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Birth-order effects on risk taking are limited to the family environment

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Abstract

Why is the empirical evidence for birth-order effects on human psychology so inconsistent? In contrast to the influential view that competitive dynamics among siblings permanently shape a person's personality, we find evidence that these effects are limited to the family environment. We tested this context-specific learning hypothesis in the domain of risk taking, using two large survey datasets from Germany (SOEP, n = 19,994) and the United States (NLSCYA, n = 29,627) to examine birth-order effects on risk-taking propensity across a wide age range. Specification-curve analyses of a sample of 49,621 observations showed that birth-order effects are prevalent in children aged 10–13 years, but that they decline with age and disappear by middle adulthood. The methodological approach shows the effect is robust. We thus replicate and extend previous work in which we showed no birth-order effects on adult risk taking. We conclude that family dynamics cause birth-order effects on risk taking but that these effects fade as siblings transition out of the home.

KEYWORDS
birth order, family dynamics, multiverse analysis, risk attitude, risk taking, specification-curve analysis

INTRODUCTION

Despite sharing the same parents, homes, routines, and many of the same genes, siblings are often perceived to have very different personalities. The causes of these differences have fascinated scholars for decades, from Galton,[1] Freud,[2] and Adler[3] to the present.[4–6] But whereas research on the relationship between birth order and intelligence has consistently found small linear effects, with firstborns performing slightly better than laterborns on intelligence tests,[7–12] the documented effects on personality are inconsistent. While early work found strong evidence for birth-order effects on personality,[6] some recent studies using modern statistical methods and with high statistical power have found no effects of birth order on various personality traits.[12–14] The debate is not yet settled. Evidence both for[15,16] and against[17,18] birth-order effects on personality continues to emerge.

Various theoretical explanations for birth order impacting personality have been proposed.[3–5,19] The most influential approach takes a Darwinian perspective, attributing such effects to family dynamics.[6] According to this family dynamics model, siblings compete for limited parental resources, such as attention, approval, and care. This competition drives them to occupy different niches within the family system.[6,20] Firstborns often seek to secure parental resources by cultivating the niche of a surrogate parent, aligning with their parents and developing conservative attitudes that help them safeguard their valued family niche. As they tend to be bigger, stronger, and smarter than their younger siblings, they are better able to use competitive strategies to defend their niche. Laterborns respond to this imbalance by seeking to minimize direct competition in their search for a niche, instead developing different interests, attitudes, and aspects of personality. Risk taking is a particularly "useful strategy in the quest to find an unoccupied niche"[6] inasmuch as it is almost guaranteed to attract parents' attention. There are three mechanisms that encourage laterborn children to take risks.[21] First, novel and unconventional options may garner parental favor. Second, because laterborns have a lower life expectancy,[22] their cost of risk taking is reduced. Third, higher risk taking is adaptive to increase a social status within a group.[23]

The family dynamics model rests on two key assumptions. First, siblings compete for parental resources within the ecosystem of the family, with laterborns seeking out unoccupied niches to elicit greater parental investment. Risk taking can be a worthwhile behavioral strategy in this effort. Second, these family dynamics shape children's personality traits, including their propensity to take risks.[a] Together, the two assumptions imply that birth-order effects on risk taking that emerge in childhood will persist into adulthood. Indeed, personality traits have been found to be moderately stable across the lifespan.[24] Yet, recent studies have consistently failed to find birth-order effects on risk taking in adulthood.[14,17,18]

Let us suppose that only the first assumption holds: Siblings are subject to family dynamics as they grow up, and those dynamics shape their behaviors. But those behaviors are contingent on the environment and do not coalesce into long-term personality traits. If this is the case, and the second assumption does not hold, birth-order effects on risk taking will be apparent while siblings are embedded in the family environment but will fade out as they leave those dynamics behind. A related hypothesis was first suggested by Ernst and Angst,[19] who noted that the behaviors children learn to get along with their family members are not usually transferred to other environments. For example, children who are dominated by their older siblings are not more likely to let themselves be dominated by peers,[25] and firstborn children who are judged by their parents as more aggressive than their laterborn siblings do not appear more aggressive to their teachers.[26] Building on the work of Ernst and Angst[19] and reviewing more recent evidence,[27] Harris[28] emphasized that "children are not compelled to drag along previously learned behaviors to new contexts. They are fully capable of acquiring new behaviors tailored to their current circumstances." Evidence supporting this "context-specific learning hypothesis"[29] comes from studies comparing children within and outside the family environment. We examine the context-specific learning hypothesis across siblings of different ages, assuming that younger age groups are more likely to live in the family environment and older age groups are more likely to have left that environment behind. Consequently, the probability of detecting birth-order effects will be higher in younger respondents and decrease gradually as they grow older.

METHODS

We tested the context-specific learning hypothesis using data from the German Socio-Economic Panel (SOEP), a dataset in which we have previously found no evidence for birth-order effects on risk-taking propensity in adulthood.[17] Here, we examined whether such effects would emerge in younger respondents. We further sought to identify a second dataset suitable for an independent replication of the analysis, specifying the following criteria: The dataset had to (a) derive from a survey study covering a wide age range of children and adults, (b) include a reliable measure of stated risk propensity administered to both children and adults (studies that asked parents to rate their children's risk propensity were excluded), (c) contain information about the respondents' birth rank, and (d) involve sufficiently large samples that allowed us to test birth-order effects. The NLSY79 Child and Young Adult (NLSCYA) cohort—a study that follows the biological children of women in the 1979 US National Longitudinal Survey of Youth (NLSY79)—met these criteria. Since both datasets are publicly available, we did not solicit approval from an ethics committee. Next, we report the details of the analysis, including how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

Analysis

The analysis of empirical data involves decisions that may be valid but that are, at the same time, often arbitrary and consequential. To increase transparency and test for robustness, Simonsohn et al.[30] proposed a specification-curve analysis. In this analysis, a large set of reasonable and defensible models is estimated, and conclusions are drawn based on results observed across all specifications.[b] We conducted a specification-curve analysis for different age ranges, varying the model universe and the data universe. Specifically, we varied several control variables (i.e., year of birth, gender, household income, mother's level of education, and sibship size, that belong to the model universe), as well as the subsample selected depending on sibship size (data universe) and whether the analysis was conducted between or within families (both model and data universe). In total, we estimated 2280 models (950 for the SOEP and 1330 for the NLSCYA). In each age-specific specification-curve analysis, we indicate the proportion of

[a] Sulloway devoted one chapter of *Born to Rebel* to "Birth Order and Personality." In it, he explored the influence of birth order on several traits, including the Big Five.[6] The fact that most of his research involved adult samples implies that birth order was assumed to have long-term effects on personality.

[b] A similar approach is multiverse analysis,[31] which differs in how results are represented graphically, and also in that the multiverse analysis lacks the inferential statistics step often present in specification-curve analysis.[32] We adopt the graphical representation of specification-curve analysis, but because we use different subsamples of the data for different specifications, we do not develop the inferential step in specification-curve analysis.

models with a coefficient for the main independent variable that was significantly different from zero. Although our hypothesis was not preregistered, our methodological approach minimizes the risk of spurious findings.

The Socio-Economic Panel

The SOEP (SOEP-Core, v36, EU Edition, https://doi.org/10.5684/soep.core.v36eu) is an annual German household survey initiated in 1984; over 32,000 respondents from more than 19,000 households were interviewed in the most recent wave.[33] The SOEP assesses a wide range of information on all members of the households surveyed, including stated risk propensity and family relations.

Initially, information on the children in the participating households was reported by parents only (e.g., via mother–child questionnaires). Since 2000, adolescents in the SOEP households have been interviewed the year they turn 17. A questionnaire for 12-year-olds was introduced in 2014 and a questionnaire for 14-year-olds in 2016. All three youth questionnaires contain the same measure of risk propensity as the standard questionnaire administered to adults, allowing for a comparable analysis across adolescence and the adult lifespan. Note that children born into SOEP households are followed into adulthood when they move out and form households of their own. This allows for intergenerational research.

Birth order

In 2013, the SOEP introduced questions on siblings' birth dates to the main survey, making it possible to determine the respondent's birth rank.[14,17] However, this information is collected only in the adult sample. We, therefore, used the information available on the family of origin to determine birth ranks. We first defined all individuals with the same mother as siblings; we then used the mother's birth biography to identify their birth ranks. Finally, we aggregated this information into a binary indicator of the respondent being laterborn (= 1) or firstborn (= 0). We used this measure of birth order for all age groups analyzed. As a robustness test, we reanalyzed data used in earlier work,[17] which was based on the sibling birth dates self-reported by adults. The results, shown in the Supporting Information, are consistent with those presented in the main analysis.

Risk measure

Our main dependent variable was the response to a question on general risk-taking propensity: "Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?" Responses were given on an 11-point scale from 0 (*risk averse*) to 10 (*fully prepared to take risks*). This measure was first included in the SOEP main questionnaire in 2004 and has since been repeated every 1 or 2 years.[34] It was added to the youth questionnaire for 17-year-olds in 2016 and has been included in the questionnaires for 12- and 14-year-olds from the outset (since 2014 and 2016, respectively).

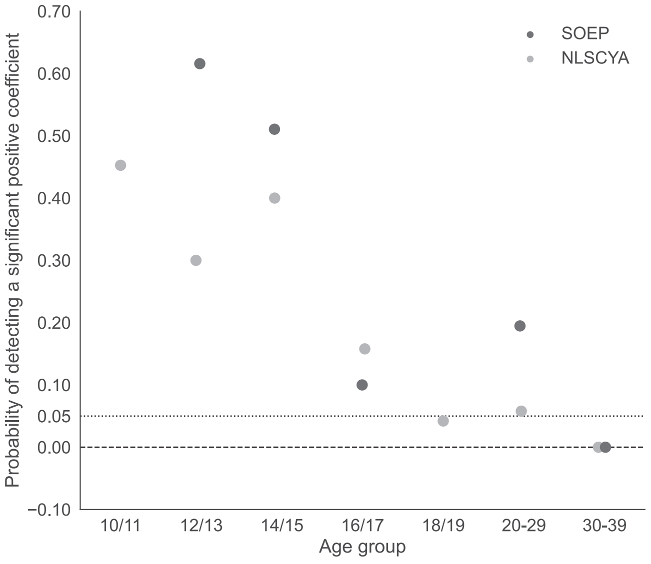

FIGURE 1 Probability of detecting a significant positive coefficient in the specification-curve analyses. Each point represents the ratio of the number of positive significant coefficients to the total number of estimations. Dark dots represent analyses of the SOEP data; gray dots represent analyses of the NLSCYA data. The horizontal line at 0.05 indicates the alpha-error level. Within the age range 10–19 years, two birth years are always pooled in the NLSCYA data; responses are available for ages 12, 14, and 17 in the SOEP data. Above age 20 years, observations in both datasets are pooled in 10-year cohorts, with the latest observation within each cohort being used in the analyses. In the SOEP data, six coefficients for the age range 30–39 years were significant but negative (see Figure 2) and were thus not included in the computation of probability.

Controls

The selection of additional controls was based on earlier work.[17] Since the focus here is on children and young adults, many of whom are still in the education system, the respondents' level of education was not included as a control. However, we did include education in the reanalysis of the data of the 20–29 and 30–39-year age groups from Lejarraga et al.[17] shown in Figure 1. In the main analysis, we controlled for year of birth, gender, household income, mother's level of education, and sibship size. Gender and year of birth were retrieved directly from the data. Number of siblings is the total number of children reported in the mother's birth biography beside the respondent themself. As it is not possible to calculate a birth rank for multiple births, we excluded twins, triplets, and so on from the analysis. Mother's level of education is measured as the ISCED-11 level of the highest qualification attained. Household income is the net family income reported in the survey year of the observed risk measure. To ensure comparability, all income values were converted to the equivalent of 2015 EUR value. Table 1 shows descriptive statistics for a subset of variables.

TABLE 1 Descriptive statistics.

	Age group (in years)	Risk score	% laterborn	% male	Household income	No. children	*n*
SOEP samples	12	5.18	0.61	0.51	49,265	3.12	3014
	14	4.93	0.59	0.51	50,349	3.21	1889
	17	5.94	0.57	0.50	49,763	3.07	5188
	20–29	5.49	0.57	0.52	44,504	2.99	7338
	30–39	4.83	0.59	0.53	43,916	2.89	2565
NLSCYA samples	10	2.21	0.73	0.49	77,693	3.14	3155
	12	2.39	0.71	0.50	78,244	3.14	4651
	14	2.53	0.68	0.49	77,170	3.16	5596
	16	2.54	0.65	0.49	74,210	3.18	4698
	18	2.56	0.57	0.50	71,608	3.16	2978
	20–29	2.53	0.57	0.50	71,735	3.18	5626
	30–39	2.38	0.40	0.52	54,269	3.26	2277

Note: The risk propensity score for SOEP samples ranges from 0 to 10, and for NLSCYA ranges from 1 to 4. Household income is converted to the equivalent of 2015 EUR value.

Sample sizes

The final sample used in our analysis consists of 3014 12-year-olds, 1889 14-year-olds, 5188 17-year-olds, 7338 20–29-year-olds, and 2565 30–39-year-olds. Differences in the number of observations are due to the different deployment dates of the risk propensity measurements and survey instruments described above. Within the 20–29 and 30–39-year age groups, each individual is only observed once. If multiple measurements for an individual were available in an age range, we used the measurement taken at the oldest age (nearest to 29 or 39 years) in the analyses. This sums up to a total of 19,994 observations. Since the SOEP is a panel dataset, it is possible that individuals are observed on several occasions over time in different age groups. However, within each subsample, each individual is included only once.

The National Longitudinal Survey of Youth 1979 Child and Young Adult Cohort

The NLSCYA is a longitudinal study that follows the biological children of women in the 1979 US National Longitudinal Survey of Youth (NLSY79). The biennial NLSCYA survey began in 1986; to date, more than 11,000 children have been identified as born to the NLSY79 mothers. Since these individuals are offspring of the women surveyed in the NLSY79, the NLSCYA is also suited for intergenerational research. Importantly, the NLSCYA includes information on the mother's birth biography, which we used to construct the measure of birth order in the same way as for the SOEP.

Birth order

Information on the number and order of births is available for the women participating in the NLSY79, making it possible to identify a birth rank for the NLSCYA respondents, even if not all siblings participate. In the same way as for the SOEP, we aggregated information on the birth rank into a binary indicator of the respondent being laterborn (= 1) or firstborn (= 0). We used this measure of birth order for all age groups analyzed.

Risk measure

Our main dependent variable was the response to an item on general risk-taking propensity: "I enjoy taking risks." Responses were given on a 1–4 scale (1 = *strongly disagree* to 4 = *strongly agree*). The item is included every time the survey is conducted (every 2 years since 1994).

Controls

The selection of control variables was again based on earlier work.[17] Respondents' level of education was again not included as a control. In the main analysis, we controlled for year of birth, gender, household income in the year of the survey, mother's level of education, and number of siblings. Gender and year of birth were retrieved directly from the data. Number of siblings is the total number of children reported by the mother in the NLSY79 besides the respondent themself. Multiple births were excluded from the analysis, as for the SOEP data. Mother's level of education, measured as the highest maternal education reported in the NLSCYA, was mapped onto ISCED-11 levels. Household income is the net family income reported in the survey year of the observed risk measure. If these data were not available, we used the most recent reported income measure. For the remaining cases with missing income data, the measure was set to zero and we included an indicator variable for this category. To ensure comparability, all income values were converted to the equivalent of 2017 USD value. Table 1 shows descriptive statistics for a subset of variables.

Sample sizes

We used age as a proxy for whether or not the respondent was still in the household and thus influenced by family dynamics. Since the NLSCYA is conducted every 2 years, we created age groups spanning two birth years (10- and 11-year-olds, 12- and 13-year-olds, etc.) to ensure that all respondents were surveyed during this interval. The final sample in our analysis consists of 3240 10–11-year-olds, 4769 12–13-year-olds, 5729 14–15-year-olds, 4813 16–17-year-olds, 3035 18–19-year-olds, 5732 20–29-year-olds, and 2309 30–39-year-olds. Within the 20–29 and 30–39-year age groups, each individual is only observed once. If multiple measurements were available in an age range, we included the measurement taken at the oldest age (nearest to 29 or 39 years) in the analyses. This sums up to a total of 29,627 observations. Since the NLSCYA is a panel dataset, it is possible that individuals are observed on several occasions over time in different age groups—and since it is based on children of women of a specific birth cohort, this is more likely than in the SOEP data.

Models

In the analysis of birth-order effects, like any other empirical analysis, "researchers must make a number of data analytic decisions, many of which are both arbitrary and defensible."[30] This analytic flexibility includes the choice of control variables, estimation methods, and subsamples. We conducted a specification-curve analysis to address this issue. Our analysis is based on estimating linear models with the individual's risk propensity measure as the dependent variable and the laterborn indicator as the variable of interest.

$$\text{risk}_i = \alpha + \beta \cdots \text{laterborn}_i + X_i \cdot \gamma + \in_i \tag{1}$$

X is a matrix with *i* rows representing each individual respondent and γ represents the estimated coefficients. We varied the specification of this general linear model by including or excluding control variables (columns in matrix *X*), by varying the sibship size analyzed, and by considering between- or within-family variation.

The first domain of analytic flexibility concerns the control variables, which can enter the model as individual variables, in sets of variables, or all together. There are five control variables (in addition to our birth-order indicator). We include specifications with each of them as the only control, as well as pairwise combinations, combinations of three, combinations of four, and the full version with all five control variables. This results in a total of 31 specifications.

The next domain of analytic flexibility concerns the sibship sizes considered for analysis. We divided our samples into five different sibship sizes (two children; two or three children; two or more children; three children; and three or more children).

In addition to these 155 (31 × 5) between-family estimates, we exploited the fact that some of the families in our datasets were represented by multiple children per mother, making it possible to estimate regressions based on within-family variation (technically, by including a mother fixed effect in our models). These subsets of data allow us to specify 35 additional specifications derived from seven combinations of control variables and the five sibship sizes. This gave us a total of 190 specifications that we estimated for each age group. In the SOEP, we observe individuals at ages 12, 14, 17, 20–29, and 30–39 years, yielding a total of 950 (5 × 190) specifications; in the NLSCYA, we analyze age groups 10/11, 12/13, 14/15, 16/17, 18/19, 20–29, and 30–39 years, yielding a total of 1330 (7 × 190) specifications. In sum, we estimated 2280 models.

The resulting coefficients for our main variable of interest (β in Equation 1), the laterborn indicator, are presented in the upper panels of Figure 2 (SOEP) and Figure 3 (NLSCYA). The proportion of models with a coefficient for the main independent variable that was significantly different from zero is shown in blue (positive significant coefficient) or red (negative significant coefficient). The lower panels of the figures show the corresponding combinations of age group, control variables, subsample, and estimation method. Figure 1 summarizes the results of the specification-curve analyses, showing the relative frequency of significant coefficients in the hypothesized direction.

The survey data used in the present analyses are available from the SOEP Research Data Centre (https://doi.org/10.5684/soep.core.v36eu), and from the National Longitudinal Surveys, https://www.nlsinfo.org/investigator (cohorts NLSCYA, released August 16, 2021, and NLSY79, released January 06, 2021). The analysis scripts are available in the Open Science Foundation, https://osf.io/xm9fz/?view_only=d659c3a441ec42a99553a1675c2951ad.

RESULTS

In both the SOEP and NLSCYA samples, laterborn children were more likely to report higher risk-taking propensity than firstborn children. However, these birth-order effects gradually declined as respondents grew older, and disappeared in adulthood. Figure 1 summarizes the results of the specification-curve analyses across age groups and datasets. Each point represents the ratio of the number of positive significant coefficients to the total number of estimations. Because the points represent the proportion of significant coefficients in the expected direction, their value reflects the probability of detecting an effect given a particular model specification. Significant birth-order effects on risk-taking propensity were clearly prevalent among children aged 10, 12, and 14 years. They became less likely to be detected but were still observable in late adolescence (age 16 years) and early adulthood (age 18 years). For respondents in their 20s, the probability of detecting a significant coefficient in the expected direction was 0.06 in the NLSCYA data and 0.19 in the SOEP data. For those in their 30s, the probability was zero.

Zooming in on the findings of the specification-curve analysis for the SOEP dataset (Figure 2) showed that laterborn 12-year-olds reported higher risk-taking propensity than firstborn 12-year-olds. Of the 190 specifications, 117 (62%) showed significant effects (in blue) in the expected direction, and there were no effects in the opposite direction. The largest coefficients were observed for within-family specifications.

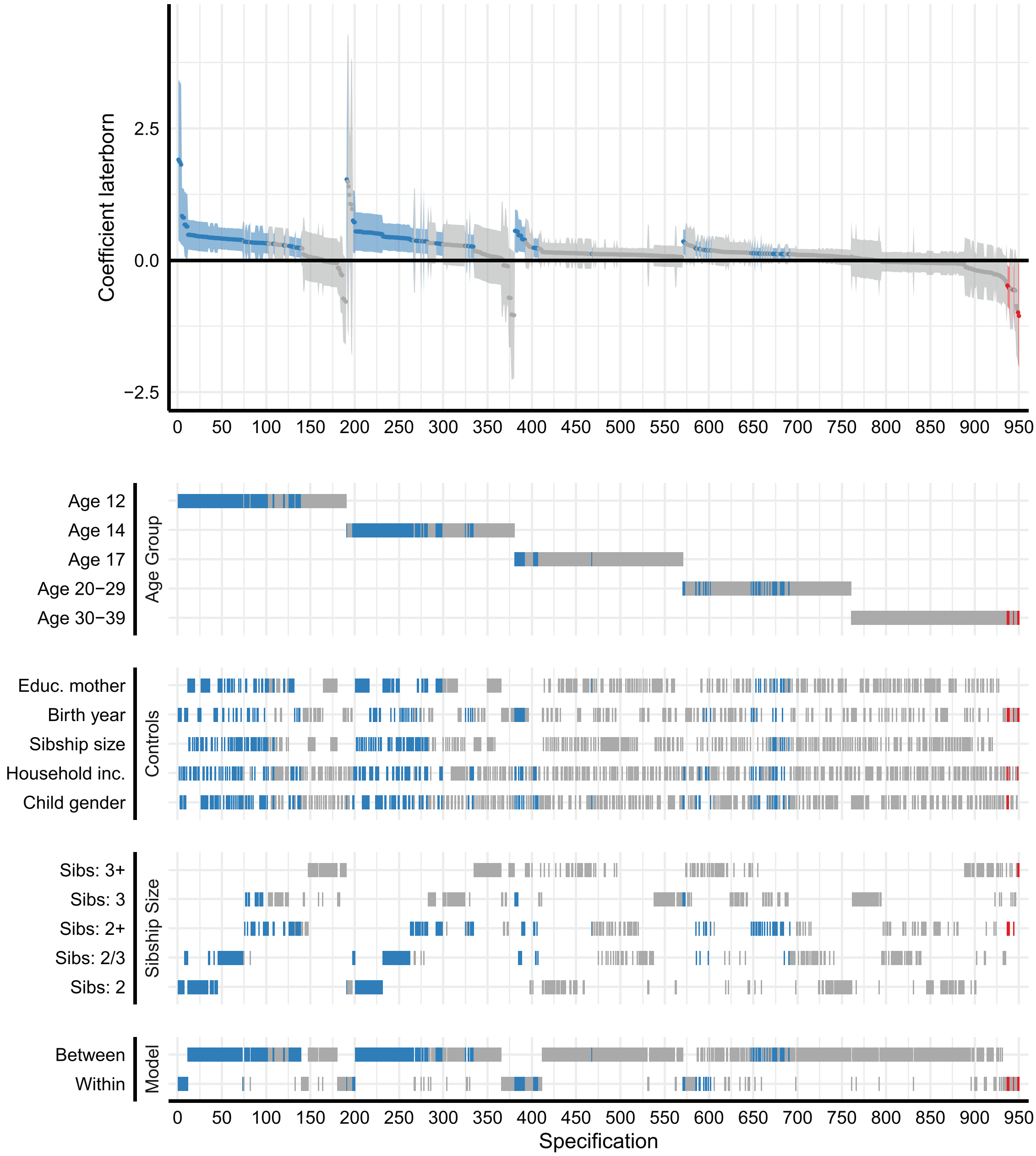

FIGURE 2 Specification-curve analysis for the SOEP data across age groups. The upper panel shows the distribution of coefficients for laterborns across 950 specifications ordered by age of sample and size of coefficient. Vertical lines are 95% confidence intervals. Blue dots and intervals indicate significant coefficients in the expected direction; red dots and intervals indicate significant coefficients in the opposite direction. The next panel shows the age of the sample used in each estimation; the proportion of blue to gray illustrates the fading out of the birth-order effect on risk-taking propensity with age. The lower panels show the control variables used in each model, the sibship size of the sample, and the estimation method.

A similar pattern emerged for 14-year-olds, with 97 (51%) of the specifications exhibiting significant coefficients in the expected direction, though the coefficients were smaller in size. For 17-year-olds, however, the pattern was different. By this age, some laterborn respondents will have experienced an older sibling leaving home and thus a lessening of competitive pressures. Accordingly, only 19 (10%) of the specifications were significant, with all coefficients pointing in the expected direction. Again, the largest coefficients emerged for within-family specifications. The analyses for the age brackets 20–29 and 30–39 years were based on the most recent measurement for each respondent in that window. In the 20–29-year age bracket, 37 (19%) of specifications showed significant birth-order effects on risk-taking propensity. In the 30–39-year age bracket, no coefficients were significant in the expected direction and 6 (3%) were significant in the opposite direction (in red). For adults in the 20–39-year age bracket, the same pattern of results was observed when birth order was self-reported (as in previous work[17]) rather than obtained from the mother's birth biography (see the Supporting Information).

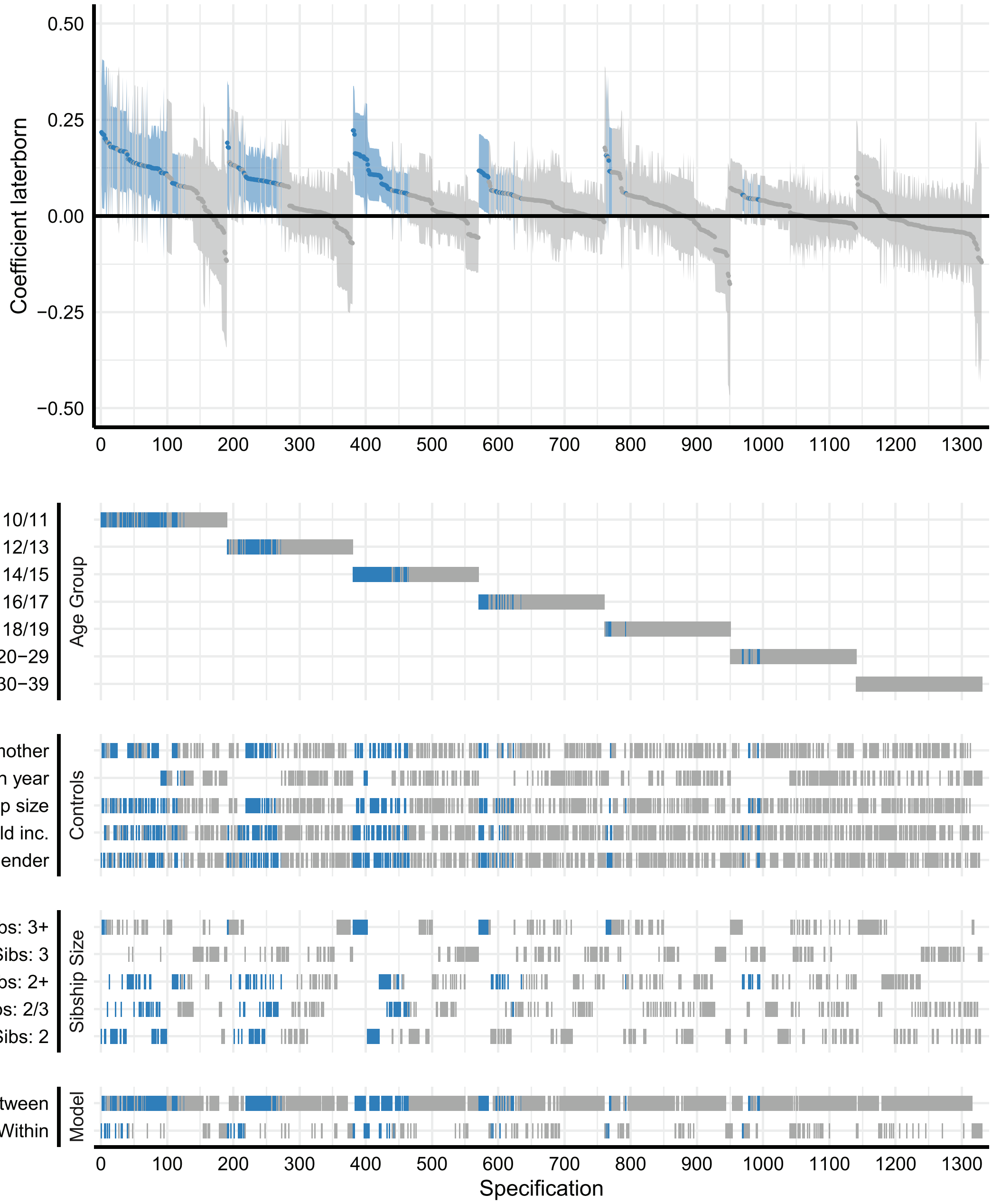

FIGURE 3 Specification-curve analysis for the NLSCYA data across age groups. The upper panel shows the distribution of coefficients for laterborns across 1330 specifications ordered by age of sample and size of coefficient. Vertical lines indicate 95% confidence intervals. Blue dots and intervals indicate significant coefficients. The next panel shows the age of the sample used in each estimation; the proportion of blue to gray illustrates the fading of the birth-order effect on risk-taking propensity with age. The lower panels show the control variables used in each model, the sibship size of the sample, and the estimation method.

The pattern of results in the NLSCYA analysis was similar (Figure 3). The proportion of significant coefficients in the expected direction decreased from 45% at age 10 to 30% at age 12, rallied to 40% at age 14, before dropping to 16% at age 16, 4% at age 18, 6% in the 20–29-year age bracket, and zero in the 30–39-year age bracket. The small proportions of observed significant coefficients in the predicted direction at older ages (18+ in the NLSCYA, 30+ in the SOEP) are precisely at the levels expected from random data and, therefore, emphasize that birth-order effects do indeed decline at older ages.

The overall pattern of results is unequivocal. The younger the respondents, the more likely it is that birth-order effects on risk-taking propensity will be detected and, in general, the larger those effects are. Although the risk-propensity measures in the SOEP and NLSCYA differed in range and wording, the results are consistent; and although our specification-curve analysis is descriptive, the results are robust. These results indicate that birth-order effects on risk-taking propensity emerge in the family environment but fade and eventually disappear as respondents transition out of the home environment. The findings are thus consistent with the first but not the second assumption of the family dynamics hypothesis: The competitive dynamics of the family system are likely to contribute to birth-order effects on risk-taking propensity, but they do not permanently shape children's risk-taking preferences. Rather, these preferences seem to be contingent on the environment.

DISCUSSION

Our findings offer new evidence supporting the context-specific learning hypothesis proposed by Ernst and Angst[19] and developed by Harris,[27] namely, that birth-order effects on personality observed in the family environment are not typically transferred to other environments. We examined risk-taking propensity. It seems plausible that siblings with systematically different physical and intellectual powers rely on different behavioral strategies when competing for limited parental resources—for instance, firstborns defend the niche of surrogate parents, while laterborns explore other niches, thus taking more risks. The question is whether such strategies translate into stable personality traits, as has been assumed.[3,6] The context-specific learning hypothesis suggests that this is not the case: The systematically different behavioral strategies emerging from competitive family dynamics may no longer be relevant or appropriate when the environment changes. This hypothesis—which is consistent with the notion of state-dependent risk preferences in behavioral ecology[35]—would at least partly explain the elusiveness of birth-order effects on risk taking. Indeed, meta-analytic findings of birth-order effects on sports choice—with laterborns being more likely to engage in dangerous sports and more likely to attempt high-risk activities within one sport (baseball) than firstborns—were strongly moderated by age, with larger effects emerging for children than for adolescents or adults.[21] Echoing our findings and consistent with the context-specific learning hypothesis, birth-order effects on risk taking were primarily observed in children who were still living at home. The question may thus not be whether birth-order effects do or do not exist, but during which development stages and in which environments they prevail.

AUTHOR CONTRIBUTIONS

Tomás Lejarraga: Conceptualization. Ralph Hertwig: Conceptualization. Tomás Lejarraga: Methodology. Daniel D. Schnitzlein: Methodology. Sarah C. Dahmann: Methodology. Ralph Hertwig: Methodology. Daniel D. Schnitzlein: Formal analysis. Sarah C. Dahmann: Formal analysis. Tomás Lejarraga: Writing—original draft preparation. Tomás Lejarraga: Writing—review and editing. Daniel D. Schnitzlein: Writing—review and editing. Sarah C. Dahmann: Writing—review and editing. Ralph Hertwig: Writing—review and editing.

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COMPETING INTERESTS

The authors declare no competing interests.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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