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No effect of birth order on adult risk taking

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Does birth order shape people's propensity to take risks? Evidence is mixed. We used a three-pronged approach to investigate birth-order effects on risk taking. First, we examined the propensity to take risks as measured by a self-report questionnaire administered in the German Socio-Economic Panel, one of the largest and most comprehensive household surveys. Second, we drew on data from the Basel–Berlin Risk Study, one of the most exhaustive attempts to measure risk preference. This study administered 39 risk-taking measures, including a set of incentivized behavioral tasks. Finally, we considered the possibility that birth-order differences in risk taking are not reflected in survey responses and laboratory studies. We thus examined another source of behavioral data: the risky life decision to become an explorer or a revolutionary. Findings from these three qualitatively different sources of data and analytic methods point unanimously in the same direction: We found no birth-order effects on risk taking.

birth order | risk taking | family dynamics | SOEP | BBRS

When Maria Elisabeth von Humboldt passed away, her sons Wilhelm and Alexander did not grieve. The relationship with their mother had been distant and tense. Shortly after her death, the younger brother Alexander departed on the most extraordinary expeditions that science has ever known. Wilhelm stayed in Berlin, married young, and became a civil servant. For many, Alexander von Humboldt represents the typical younger brother: adventurous, sociable, and intrepid. He challenged established ideas, befriended world leaders, traveled to terra incognita, climbed the highest known peak of his time, and navigated the unchartered waters of the Amazonian forest. Wilhelm, in contrast, represents the quintessential older brother: conscientious, prudent, and conservative.

Sulloway's Family Dynamics Model

Does birth order shape people's personalities? In his family dynamics model, Sulloway (1, 2) proposed that the family is a set of niches that provide siblings with distinct experiences and viewpoints. Siblings compete for parents' limited resources, such as attention and acceptance. Firstborns, having experienced their parents' undivided attention and care, and being stronger and more intellectually developed than their younger siblings, occupy a dominant position. They thus tend to safeguard their status by developing conservative values and attitudes that help them defend the status quo. Later-borns try to find a valued family niche that is not already occupied by an older sibling. To this end, they will explore—literally, as Alexander von Humboldt did, and metaphorically—and, in the process, rebel against the status quo. According to Sulloway, these competitive dynamics during childhood influence the development of siblings' distinct personalities—including different propensities to take risks—as a function of birth rank (3). Competing with firstborns who are older and thus stronger and more intelligent, and who may receive more parental resources by occupying the niche of a surrogate parent, later-borns have no choice but to take greater risks to differentiate themselves from their older siblings and to attract their parents' attention. Thus, according to Sulloway's childhood niche hypothesis, growing up subject to this dynamic makes later-borns develop a more pronounced propensity to take risks than firstborns because "risk taking is a useful strategy in the quest to find an unoccupied niche" (ref. 1, p. 112).

The Empirical Evidence

Although early research on birth-order effects on personality supported the family dynamics model (e.g., refs. 4–6), more recent research has challenged these findings, arguing that early personality studies were underpowered, used nonrepresentative samples, and relied on between- rather than within-family comparisons, and that personality characteristics were often judged by a single observer member of the family. A recent study using data from three large national panel studies, including the German Socio-Economic Panel (SOEP), controlled for these methodological problems and found that birth order had no substantive effect on personality traits and only a negligible effect on intelligence (7). In parallel, the largest yet study of birth-order effects, which used a sample of 377,000 US high school students, found the same results (8), which were recently corroborated in a non-Western sample (9). For its authors, Damian and Roberts (10), Rohrer et al.'s (7) work has settled the debate: Birth order has no effect on personality.

The evidence concerning birth-order effects on risk taking is less clearly tilted against the family dynamics model, however. Did the risk-taking propensities of Wilhelm and Alexander von Humboldt differ because of the order in which they were born? Researchers examining the sociodemographic factors associated with childhood accidents have stumbled on findings indicating

Significance

Does birth order shape people's propensity to take risks? For decades, personality psychologists have believed that birth order influences personality, but recent evidence has accumulated to indicate that this is not the case. The effect of birth order on risk taking is less clear. We searched for evidence in survey, experimental, and real-world data, analyzing self-reports, incentivized risky decisions, and consequential life choices. The findings point unanimously in the same direction: We found no birth-order effects on risk taking in adulthood.

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Data deposition: The scripts for the first analysis have been deposited in the Open Science Framework, osf.io/9ahxk. The data and scripts for the second and third analyses have been deposited in the Open Science Framework, osf.io/5nj8s and osf.io/w3zmr, respectively.

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that birth order appears to play a role. Later-born children are 4 SDs more likely to be involved in near-drowning accidents (11), more likely to be involved in household accidents (12), and more likely to suffer from accidental injury (13). This pattern is consistent with Sulloway's model, but it is also consistent with the possibility that accidents are more likely to occur in households with more siblings, and in households with older siblings whose behaviors may become a reference point for younger children. Later-born children may be more likely to have accidents not because they seek more risks than their older siblings, but because they observe, imitate, and model their behaviors, possibly before acquiring the necessary cognitive and motor abilities.

Sulloway and Zweigenhaft (3) examined the possible relationship between birth order and choice of risky activities. Specifically, they conducted a metaanalysis of research that reported siblings' choice of sports, with samples covering children, adolescents, and adults. They found that the mean odds ratio was 1.5 to 1 in favor of greater later-born than firstborn participation in high-risk sports (i.e., contact and injury-prone sports, as rated by experts), such as rugby or football. They also examined statistics on 700 brothers who played major league baseball in the United States. Later-borns were 10 times more likely than firstborns to attempt the high-risk activity of base stealing. These studies support Sulloway's hypothesis (ref. 1, p. 433): Later-borns select more dangerous sports than firstborns, and, when they choose the same sport, they take more risks when playing that sport. In the same vein, one small-scale self-report study of financial risk tolerance ($n = 368$) found that firstborns have a lower risk tolerance than later-borns, and are less likely to allocate a majority of their assets to stocks (14). Another small-scale study ($n = 200$), however, found no effect of birth order on self-reported risk behaviors [e.g., birth control, unprotected sex (15)].

Against this background, Rohrer et al. (16) used cross-sectional data from the 2013 wave of the SOEP to explore whether birth order affects the self-reported propensity to take risks (as well as several personality traits beyond the Big Five traits). Using specification curve analysis (16, 17), an exhaustive econometric approach, they observed, in contrast to previous findings on the selection of sports and risky play, that birth order had no substantive effect on risk taking, or indeed on the various personality dimensions examined. Recently, these results were supported in an Indonesian sample (9).

To summarize, although there appears to be an emerging consensus that birth order has no substantive effects on the formation of personality traits, its influence on risk-taking propensity is not yet settled. Accident statistics suggest that later-borns may take more risks than firstborns, but this finding is not necessarily a result of birth-order-specific risk preferences. Sports statistics indicate that later-born children choose more risky sports and take more risks in baseball than firstborns. However, such a predisposition was not corroborated by Rohrer et al. (16), whose specification curve analysis found no birth-order effect on risk taking in a large sample of adults. An important difference between the approaches of Sulloway (4) and Rohrer et al. (16) is that the former analyzed behavioral data from sports choice and play, whereas the latter examined self-reported propensity to take risks. In short, the effect of birth order on risk taking is still an open question, and the choice of the dependent measure may be crucial in answering the question of whether later-borns are more inclined to take risks: To date, birth-order effects have emerged only in behavioral data.

The Present Study

We conduct the most thorough examination of the relation between birth order and risk preference to date. To this end, we examine three sources of data, with multiple dependent measures: self-reports, behavioral measures, and risky life decisions outside the laboratory. To corroborate Rohrer et al.'s (16) observation, we begin by updating their analysis using the most recent wave of SOEP data, and additional estimation methods. These data consist in self-reports of risk-taking propensity. Second, we use data collected in the Basel–Berlin Risk Study (BBRS) (18). This study administered a battery of 39 state-of-the-art measures of people's risk preferences, including incentivized behavioral tasks, such as decisions between monetary gambles and the Balloon Analogue Risk Task. These tasks are crucial to the extent that birth-order effects may be more likely to emerge in behavioral data. The BBRS also contains a set of self-reported "propensity measures," including the SOEP items on risk-taking propensity—allowing us to test for consistency between the BBRS and SOEP data—and a set of self-reported "frequency measures" quantifying respondents' engagement in risky activities (e.g., a test for alcohol use disorders; questions on the frequency of risky behaviors in the past month). Moreover, the BBRS is the first study to run extensive psychometric analyses across a wide range of risk-taking measures. The results suggested that risk preference comprises both a general factor with substantial temporal stability (*R*; akin to *g*, the general factor of intelligence) and several (domain-) specific factors (18). These psychometric factors may reflect the most comprehensive assessments of people's risk preferences to date, and thus constitute ideal measures to examine the potential role of birth-order effects. Finally, we study another source of behavioral data—behaviors outside the laboratory—to provide another test of whether birth-order effects manifest in behavioral data. To this end, we examine samples of explorers and revolutionaries, two particularly risky life choices. In sum, our contribution to the understanding of birth-order effects on risk taking rests on abundant data and diverse dependent measures.

Results

Self-Reports from SOEP: Corroborating the Results of Rohrer et al. (16). Fig. 1 shows the results of the specification curve analysis. Fig. 1, *Upper* plots the coefficient of the variable indicating whether or not the respondent is a later-born. Error bars indicate the 95% confidence interval (CI) for ordinary least squares (OLS) and the 95% highest-density interval (HDI) for Bayesian regressions. Positive coefficients indicate that later-borns reported a higher propensity to take risks, in line with Sulloway's hypothesis (1). Of 1,456 specifications, only 48 (3.3%) showed coefficients that were reliably different from 0 (in red). Of these, 22 indicate that later-borns take more risk than firstborns, and 26 indicate the opposite. Fig. 1, *Lower* describes the characteristics of each specification. Overall, the results are clear. Like Rohrer et al. (16)—but using more-recent data—we found no effect of birth order on self-reported general risk-taking propensity. In a more stringent test, we contrasted firstborns with last-borns; the pattern of results was practically identical (*SI Appendix*).

A Range of Measures in the BBRS. Fig. 2 shows the results for the BBRS dataset (18). Each dependent variable appears as a row, and each independent variable appears as a column. Within each column, the dots indicate the magnitude of the estimated coefficients (i.e., means of the posterior distributions), and the horizontal bars indicate the 95% HDI. The vertical line in each column indicates a null effect, and we denote 95% HDIs that do not include the null line "credible effects." Our key independent variable is whether a participant was a later-born (first column). Positive coefficients (i.e., points falling to the right of the vertical line) indicate that being a later-born was associated with higher risk taking. Overall, being a later-born had no consistent effect on risk taking across measures, and only 5 of the 47 indicators (i.e., 39 measures and

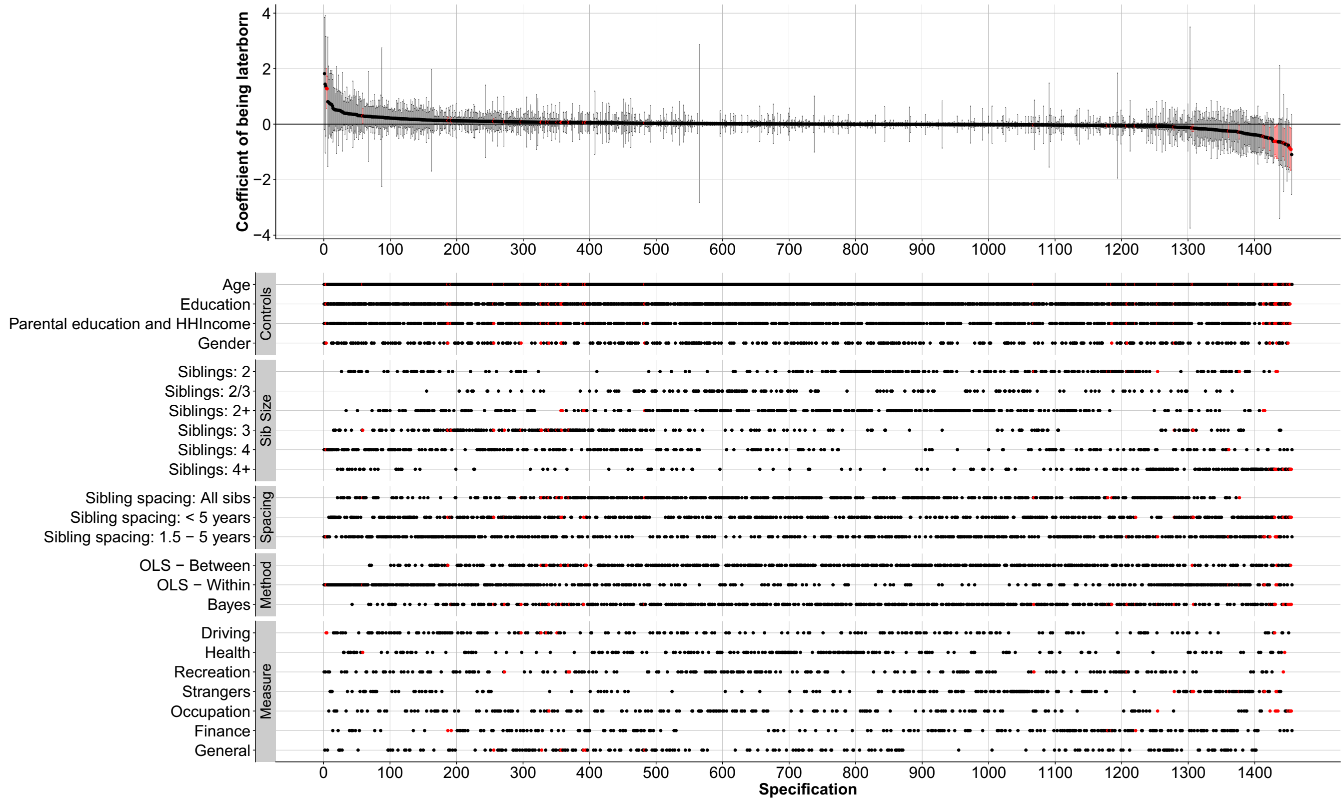

Fig. 1. (*Upper*) The coefficient of being a later-born across specifications. The error bars indicate the 95% CI for OLS regressions and the 95% HDI for Bayesian regressions. Red dots and intervals indicate "significant" coefficients in OLS and "credible" ones in Bayesian specifications. (*Lower*) The controls used in each model, the sibship size of the sample, the sibship spacing, the estimation method, and the dependent measure of risk taking. The distribution of the 1,456 specifications has a mean of 0.006, median of 0.003, 95th percentile of 0.261, 5th percentile of −0.327, and SD of 0.198.

8 psychometric factors) indicated credible effects (4 positive and 1 negative).

Consistency of SOEP and BBRS on the General Risk Item. The regression results for the SOEP items show that the responses of participants in the BBRS and the SOEP were largely consistent. We found no relationship between birth order and self-reported risk-taking propensity for the SOEP general risk item. The same applied to the rest of the SOEP items on risk-taking propensity, with the exception of the item measuring risk-taking propensity in the context of driving. Here, our results suggest the opposite tendency to the one theoretically expected: Later-borns reported lower risk-taking propensity while driving than firstborns.

Propensity Measures. A similar picture emerged for the rest of self-reported measures of risk-taking propensity. Of the 22 measures, only the "health" measure from the Domain-Specific Risk-Attitude Scale (Dhea) and the "Thrill and adventure seeking" (SStas) measure of the Sensation Seeking Scale showed a small but credible relationship between being a later-born and reporting higher risk taking. However, other propensity measures of health risk, such as the measure included in the SOEP (SOEPhea), showed no such relationship. Likewise, other measures of recreational risk taking, such as the SOEPrec item and the "recreational" measure in the Domain-Specific Risk-Attitude Scale (Drec), showed no birth-order effects on risk taking.

Behavioral Measures. Past research found birth-order effects on risk taking only in behavioral data (3). In our behavioral laboratory measures, participants made an incentivized decision (or series of decisions) between options that offered various payoffs with different probabilities. None of these behavioral measures showed any credible relationship between being a later-born and taking more risks.

Frequency Measures. A consistent picture also emerged from the self-reported frequency measures that quantify respondents' engagement in risky activities. None of the frequency measures showed a credible relationship between being a later-born and the frequency of past engagement in risky activities.

Psychometric Factors. Being a later-born was not related to the general factor *R*. However, of the seven specific factors, two revealed small birth-order effects. F3, a factor that reflects recreational risk taking, showed a small but credible effect: Later-borns had higher F3 scores, indicating higher risk taking. Similarly, F7, a factor that captures risk taking in choices between lotteries (i.e., the strongest common signal across all of the behavioral measures; see ref. 18), showed a small but credible positive effect. We again also compared risk taking in firstborns and last-borns, and found that results across all measures remained largely unchanged (*SI Appendix*).

Risky Life Choices: Explorers and Revolutionaries. The absence of birth-order effects in our behavioral laboratory measures is consistent with the findings from the self-reported propensity and frequency measures, but not with past behavioral findings on sports choice and play (3). We therefore additionally examined behavioral data that are not constrained to the laboratory setting, that sidestep the issue of behavioral measures having lower reliability than self-report measures of risk (18), and that are more comparable with sports choice and play: the risky life

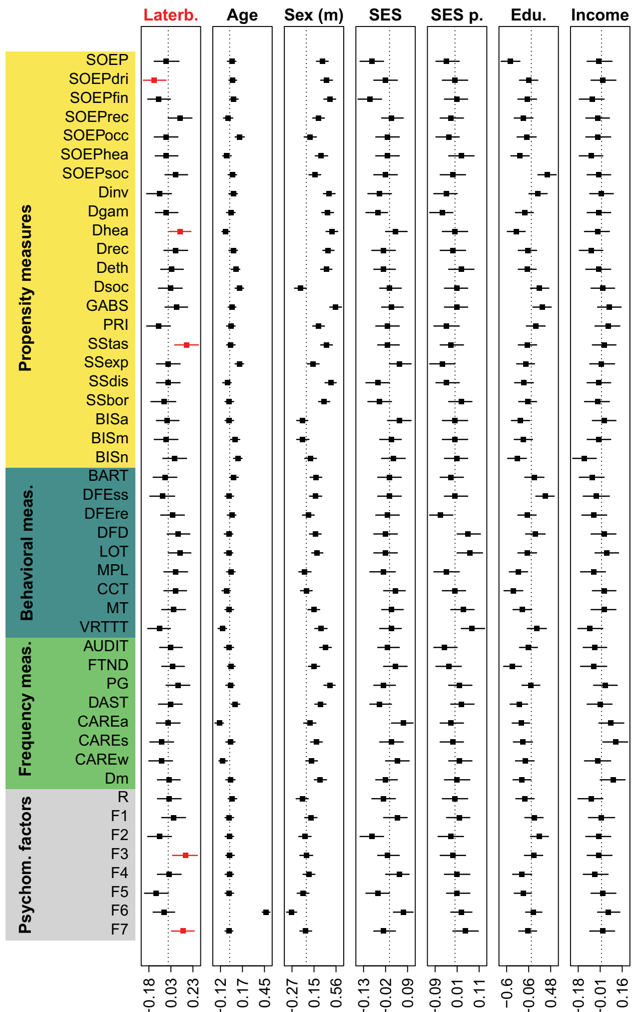

Fig. 2. Results of the BBRS. Each dependent variable appears as a row, with its corresponding classification in the left margin; each independent variable appears as a column. The first column indicates the effect of being a later-born. Within each column, the dots indicate the magnitude of the estimated coefficient, and the horizontal error bars indicate the 95% HDI. SES, socio-economic status as measured on Cantril's Ladder; SES p., SES of parents; Edu., Education: highest completed qualification. To make education and income comparable in the two study centers of Berlin and Basel, both variables were converted to ordinal categories. Higher values indicate higher education or higher income. Row terminology, top to bottom, is as follows. SOEP: Socio-economic Panel, general risk (19); SOEPdri, driving; SOEPfin, financial; SOEPrec, recreational; SOEPocc, occupational; SOEPhea, health; SOEPsoc, social; Dinv: Domain-Specific Risk-Attitude Scale, investment (20); Dgam, gambling; Dhea, health; Drec, recreational; Deth, ethical; Dsoc, social; GABS, Gambling Attitude and Beliefs Survey, total score (21); PRI, Personal Risk Inventory, total score (22); SStas: Sensation Seeking Scale, thrill and adventure (23); SSexp, experience seeking; SSdis, disinhibition; SSbor, boredom susceptibility; BISa: Barrat's Impulsivity Scale, attentional (24); BISm, motor; BISn, nonplanning behavior; BART, Balloon Analogue Risk Task, number of pumps (25); DFEss: Decisions from experience, sample size (26); DFEre, percent of risky choices (26); DFD, Decisions from description, percent of risky choices (26); LOT, Adaptive lotteries, percent of risky choices (27); MPL, Multiple price list, switching point (inverted) (28); CCT, Columbia Card Task, number of cards (29); MT, Marbles task, percent of risky choices (30); VRTTT, Vienna Risk-Taking Test Traffic, reaction latency (31); AUDIT, Alcohol Use Disorders Identification Test, total score (32); FTND, Fagerström's test for nicotine dependence, total score (33); PG, Pathological gambling, total score (34); DAST, Drug Abuse Screening Test, total score (35); CAREa: Encounters with risky situations, aggressive behavior (36); CAREs, sexual behavior; CAREw, behavior at work; Dm, risky behaviors in the past month, total score (20); *R*, general factor of risk preference (18); F1, health risk factor; F2, financial; F3, recreational; F4, impulsivity; F5, traffic; F6, work; F7, lotteries.

decision to become an explorer or a revolutionary. Specifically, we used a historiometric approach (37) to select eminent historic explorers and revolutionaries. Are later-borns overrepresented among people who made these risky life choices? Fig. 3 provides an answer. The dotted line indicates the expected birth rank across increasing sibship sizes under the assumption of no birth-order effects, and each dot represents an explorer or a revolutionary. If later-borns were overrepresented among explorers and revolutionaries, the mean observed rank (in yellow) should fall above the dotted line. However, the observed rank for explorers and revolutionaries is just what one would expect to find in the absence of birth-order effects in these risky life choices. The mean difference ($M = -0.17$) between the observed and expected birth order does not differ from 0, $t(166) = -1.38$, $p = .17$, $d = 0.11$ (excluding 20 single-child sibships).

Discussion

We have used a three-pronged approach to investigate birth-order effects on risk taking. First, we examined the propensity to take risks as measured by a self-report item in the German SOEP, one of the largest and most comprehensive household surveys. Using specification curve analysis, we found no significant effects of birth order in 96.7% of the specifications. Overall, our results corroborate those by Rohrer et al. (16) with more recent data and an alternative estimation method, namely, Bayesian regression.

One limitation discussed by Rohrer et al. (16) is that self-report measures may not capture revealed risk-taking behavior. Thus, to complement the SOEP's self-report approach, we drew on data from one of the most exhaustive attempts to measure risk-taking propensity, the BBRS. We first confirmed that responses to the general risk item administered in both the SOEP and the BBRS were aligned. Indeed, birth order had no effect on self-reported (general) risk taking in either sample. We then went on to explore birth-order effects on the variety of behavioral measures examined in the BBRS, as well as other self-reported propensity and frequency measures. Of the 39 implemented measures, only three showed a credible relationship between birth order and risk taking. Whereas previous research has found birth-order effects on risk taking only in behavioral data, none of our behavioral measures showed any credible birth-order effect on risk taking. Moreover, one of the 39 measures (SOEPdri) suggested that later-borns take less risk than firstborns, and two measures (Dhea and SStas) suggested the opposite. Finally, of the eight psychometric factors identified by Frey et al. (18), F3 (capturing recreational risk taking) and F7 (summarizing mostly the lotteries among the behavioral risk-taking measures) showed a small but credible positive effect, but the general factor *R* showed no credible relationship between being a later-born and taking more risk.

We then considered the possibility that birth-order differences in risk taking are not reflected in survey responses and laboratory studies. We thus examined another source of behavioral data: the choice of becoming an explorer or a revolutionary. The birth rank of explorers and revolutionaries was precisely what one would expect to find in families where birth order has no effect on these life choices.

According to Sulloway's childhood niche hypothesis, family dynamics shape personality during early development and thus influence risk taking in adulthood. If this assumption holds, it should be possible to observe birth-order effects when risk-taking propensity is measured in adults, using standard methods from psychology and economics. Our evidence strongly indicates that family dynamics do not produce stable differences in adult risk-taking propensities.

One possible explanation for the discrepancy between the present results and findings on the choice of risky sports (3)

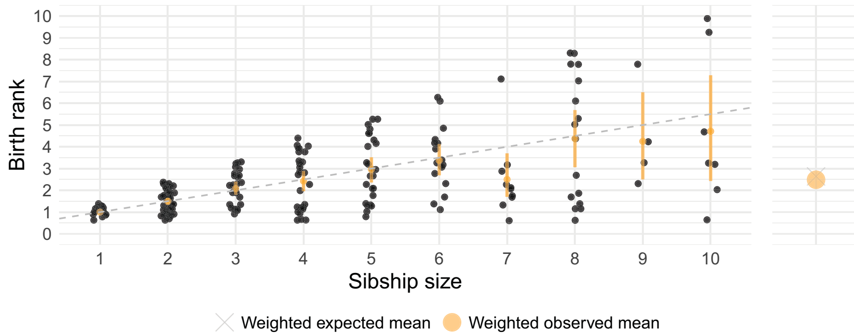

Fig. 3. Each black point indicates an explorer or revolutionary. The dashed diagonal line indicates the expected birth rank under the assumption of no birth-order effects. The yellow point indicates the mean for each sibship size and the corresponding 95% CI. The rightmost point along the *x* axis indicates the expected rank weighted by the frequency of observations at each sibship size, and the mean of observed ranks also weighted by the number of observations. Confidence intervals were computed by bootstrapping using the mean_cl_boot command in R.

is that past studies of birth-order effects may have been less stringent in their methodological requirements—and a metaanalysis can only be as good as the studies on which it is based. For illustration, one article in Sulloway and Zweigenhaft's metaanalysis contributed 4 of the 24 samples analyzed, as well as the largest individual sample (38). In this study, the ratings of a sample of 35 students determined the three most dangerous sports played at Columbia University (football, soccer, and rugby). This classification meant that wrestling was treated as a nondangerous sport. Sulloway and Zweigenhaft (ref. 3, p. 404), in contrast, listed it as a dangerous sport. Although we cannot judge to what extent such selection criteria contributed to discrepancies between the current and past findings, they cannot be excluded as a potential source of ambiguity.

There is another possibility, however. As Sulloway suggests, it may well be that, because later-born children are at a disadvantage when competing with firstborns for parental resources, it pays for them to take risks (ref. 5, p. 107). However, the reach of these dynamics may be restricted to the child and, perhaps, adolescent, and may not necessarily impact personality and behavior in temporally distant adult environments. For example, according to risk-sensitivity theory (39, 40), individuals may favor risky options under conditions of high need, with "need" referring to the disparity between an individual's current state and required target state. When low-risk options fail to provide sufficient benefits, such as enough food to prevent starvation, risk taking will constitute an adaptive strategy to increase the chance of securing outcomes that might otherwise be beyond reach. [This view is compatible with recent findings suggesting that risk preference shares the psychometric structure of major psychological traits, including a general factor that remains relatively stable across time—which does not preclude the possibility that risk taking may vary substantially across specific states (e.g., in response to specific situations or contexts) (18, 41).] This account predicts that risks will be taken by individuals who are competitively disadvantaged—say, weaker, poorer, and less skilled—and thus cannot compete if they stick to low-risk strategies.

This notion suggests that later-borns may take risks during childhood because it is during this period that their competitive handicap is greatest. Later in life, they may be just as likely or unlikely as their older siblings to take risks. In other words, a person can, depending on their state, behave in a risk-seeking manner without being a dispositional daredevil. This view suggests an explanation for the evidence that Sulloway and Zweigenhaft (3) found for birth-order effects on sports choice. Importantly, these effects were strongly moderated by age, with children showing larger effects than adolescents and adults. In other words, the birth-order effects observed were largely driven by children who were still living at home and subject to family dynamics, and thus in a state in which it pays to take risks in activities (e.g., sports, arts, music) in the hope of attracting parental attention and resources.

Conclusion

The idea that birth order influences personality—and risk taking in particular—is powerful. We searched for evidence in survey, experimental, and real-world data, analyzing self-reports, incentivized risky decisions, and consequential life choices, but the findings point unanimously in the same direction: There are no birth-order effects on adult risk taking. To understand why Alexander von Humboldt, and not Wilhelm, climbed Mount Chimborazo, we need to look beyond birth order and family dynamics.

Materials and Methods

SOEP. We examined the relationship between birth order and risk taking in the SOEP (v33.1, DOI: 10.5684/soep.v33.1), an annual household survey (42) with over 30,000 respondents from nearly 15,000 households living in Germany. The dependent variables were responses to questions on general risk taking, as well as six domain-specific questions. The main independent variable was whether or not the respondent was a later-born. We conducted specification curve analysis (16, 17), amounting to 1,456 specifications, varying control variables, sibship size, sibship spacing, within- and between-family analyses, estimation method, and risk measure. The analysis scripts are available from https://osf.io/9ahxk (43).

BBRS. We also examined birth order and risk taking in the BBRS (18), an exhaustive study on risk preferences with 1,507 participants completing a daylong laboratory session in either Basel or Berlin (of these, 1,324 participants had at least one sibling and were used in the present analysis). The BBRS includes 22 self-reported propensity measures, 9 incentivized behavioral measures, and 8 frequency measures. Based on these measures, eight psychometric factors were extracted. We used Bayesian regressions to model the associations between the key independent variable of whether a respondent was a later-born (and several covariates) and all indicators of risk taking. The analysis scripts and the dataset of the BBRS are available from https://osf.io/5nj8s (44).

Explorers and Revolutionaries. Finally, we constructed a database of explorers and revolutionaries, two risky life endeavors. To identify eminent explorers and revolutionaries, we followed a historiometric approach and analyzed only those individuals who were consistently featured in different sources (37). For each sibship size, we compared the mean observed rank with the expected rank. The dataset and scripts are available from https://osf.io/w3zmr (45).

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