Parent-Offspring Conflict and Cost-Benefit Analysis in Adolescent Suicidal Behavior

Effects of Birth Order and Dissatisfaction with Mother on Attempt Incidence and Severity

Paul W. Andrews
Virginia Institute of Psychiatric and Behavioral Genetics

Data on birth order and parent-offspring relations for 1,601 adolescents participating in the National Longitudinal Study of Adolescent Health were used to test hypotheses about the role of adolescent suicidal behavior in parent-offspring conflict. Among adolescents highly dissatisfied with their mothers, the odds that middleborns would make at least one suicide attempt was 23% that of first- and lastborns ($p < .001$), but their odds of receiving medical treatment for their attempts was 8.5 times greater than the odds for first- and lastborns ($p = .032$). The results are tentatively interpreted as supporting the hypothesis that adolescents use suicide attempts to leverage investment from their parents.

KEY WORDS: Add Health; Adolescents; Attempted suicide; Birth order; Blackmail; Cost-benefit analysis; Parent-offspring conflict

Adolescent suicidal behavior is a serious problem. Though it is predominantly non-fatal (there may be up to 1,000 attempts for every fatality; Koplin and Agathen 2004), the death rate is undoubtedly reduced by the interventions of others, the efficacy of modern medicine, and misperceptions about the lethality of methods (e.g., the toxicity of chemical substances; Huott and Storrow 1997). Understanding the causes of suicidal behavior is important for devising effective treatments. It is commonly believed that suicidal behavior is caused by the dysregulation

Received November 15, 2004; accepted February 22, 2005; final version received April 7, 2005.

Address all correspondence to Paul W. Andrews, Virginia Institute of Psychiatric and Behavioral Genetics, 800 E. Leigh, Suite 100, Richmond, VA 23298-0126. Email: pandrews@vcu.edu

Human Nature, Summer 2006, Vol. 17, No. 2, pp. 190–211. 1045-6767/98/$6.00 = .15

of serotonin or other neurotransmitters (Isacsson and Rich 1997) or the desire to escape depression and other unpleasant feelings (Baumeister 1990; Schneidman 1993). These hypotheses have been somewhat undermined by recent evidence that antidepressants promote suicidal behavior in adolescents and adults (Ferguson et al. 2005; Whittington et al. 2004). There is therefore a great need to consider and rigorously test a broader range of hypotheses.

Adolescent suicidal behavior is highly associated with conflict and other disturbances in the family environment (Wagner 1997). Several evolutionary and economic hypotheses suggest that adolescent suicidal behavior might be used to negotiate conflicts between parents and offspring over the allocation of parental investment (PI). The *honest signaling* hypothesis proposes that offspring may take risks that jeopardize their lives to convey to parents that their need for help is real (Cutler et al. 2001; Godfray 1991; Kilner and Johnstone 1997). The *cry-for-help* hypothesis (Stengel and Cook 1958) is similar to honest signaling except it does not require the risk incurred to accurately reflect the need for help. The *leveraging* hypothesis proposes that desperate offspring may take risks that endanger their lives to leverage extra investment from their parents, whose interest in the continued existence of their offspring is put in jeopardy (Johnstone 1996; Parker and Macnair 1979; Zahavi 1975).[1] These hypotheses are similar because offspring must avoid taking risks that are certain to result in death; the goal is not to kill themselves, but to use the suicide attempt as a vehicle for acquiring extra PI.[2] They are also similar in that parents must become aware of the attempt before they can respond to it.

There is some indication that suicide attempts may indeed have useful social effects. Anecdotes in large- and small-scale societies describe adolescents using suicide attempts to compel parents and significant social partners to provide help or make concessions (Baechler 1979; Giddens 1964). Little formal research has been conducted on this issue, but one study shows that parents treat their adolescent offspring with greater sympathy after they have made attempts (Wagner et al. 2000), and another suggests that suicide attempts may have a positive impact on income (Marcotte 2003). Moreover, adolescents are more likely to make repeat attempts when family relations remain conflicted (Brinkman-Sull et al. 2000; King et al. 1995; Spirito et al. 2003), which suggests that they may be a strategic response to conflict.

The three hypotheses suggest that cost-benefit analyses underlie the decision to make suicide attempts, but they differ on the cost-benefit factors that are weighed and analyzed. Honest signaling requires differences in risk-taking to reflect differences in *condition* (the need for PI); else, risk-taking is not an honest signal. Put in cost-benefit terms, the marginal benefits of risk-taking must be greater for those in worse condition (greater need) (Godfray 1993). Thus, honest signaling predicts that offspring modulate their risk so that it reflects their condition.

Leveraging proposes that the risks that offspring impose on their parents play a functional role in forcing the parent to give up the resource. (In honest signaling and cry-for-help, the imposition of risks on parents is incidental.) For instance,

offspring could make repeated suicide attempts, each with a probability of death, *t*, and make the cessation of risk-taking contingent upon the receipt of parental investment. This strategy gets its leveraging power by virtue of the fact that each attempt jeopardizes the parents' genetic interests in offspring survival. Since parents are always exposed to some risk that their offspring will die, the probability of death must be great enough to force the parent to give up the resource (Appendix). This implies that parents must be able to assess whether the probability of death is sufficiently dangerous to force capitulation. It also predicts that offspring will modulate the probability of death with respect to parental sensitivity to risk (i.e., offspring with less sensitive parents must take greater risks to leverage them). There are, in principle, other ways in which leveraging could work, but they are relatively more problematic.[3]

The cry-for-help hypothesis proposes that offspring engage in risk-taking to convince parents of the need for greater investment, but low-level risk-taking need not reflect actual need. As a result, parents can become increasingly resistant to false cries of "wolf!" and offspring may have to take greater risks to convince parents of the need for help (Cutler et al. 2001).

If one or more of these hypotheses are correct, the nervous system must somehow (consciously or not) make cost-benefit calculations. Honest signaling predicts that adolescent suicidal behavior will reflect differences in the need for help, and cry-for-help and leveraging predict that parental sensitivity to risk will also play a role in adolescent decision-making.

The effects of condition and parental sensitivity to risk on adolescent suicidal behavior should be distinguishable. Since condition is an internal factor, it should influence various aspects of the decision-making process in the same way. For instance, if those in worse condition are more likely to make suicide attempts because their need for parental investment is greater, then their attempts should also tend to be riskier. In other words, the likelihood of making an attempt and the severity of attempts should both increase with a worsening of condition.

Conversely, parental sensitivity to risk is an externally imposed variable. Adolescents with less sensitive parents must take greater risks to elicit parental investment and this should have an inhibitory effect on suicidal behavior. Put another way, if adolescents "purchase" extra parental investment with suicide attempts, then those who have to pay a higher price should be less willing to "buy" than those who have to pay a lower price.

Birth-order effects in adolescent suicidal behavior could help distinguish between decision-making driven by condition (implicit in honest signaling) and that driven by parental sensitivity to risk (implicit in cry-for-help and leveraging). Birth-order effects are complex (Conley 2004; Ernst and Angst 1983; Harris 1998, 2000; Hertwig et al. 2002; Rohde et al. 2003; Salmon and Daly 1998; Sulloway 1996), but birth order is thought to denote distinct family niches that influence how offspring learn to negotiate their family environment (Harris 1998, 2000; Sulloway 1996). Indeed, reliable birth-order effects are found primarily in the context of familial

interactions, presumably because birth order matters most to parents and siblings and little to non-relatives (Harris 1998, 2000).

Evolutionary theory suggests that the allocation of PI should be influenced by sibling rivalry and parent-offspring conflict (Mock and Parker 1997). Sibling rivalry occurs when the allocation of PI is influenced by competition between offspring, and it can result in suboptimal allocations from a parental perspective (Mock and Parker 1997). In humans, sibling rivalry is thought to generate linear birth-order effects because older children should have a competitive advantage over their younger siblings (Rohde et al. 2003).

Parent-offspring conflict (POC) occurs when parents and offspring prefer different allocations of PI—it does not require overt antagonism (Trivers 1974). In humans, POC is thought to give rise to quadratic (n- or u-shaped) birth-order effects (Hertwig et al. 2002; Salmon and Daly 1998). The idea is that middleborns (offspring not born first or last) are in an unfavorable position with respect to POC. Firstborns are thought to occupy a better position because they have survived more years, are closer to reproduction, and are therefore more valuable to parents. Lastborns are thought to occupy a better position because they have greater needs and less of a capacity to care for themselves. There is some evidence of quadratic birth-order effects in parent-offspring interactions. For instance, middleborns have been found to receive less cumulative investment from their parents (Hertwig et al. 2002), and they tend to report being less close to their parents (Salmon and Daly 1998).

Birth order could influence suicidal behavior by affecting condition or parental sensitivity to risk. If driven by condition, then attempt incidence and severity should exhibit similar birth-order effects. If driven instead by external differences in parental sensitivity to risk, then the birth order that takes the highest risks should be the least likely to make attempts. Moreover, if birth-order effects arise primarily in familial interactions (Ernst and Angst 1983; Harris 1998, 2000), birth-order patterns in adolescent suicidal behavior might depend on the level of POC.

The existence of birth-order effects in adolescent suicidal behavior was explored using data collected from the National Longitudinal Study on Adolescent Health (Add Health). Add Health contains information on birth order, the incidence of adolescent suicide attempts and their severity, and the degree of satisfaction that adolescents reported regarding their relationships with their parents. There is no corresponding information about sibling interactions.

METHODOLOGY

The Add Health Data Set

Add Health was a longitudinal study of adolescents recruited from a weighted sampling of middle and high schools in the United States. It included information on non-lethal attempts, suicidal ideation (serious thoughts of killing self), depres-

sion, birth order, number of siblings, and measures of adolescent dissatisfaction with parents. More than 20,000 adolescents took part in the in-home interviews that took place from late 1994 to 1995 (Wave I). Of these, 12,118 formed the core sample, and the remainder were from oversampled groups with small populations (e.g., twins, minority groups). A second set of in-home interviews (Wave II) took place in 1996. The public-use version of the dataset (used in these analyses) includes 6,504 adolescents from the core sample and the special groups that were oversampled. Further details on Add Health and data collection procedures can be found elsewhere (Resnick et al. 1997).

Defining the Sample

First, in order to generate a more representative sample, the special oversampled groups were eliminated. Second, because family dynamics are often different for sibships of one (where sibling rivalry is absent) and two (where no middleborns are present) (Conley 2004; Hertwig et al. 2002; Rohde et al. 2003; Salmon and Daly 1998; Sulloway 1996), the sample was restricted to adolescents who reported having two or more full siblings. Within this subsample, adolescents were coded as middleborns if they were not born first or last in their family (e.g., in a family with four children, the children born second and third would be coded as middleborns).

Instabilities in family structure (e.g., parental divorce) can interact with birth order to influence family dynamics in complex ways (Conley 2004). To reduce the impact of instabilities in family structure, the sample was further restricted to adolescents (*a*) who participated in both waves of data collection; (*b*) who were living with their biological mother during both waves, and (*c*) whose biological father was either living with them for both waves or had left the household before the first wave ($N = 1{,}601$). Background characteristics are given in Table 1.

Dependent Variables

Information about suicidal behavior was retrospective, so no reported attempts were fatal. Suicidal ideation was a binary variable reflecting whether the adolescent reported any serious thoughts of killing self during the year preceding each interview. The number of attempts each adolescent reported making during the year preceding each interview was recoded into a binary variable reflecting whether the adolescent had made any attempts during the period. Attempt severity was measured by whether the adolescent received medical treatment for any attempt during the year preceding each interview. (The limitations of this variable are discussed below.)

Independent Variables

The following independent variables were used: sex, racial category (coded as non-African-American or African-American—African-Americans have a different

Table 1. Age, Sex, and Proportion of Adolescents Reporting Suicidal Behavior over the Two Waves Combined as a Function of Birth Order. Last column is the proportion of attempters reporting the receipt of medical treatment for an attempt. Numbers in parentheses are standard deviations.

Birth Order	*N*	% Females	Age	Suicidal Ideation	Suicide Attempts	Medically Treated
Firstborn	448	51	15.8 (1.63)	.1558 (.36)	.0625 (.24)	.2143 (.42)
Middleborn	666	50	15.7 (1.60)	.1799 (.38)	.0496 (.22)	.3636 (.49)
Lastborn	487	54	15.5 (1.56)	.2033 (.40)	.0700 (.26)	.2353 (.43)
Total	1,601	51	15.7 (1.60)	.1803 (.38)	.0594 (.24)	.2737 (.45)

profile for suicidal behavior; Gibbs 1997), a measure of family size (number of children parents had), birth order (computed from number of biological children produced by the adolescent's parents and the number that the adolescent was), presence/absence of the biological father, and a measure of socioeconomic status (total family income in the year preceding Wave I). Since maternal age at birth (calculated as the mother's age minus the adolescent's age) sometimes influences birth-order effects (Salmon and Daly 1998), it was also included. Neither the results nor their interpretation changes substantially if the adolescent's and the mother's ages are used instead.

Two constructed scales were used. Add Health used 19 items from the Center for Epidemiological Studies depression scale (CES-D) to assess adolescent depression. The internal reliability of the CES-D was 0.67 for both waves. Add Health also contains several variables on adolescent satisfaction with the biological mother and father (how warm and loving mom/dad is; the quality of communication with mom/dad; and overall satisfaction with relationship with mom/dad). These were used to generate scales to assess adolescent dissatisfaction with the mother and father at Wave I. The internal reliability for each of the two scales was .83 (maternal dissatisfaction) and .88 (paternal dissatisfaction).

Missing Data

Racial data and several variables that were used in constructing the depression and dissatisfaction scales were missing data in just a few (<0.5%) of the cases. For noncategorical data, the mean value was substituted for the missing data. A third category was assigned to those with missing racial data. Information on suicidal ideation and suicide attempts was missing for a few cases. As these were important dependent variables, no values were substituted in. Data on family income was missing in 23.7% of the cases. For these, a value was imputed (Little and Rubin 1989). The existing data were first log transformed to generate a more normal distribution. A predicted value was generated for every case based on a linear regression of income on sex, number of children produced by biological parents, birth order (both linear and quadratic terms), maternal age at birth, racial category, father presence or absence, depression at Wave I, and dissatisfaction with mother at Wave I. For the missing cases, the imputed income was equal to the predicted value plus a random value. The random value was drawn from a normal distribution with a mean of zero and the same standard deviation as the residuals of the predicted values. Because of the large amount of missing income data, three imputations were made (Little and Rubin 1989).

Assessing Parent-Offspring Conflict

If quadratic birth-order effects arise from POC, they should be specific to adolescents in situations of high POC. As noted above, POC refers to different prefer-

ences in the allocation of parental investment and does not require overt antagonism. POC is not measured directly in Add Health, so dissatisfaction with parents was used as a proxy variable.

Suicide attempts were correlated with dissatisfaction with mothers and fathers, but maternal and paternal dissatisfaction were correlated with each other, r_{1181} = .48, $p < 0.001$. When controlling for maternal dissatisfaction, paternal dissatisfaction was not significantly correlated with the making of suicide attempts in Wave I, partial r_{1178} = .024, p = n.s., or Wave II, partial r_{1178} = .047, p = n.s. However, when controlling for paternal dissatisfaction, maternal dissatisfaction was significantly correlated with the making of suicide attempts in Wave I, partial r_{1178} = .14, $p <$ .001, and Wave II, partial r_{1178} = .12, $p < .001$. This suggested that maternal dissatisfaction might be the more important predictor of adolescent suicide attempts. For this reason, maternal dissatisfaction was used as the proxy measure of POC.

Those reporting high levels of dissatisfaction with mother (80th percentile or greater) were lumped together (N = 316). The 80th percentile reflects a natural breaking point in the data and the idea that adolescents must be sufficiently dissatisfied with their mothers to make suicide attempts. The remainder were lumped into another group (N = 1,285). The high dissatisfaction group tended to be older (16.0 vs. 15.6 years, Mann-Whitney, $p < .001$) and biased toward females (61% vs. 49%, Mann-Whitney, $p < .001$), but did not differ in racial composition (17.3% vs. 18.5%, Mann-Whitney, p = n.s.). The combined wave data on suicidal behavior are broken down by dissatisfaction group and birth order in Table 2. Neglecting birth order, the high dissatisfaction group had higher rates of suicidal ideation (34% vs. 14%, Mann-Whitney, $p < .001$) and suicide attempts (13.7% vs. 4.1%, Mann-Whitney, $p < .001$), but attempters in the two groups did not significantly differ in the receipt of medical treatment (32.5% vs. 23.1% Mann-Whitney, p = n.s.).

ANALYSES AND RESULTS

All linear and logistic regressions were conducted in SAS so the normalized weights of the sample could be taken into account.

Are There Birth-Order Effects in Adolescent Dissatisfaction with Mother?

To explore whether there were birth-order effects in POC, maternal dissatisfaction at Wave I was regressed onto maternal age at birth, the linear and quadratic birth-order terms, income, number of biological siblings, racial category, sex, and depression at Wave I. The quadratic term was not significant, F = .40, p = n.s., so the regression was rerun with only the linear term. The linear term was also not significant, F = .52, p = n.s.; therefore, there is no evidence of linear or quadratic birth-order effects in adolescents' dissatisfaction with their mothers.

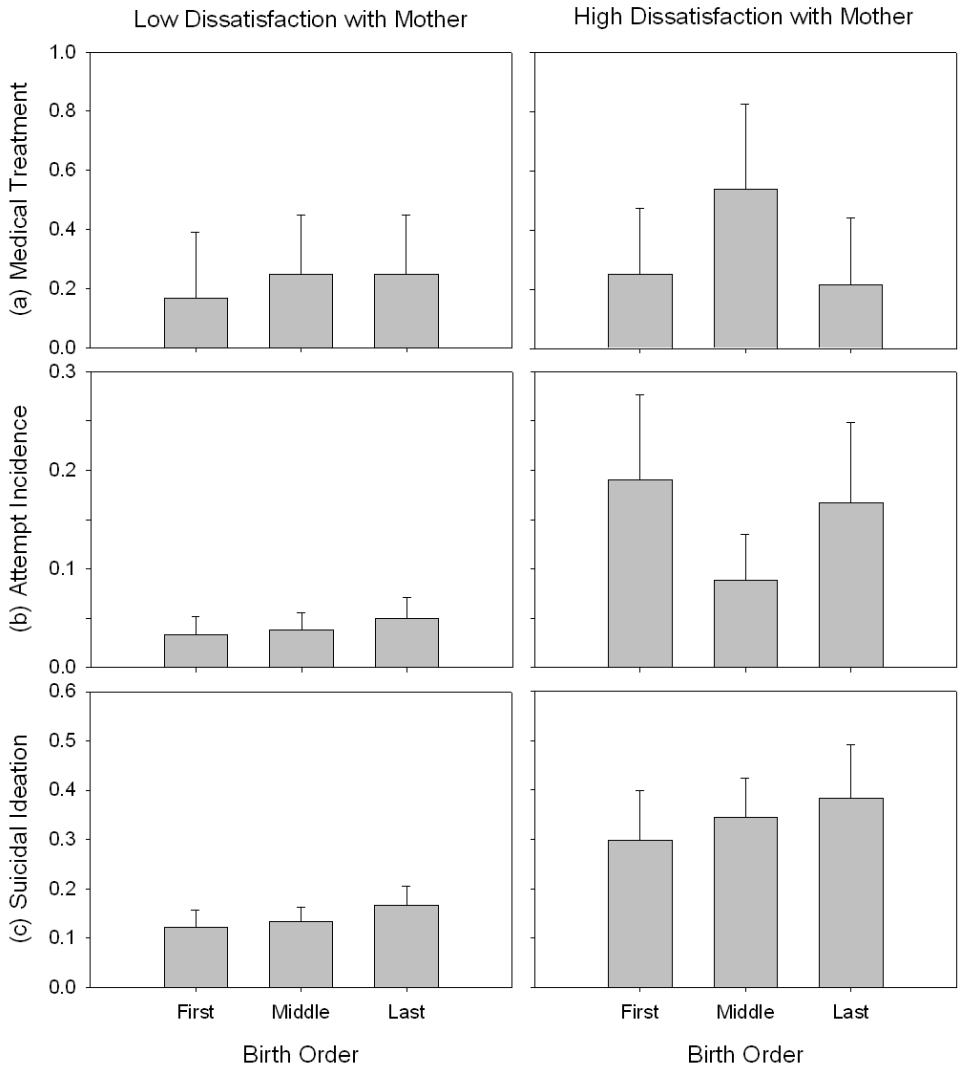
Table 2. Number of Adolescents in Each Birth-Order and Dissatisfaction Category Reporting Suicidal Behavior over Both Waves Combined. (Numbers in parentheses represent total number of adolescents in each category for which information is available.)

	Low Dissatisfaction with Mother						High Dissatisfaction with Mother					
Birth Order	Suicidal Ideation		Attempt Incidence		Medical Treatment		Suicidal Ideation		Attempt Incidence		Medical Treatment	
Firstborn	44	(359)	12	(364)	2	(12)	25	(84)	16	(84)	4	(16)
Middleborn	68	(511)	20	(519)	5	(20)	50	(145)	13	(147)	7	(13)
Lastborn	67	(401)	20	(402)	5	(20)	31	(81)	14	(84)	3	(14)
Total	1,271		1,285		52		310		315		43	

Birth Order and Adolescent Suicidal Behavior

Graphical representations of the raw birth-order data (for both waves combined) are presented in Figure 1. Middleborns in the high dissatisfaction group were more likely to report receiving medical treatment for their suicide attempts than first- and lastborns but were less likely to report making attempts. There appear to be no

Figure 1. Birth-order effects in adolescent suicidal behavior as a function of level of dissatisfaction. (*a*) Proportion of attempters receiving medical treatment during a 2-year period. (*b*) Proportion of adolescents making at least one attempt during a 2-year period. (*c*) Proportion of adolescents having suicidal ideation during a 2-year period. Bars represent twice the standard error.



birth-order effects in attempt incidence or severity in the low dissatisfaction group. Also, there appear to be no quadratic effects in suicidal ideation, though there may be a slight linear effect, in the high dissatisfaction group.

A logistic regression model was constructed to test for quadratic birth-order effects in attempt severity, attempt incidence, and suicidal ideation in the low and high dissatisfaction groups. The model included sex, race, number of siblings, birth order, depression, father presence/absence, maternal age at birth, and family income. Both the linear and quadratic birth-order terms were included. Every regression was run three times, once for each of the three imputed incomes. The test statistics for the three regressions in each group were then averaged and are reported in Tables 3 and 4.

Attempt Severity. Attempt severity can only be analyzed with the subsample of attempters. There were not enough attempters of each birth order to analyze each wave separately, so the combined data were analyzed. Only 95 adolescents reported making attempts over the two waves combined (low dissatisfaction group, $N = 52$; high dissatisfaction group, $N = 43$). The results of the logistic regression analysis are given in Table 3. A quadratic birth-order effect was found in the high dissatisfaction group (i.e., middleborns made more severe attempts), but no quadratic effect was found in the low dissatisfaction group.

While this provided some evidence for a quadratic effect in the high dissatisfaction group, ten independent variables is large for the sample size, and the results of an overparameterized model are less likely to be generalizable to other samples. Using the "selection = score" option in PROC LOGISTIC to compare the score chi-square fit statistic of the submodels, it was clear that six variables could be eliminated with a negligible loss in fit, $\Delta\chi^2 = .722$, $\Delta df = 6$, p = n.s. Attempt severity was regressed onto the remaining four variables: maternal age at birth, OR = .841, s.e. = .084, $p = .039$; birth order (linear), OR < .001, s.e. = 4.032, $p = .040$; birth order (quadratic), OR = 10.202, s.e. = 1.033, $p = .025$; and Wave II depression, OR = 1.108, s.e. = .063, $p = .100$. The odds ratio for the quadratic birth-order effect in the high dissatisfaction group is difficult to interpret, so a similar logistic regression was conducted for the combined wave data in which middleborns were compared with a group composed of first- and lastborns. The odds that middleborn attempters would report getting medical treatment was 8.5 times greater than for first- and lastborns (s.e. = .971, $p = .032$).

There seems to be sufficient evidence to reject the null hypothesis of no quadratic birth-order effect in the high dissatisfaction group, but not in the low dissatisfaction group, which suggests that the two groups may be different. To test this more rigorously, the entire group of attempters ($N = 95$) was analyzed. The independent variables included maternal age at birth, birth order (linear), birth order (quadratic), Wave II depression, adolescent dissatisfaction with mother, and the interactions of dissatisfaction with the linear and quadratic birth-order terms. The quadratic interaction term was not significant, OR = 2.115, s.e. = 1.086, p = n.s., so

Table 3. Average Odds Ratios and Standard Errors (in parentheses) of the Logistic Regression Model Variables for Predicting Attempt Severity in the Low and High Maternal Conflict Groups in Both Waves Combined. Averages are calculated from the test statistics resulting from the regressions of each of the three income imputations. Birth order (quadratic) is the square of birth order.

	Attempt Severity			
	Low Maternal Dissatisfaction		High Maternal Dissatisfaction	
Maternal age at birth	1.06	(.12)	.82	(.10)†
Father presence/absence	.44	(1.04)	.47	(1.73)
Birth order (linear)‡	.88	(.73)	2.33	(.63)
Birth order (quadratic)	2.59	(.94)	10.71	(1.18)[a,]*
Depression (Wave I)	.95	(.05)	1.04	(.26)
Depression (Wave II)	.94	(.06)	1.1	(.07)
Family income	.79	(.76)	1.59	(.78)
Number of sibs	.94	(.58)	1.22	(.37)
Racial category	.24	(1.13)	.82	(1.87)
Sex	1.44	(.86)	1.05	(1.01)
N	52		43	

† $p < 0.10$, * $p < 0.05$

‡ "Birth order (linear)" gives the linear birth order statistics when the quadratic term is excluded (they are uninterpretable when the quadratic term is included).

[a] Middleborns make more severe attempts than first- or lastborns.

the two groups are not significantly different from each other. Put another way, there is evidence of a significant quadratic birth-order effect in attempt severity in the high dissatisfaction group, but insufficient evidence to rule out such an effect in the low dissatisfaction group. This may be attributable to the substantial confidence intervals in the low dissatisfaction group (Figure 1a).

Attempt Incidence and Suicidal Ideation. Attempt incidence and suicidal ideation were analyzed with the full sample of 1,601 adolescents (high dissatisfaction group, $N = 316$; low dissatisfaction group, $N = 1,285$). The two groups were first analyzed separately, and the results can be seen in Table 4. For Waves I and II, and the combined data, quadratic birth-order effects were found for attempt incidence in the high dissatisfaction group, with middleborns being less likely to attempt suicide. The opposite quadratic birth-order effect was found in the low dissatisfaction group for Wave I (i.e., middleborns were *more* likely to make attempts), but this was not replicated in Wave II, nor was it strong enough to drive significance in the combined wave data.

Again, the odds ratio reported in Table 4 for the quadratic birth-order term for attempt incidence in the high dissatisfaction group was difficult to interpret. A lo-

Table 4. Average Odds Ratios and Standard Errors (in parentheses) of the Logistic Regression Model Variables for Predicting Attempt Incidence and Suicidal Ideation in the Low and High Maternal Conflict Groups for Wave I, Wave II, and Both Waves Combined. Averages are calculated from the test statistics resulting from the regressions of each of the three income imputations.

	Attempt Incidence											
	Low Maternal Conflict						High Maternal Conflict					
	Wave I		Wave II		Both		Wave I		Wave II		Both	
Maternal age at birth	1.08†	(.04)	.99	(.05)	1.05	(.03)	.96	(.05)	1.03	(.05)	1.00	(.04)
Father presence/absence	2.23†	(.43)	.77	(.57)	1.47	(.37)	1.25	(.58)	.80	(.59)	.75	(.52)
Birth order (linear)‡	.91	(.26)	.58	(.35)	.75	(.22)	1.26	(.34)	1.00	(.35)	1.23	(.30)
Birth order (quadratic)	2.22*[a]	(.38)	.98	(.52)	1.40	(.32)	.32*[b]	(.48)	.31*[b]	(.47)	.23***[b]	(.43)
Depression (Wave I)	.91***	(.02)	—		.94**	(.02)	.90***	(.02)	—		.91***	(.02)
Depression (Wave II)	—		.89***	(.02)	.93***	(.02)	—		.88***	(.03)	.93**†	(.03)
Family income	1.49	(.25)	1.54	(.33)	1.46†	(.22)	.72	(.31)	.99	(.32)	.83	(.27)
Number of sibs	1.62†	(.27)	1.36	(.25)	1.49*	(.20)	1.01	(.15)	.99	(.16)	.96	(.13)
Racial category	3.02†	(.59)	1.54	(.66)	2.70*	(.50)	2.07	(.70)	1.47	(.65)	2.30	(.62)
Sex	.76	(.38)	.72	(.47)	.74	(.31)	.56	(.48)	.38†	(.51)	.52	(.42)
N	1,285		1,285		1,285		315		316		315	

	Suicidal Ideation											
	Low Maternal Conflict						High Maternal Conflict					
	Wave I		Wave II		Both		Wave I		Wave II		Both	
Maternal age at birth	1.04†	(.02)	1.00	(.03)	1.03	(.02)	.96	(.03)	1.00	(.04)	.98	(.03)
Father presence/absence	1.08	(.26)	.87	(.30)	.94	(.22)	.65	(.40)	1.03	(.42)	.63	(.37)
Birth order (linear)‡	.71*	(.15)	.99	(.17)	.76*	(.13)	1.01	(.24)	.94	(.07)	.96	(.23)
Birth order (quadratic)	1.05	(.21)	.86	(.24)	.89	(.18)	1.10	(.29)	.61	(.33)	.96	(.28)
Depression (Wave I)	.90***	(.01)	—		.94***	(.01)	.89***	(.02)	—		.90***	(.02)
Depression (Wave II)	—		.91***	(.01)	.95***	(.01)	—		.88***	(.02)	.94**	(.02)
Family income	.97	(.15)	1.05	(.17)	.95	(.13)	.93	(.21)	.87	(.23)	.97	(.19)
Number of sibs	1.31*	(.12)	1.00	(.09)	1.12	(.08)	.93	(.10)	1.06	(.12)	.96	(.11)
Racial category	2.60*	(.37)	1.89†	(.37)	2.29**	(.30)	2.49†	(.48)	1.13	(.48)	1.88	(.43)
Sex	.86	(.20)	.50**	(.23)	.74†	(.17)	.84	(.30)	.69	(.34)	.83	(.28)
N	1,277		1,276		1,271		311		313		310	

† $p < 0.10$, * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

‡ "Birth order (linear)" gives the linear birth order statistics when the quadratic term is excluded (they are uninterpretable when the quadratic term is included).

[a] Middleborns more likely than first- or lastborns to make attempts.

[b] Middleborns less likely than first- or lastborns to make attempts.

gistic regression was run on the combined wave data in which middleborns were compared with a group composed of first- and lastborns. The odds that middleborns made at least one suicide attempt was only 23% of the odds of the group composed of first- and lastborns (s.e. = .428, $p < .001$).

The null hypothesis of no birth-order effect was rejected in the high dissatisfaction group, but not in the low dissatisfaction group, which suggests that the quadratic birth-order effect may be specific to the high dissatisfaction group. To test whether the two groups were significantly different from each other, the entire sample ($N = 1,601$) was analyzed for the combined wave data. Dissatisfaction with mother was included as an independent variable as well as the interactions of dissatisfaction with the linear and quadratic birth-order terms. The quadratic interaction term was significant, OR = .233, s.e. = .512, $p = .004$, which suggests that the quadratic birth-order effect was specific to the high dissatisfaction group.

No quadratic birth-order effects were found in suicidal ideation in either the high or the low dissatisfaction groups.

Linear Birth-Order Effects. All the logistic regressions were rerun with only the linear birth-order term. The linear birth-order statistics are reported in Tables 3 and 4 under the "Birth order (linear)" variable. No linear effects were found for attempt severity or attempt incidence. In the low dissatisfaction group, there were significant linear birth-order effects in suicidal ideation in Wave I and the combined wave data.

DISCUSSION

Consistent with prior research implicating family dynamics in adolescent suicidal behavior (Wagner 1997), adolescent dissatisfaction with mother at Wave I was a significant predictor of adolescent suicidal attempts reported at Wave II. The existence of birth-order effects also implicates family processes. Linear birth-order effects were found in suicidal ideation in the low dissatisfaction group, suggesting a possible role for sibling rivalry. But Add Health does not contain data on the quality of sibling relationships, so it was not possible to test this further.

No birth-order effects were found in adolescents' reported level of dissatisfaction with their mothers, so there was no evidence that birth order was merely an indicator of POC. However, the evidence that birth order interacted with dissatisfaction to predict suicidal behavior suggests that birth order may affect the ability of offspring to influence the outcome of POC, with middleborns being in a worse position than first- and lastborns.

In both waves, attempt incidence in the high dissatisfaction group was u-shaped (middleborns less likely to make attempts). In the combined wave data middleborns were one-quarter as likely to make suicide attempts as first- and lastborns. Conversely, attempt severity was n-shaped (middleborns tending to make more severe attempts). This finding should be treated with caution because it is based on a small

sample size. Still, it is consistent with another study examining suicidal behavior in schizophrenics which found that middleborns were more likely to make fatal suicide attempts than first- or lastborns (Funahashi et al. 2000). It seems that middleborns' decisions to make suicide attempts are negatively related to the greater risks they take. These birth-order effects add to the growing evidence that middleborns are different (Salmon and Daly 1998).

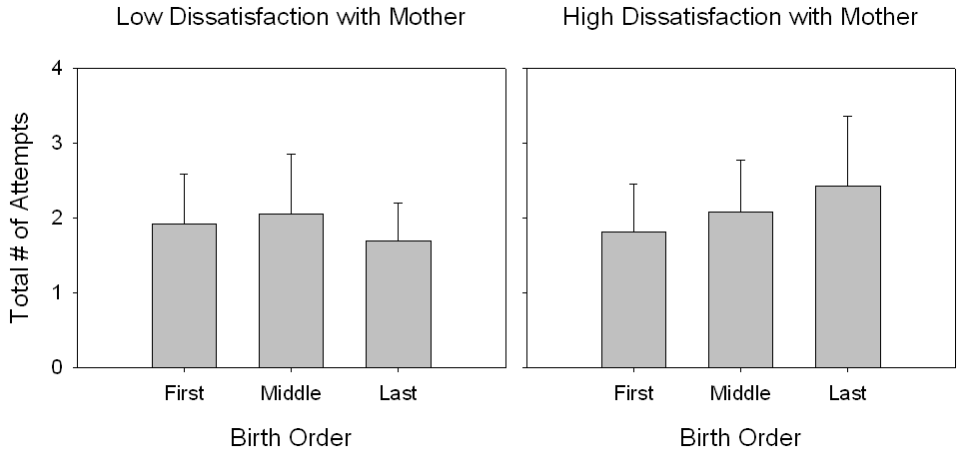
What processes can explain this pattern? Several cost-benefit hypotheses for how offspring may negotiate POC were proposed. The logic of honest signaling requires those with a greater need for parental investment to take greater risks than those with lesser needs. If the birth-order effects were driven by internal differences in the need for help, then those in the birth-order category that tends to be in the worst condition should have exhibited the greatest incidence of attempts and the highest attempt severity. The fact that the birth order that made the most severe attempts was also the one that was least likely to make attempts seems to argue against the honest signaling hypothesis.

The cry-for-help and leveraging hypotheses predict that parental sensitivity to risk will affect adolescent suicidal behavior. Based on evidence that middleborns are in a disfavored birth-order position (Hertwig et al. 2002; Rohde et al. 2003; Salmon and Daly 1998), it was suggested that parents might be less sensitive to the risks that their middleborn offspring take. Thus, middleborns might need to take higher risks than first- or lastborns to elicit extra PI, and this should have an inhibitory impact on their decision to make an attempt. This is consistent with the opposing quadratic birth-order effects in attempt incidence and severity that were found in the high dissatisfaction group. The fact that middleborns made more severe attempts, but were less likely to make attempts, suggests that adolescents may have been assessing whether the value of additional parental investment was worth the risk of death, and discounting the utility of the gamble when they had to take greater risks to overcome parental resistance.

Is it possible to distinguish between cry-for-help and leveraging? Under the cry-for-help hypothesis, increasing parental insensitivity to risk is the product of gradual parental habituation to adolescent suicidal behavior. If middleborns made riskier attempts because their parents had become increasingly insensitive to their suicidal behavior, then middleborn attempters should have had a greater history of making suicide attempts. To test this, the total number of attempts made by each adolescent attempter over the two waves was calculated. As seen in Figure 2, middleborn attempters in the high dissatisfaction group don't seem to have a significantly greater history of suicide attempts. The quadratic birth-order term was also not a significant predictor of total number of attempts when included in a linear regression version of the reduced logistic regression model used in the attempt severity analyses, $F = .14$, p = n.s. This seems inconsistent with cry-for-help, but this interpretation should also be treated with caution owing to the small sample size of attempters for each birth order.

The fact that suicidal ideation exhibited no quadratic birth-order effects (Figure

Figure 2. Birth-order effects in the total number of attempts as a function of dissatisfaction with mother.



1c) implies that birth order influences the decision-making process only after ideation has begun. This suggests that one purpose of suicidal ideation could be to assess parental sensitivity to risk, determine whether the risk of death is worth the gamble, and devise a plan in which the risk matches the threshold needed to compel parental capitulation.

LIMITATIONS

There are several important limitations to this study. First, information about suicidal behavior was based on retrospective self-reports, which are subject to biases in memory and veracity. Second, it was impossible to identify those who may have dropped out after Wave I because they completed suicide. But since the ratio of non-fatal attempts to completions in adolescents may be as high as 1,000:1 (Koplin and Agathen 2004), this number is likely to be very small.

Third, some of the 1,601 adolescents included in these analyses could have been siblings. It was not possible to identify siblings, so birth-order effects could not be examined within families. The overall proportion who were siblings is likely to be low, but their presence could bias significance estimates because some variables are not completely independent. This is a general problem with the Add Health data (some participants could also be friends or romantic partners), but for the purposes of this study it is mitigated by the fact that most siblings have different birth orders (as defined here).

Fourth, it was not possible to use a fine-grained measure of the risk of death associated with suicide attempts. Risk was approximated by whether an adolescent reported making an attempt that resulted in medical treatment, and sociodemographic factors could bias the receipt of medical treatment. However, in this sample, those

who did and did not receive medical treatment did not differ in age, sex, racial makeup, or family income.

Fifth, it could be asserted that there is little reason to view medically untreated attempts as serious attempts. This objection must be counterbalanced with the consideration that one of the primary purposes of this study is to examine variation in risk, and many attempts could have a low risk of death, and even a low risk of physical harm. From a theoretical perspective, many parents might respond to low risks if it is better to do so than to deny access to the parental resource. Restricting the study to medically serious attempts would eliminate the interesting variation. It is also important to note that this study is unable to make any inferences about how the risk of harm was reduced by the interventions of parents or others.

Sixth, Add Health data are not detailed enough to assess whether adolescent attempters in the high dissatisfaction group were successful in eliciting contested parental resources.

Finally, while adolescents could use suicide attempts to elicit additional investment from their parents, they could also be used to elicit investment from other social partners (Watson and Andrews 2002). In Add Health, some adolescents reporting low dissatisfaction with their mothers did make suicide attempts, and they may have done so to negotiate other relationships (e.g., with peers or romantic partners) that would not give rise to birth-order effects. It is also very likely that adolescent suicidal behavior has multiple causes, and other theories will be needed to fully explain it.

Geoffrey Miller graciously provided funding and material support so that I could carry out this research as a postdoctoral fellow at the University of New Mexico. I am currently supported by a National Research Service Award from the National Institutes of Health, P32 MH-20030 (PI: Michael C. Neale). Virginia Rutter, Andy Thomson, Geoffrey Miller, Steve Gangestad, Frank Sulloway, Emory Morrison, Chuck Gardner, and Bill Grady kindly provided comments and/or statistical advice. Special thanks are also due to Ed Hagen and two anonymous reviewers for reading and commenting on the manuscript in detail.

Paul Andrews, JD, PhD, is currently a postdoctoral fellow at the Virginia Institute of Psychiatric and Behavioral Genetics in Richmond. His research involves the possible evolved cognitive and behavioral functions of depression and suicidal behavior and the epistemology of adaptationism.

NOTES

1. Sometimes called the *blackmail hypothesis*, I have renamed it because "blackmail" has nonscientific implications (Linehan 1993). *Leveraging* is more in line with less moralistic anthropological descriptions of hunter-gatherer groups in which suicide attempts are used to levy pressure on others for instrumental purposes (Giddens 1964).
2. For this reason, I am neglecting discussion of the burden-to-kin hypothesis (deCatanzaro 1981), which also implies cost-benefit decision-making, where the central decision is whether to kill oneself to relieve the burden that continued existence may place on the reproduction of close relatives.
3. For instance, if offspring could provide a credible threat that they will kill themselves if their demands are not met, parents might capitulate to prevent the suicide (Bergstrom and Bergstrom 1999). The problem is that it is not clear how such a threat could be credible (Dawkins 1976). If

parents do not comply with offspring demands, the offspring have a higher fitness payoff if they don't kill themselves. Another model suggests that offspring behave in a way that irrevocably reduces their probability of surviving, but parents can increase it with new investment (Eshel and Feldman 1991). However, it is not clear what sorts of behavioral outcomes would be irreversible from an offspring's perspective, and reversible from a parent's perspective. Apart from this, offspring inability to reverse the consequences of their behavior is clearly a limitation. The advantage of the strategy described in the text and Appendix is that if the offspring survives the attempt and gains the parental investment, there has been no permanent decrement to survival.

APPENDIX

More formally, a child, C, seeks extra investment, x, from a parent, P, who has already invested i. P can invest x in C or in another activity (e.g., mating effort or other children). If given to C, C will eventually convert it to fitness equal to $f(i + x)$, where $\partial f / \partial x > 0$. If given to another activity, it is converted to parental fitness equal to $g(x)$, where $\partial g / \partial x > 0$. For selection to favor leveraging, P must not find it profitable to give up x unless forced to do so by C. Under the leveraging strategy, C makes a suicide attempt with probability of death t, and makes repeated attempts until P capitulates or C dies. P will capitulate when it is profitable to give x to prevent C from making a new suicide attempt. If P gives x, P's payoff equals C's fitness, discounted by their relatedness, r (0.5 between parents and offspring), plus the fitness from the other activity, $W(t = 0) = r \times f(i + x) + g(0)$. If P does not give x, the new attempt is made, and $W(t) = (1 - t) \times \mathrm{r} \times f(i) + g(x)$. P's help is forced if $W(t = 0) > W(t)$. The minimum risk C must incur to force P to give up x is:

$$t^* = -(r \times \Delta f - \Delta g) / r \times f(i)$$

(Δf is the increase in C's fitness from acquiring x with needier offspring having higher Δf, so $r \times \Delta f$ is the inclusive fitness payoff to P for giving up x; Δg is the decrease to P's fitness from reduced ability to invest elsewhere; and $f(i)$ is C's fitness from the PI already accumulated with older offspring having higher $f(i)$, with $r \times f(i)$ being the inclusive fitness payoff to P. Note that $r \times \Delta f - \Delta g$ is negative because P must not find it profitable to give up x unless forced to do so by C. Thus, t^* is positive.)

All else being equal, the minimum risk needed to leverage a parent will be lower for older offspring (because $\partial t^* / \partial f(i) < 0$) and for needier offspring (because $\partial t^* / \partial \Delta f < 0$). Moreover, even if they are in a disfavored position, middleborns will often have accumulated more parental investment than their younger siblings prior to weaning because they have been alive for more years. If so, quadratic birth-order effects in suicidal behavior can be expected when t^* peaks at intermediate i. This is true when $-(\partial \Delta f / \partial i) / (\partial f / \partial i) \leq t^*$, where $\partial \Delta f / \partial i < 0$, $\partial f / \partial i > 0$, and $\partial^2 f / \partial i^2 < 0$. These are restrictions on the curvature of f (i.e., they describe how f must increase with i at a decreasing rate and how quickly the rate must decrease). Adolescence is a time when many important life history and fitness-correlated traits exhibit this sort of rapid transition—physical strength (Walker and Hill 2003), height and age-specific fertility (Mace 2000), and the acquisition and development of motor and

cognitive skills (Kaplan et al. 2000; Li et al. 2004; Walker et al. 2002). This suggests that quadratic birth-order effects in suicidal behavior are most likely to occur during adolescence.

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