gap correspond with a time period in which the oldest daughter should seek reproductive assistance from her mother. Previous research conducted within this community suggests a tendency to breastfeed daughters longer than sons (Quinlan et al. 2005), one explanation for smaller family sizes and increased interbirth intervals following the birth of a firstborn daughter. In this dataset, the interbirth interval did not increase after the birth of a firstborn daughter compared with a firstborn son ($b=.375$, $p=.488$). An alternative explanation for the disparity in family sizes may be that older firstborn sons are providing economic support for the families, as suggested by other research into adult sibling investments (Draper and Hames 2000), and therefore increasing the fecundity of the mothers.

Children who are far apart in age are not concerned with similar resources (Daly et al. 2001) and displayed markedly reduced levels of rivalry. This supports the resource competition framework. Resource competition and resource dilution suggest that children of the same sex should also compete for similar resources. Same-sex dyads, however, were not correlated with the likelihood of fighting. Lastborn daughters do have a greater likelihood of fighting as the percentage of other daughters in the family increases, reiterating that potential competitors for resources are associated with greater levels of competition within a family.

If siblings fought, sister dyads fought less frequently than mixed-sex or brother dyads, while brother dyads were not correlated with frequency of conflict. Although these findings differ from resource competition hypotheses, they follow other results for sororal aggression (e.g., Cicirelli 1982). The results suggest that sisters and brothers aggress differently and that

each sex has a distinct style. This supports other research on gendered aggression, but does not specifically support resource competition.

Dyads containing lastborns were significantly more likely to generate conflict than dyads with two middle children or a firstborn. Although lastborns had a lower probability of fighting when born to older mothers, the correlation disappeared when controlled for the number of siblings, which increase with a mother's age. These results support the resource competition framework, in which laterborn children should experience decreased levels of parental resources due to additional, older siblings (Hertwig et al. 2002). Firstborns have fewer incentives to fight (Salmon and Daly 1998), so large families are only problematic for laterborn siblings (Davis 1997). One potential confound is a memory bias toward younger children, who are more likely to live at home and interact more with the mother than older children, yet younger firstborns were not more likely to be described as competing with siblings than older firstborns. When restricted to younger children, firstborns were still less likely to fight than other siblings. When firstborns fought, the second child was the sole recipient of the aggression. Other siblings targeted wider birth order ranges, suggesting a restriction on fighting by firstborn children.

Together, these results suggest that intrafamilial competition—quite possibly about resource distributions—underlies many occurrences of sibling rivalry. Siblings may compete with other siblings to gain access to current resources or perhaps to show displeasure about current, or future, resource allocations.

CONCLUSION

In the decades since the publication of Trivers' (1974) seminal article, which suggested a connection between parental investment and sibling competition, resource competition has proved to be a fertile heuristic for sibling relationships. Research has demonstrated repeatedly that children are sensitive to the resource distribution within families (McHale and Pawletko 1992). Toddlers, for example, show more negativity toward an infant as the mother increases her investment into the younger sibling (Dunn and Kendrick 1981). Sibling rivalry is likely to be more greatly affected by perceptions of intra-family, rather than inter-family, inequities, as children compare themselves to the future target of sibling rivalry. Therefore, both the total level of resources and perceptions of distribution are important to future research into rivalry.

Resource distribution has the potential to explain sibling rivalry as the result of the family constellation, age, sex, and even birth order. The results from this study demonstrate that the resource competition framework, at minimum, can explain competition resulting from age differences, family size, and paternal investment. Although extra-maternal support was not broadly demonstrated to affect sibling rivalry, perceptions of investment from fathers, while allowing the family size to increase, decreased levels of rivalry. Without paternal investment, the amount of rivalry within a family increased with the number of children. The increase of sibling rivalry with an increase in the number of children in a family would be expected whether or not resource competition was the basis for rivalry. However, only resource competition states that large families with additional resources should experience less fighting overall than large

families without supplemental resources. Children who were closely spaced tended to produce more conflict. Although less related children did not fight more, the presence of half siblings in a family increased the overall levels of conflict.

These results support hypotheses drawn from resource competition literature. The small sample size for families in the current study (n=32) is a limitation which should be resolved in future research. Additionally, this research tested correlations: a next step will be to uncover causational patterns in the data. It is clear that the connections between resource distribution and sibling rivalry necessitate further research, but this broad overview of the implications of resource competition has produced suggestive results for future inquiries.

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