

Univerzita Karlova
Přírodovědecká fakulta
Katedra filosofie a dějin přírodních věd

Studijní program: Teoretická a evoluční biologie



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Pořadí narození jako faktor ovlivňující člověka
Birth Order as a Factor Influencing an Individual

Disertační práce

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Praha, 2025

Prohlášení:

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V Praze, dne 31. 1. 2025



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Poděkování

Rád bych vyjádřil své upřímné poděkování svému školiteli, prof. RNDr. Jaroslavu Flegrovi, CSc., za jeho trpělivost, odborné vedení a cenné rady, které mě provázely celým procesem přípravy této disertační práce. Mé poděkování patří také mé rodině za jejich neochvějnou podporu, pochopení a motivaci během mého studia. Děkuji svým kolegům z Katedry učitelství a didaktiky biologie za jejich neocenitelnou spolupráci, užitečné rady a za možnost přenášení teoretických poznatků do praxe. Děkuji všem, kteří mi na této cestě poskytli podporu, sdíleli své znalosti a inspirovali mě k překonání výzev.

Abstrakt

Pořadí narození hraje významnou roli ve vývoji jedince, ovlivňuje jeho osobnostní rysy, vzdělávací úspěchy a reprodukční strategie. Tato disertační práce zkoumá sourozenecké pozice v rámci rodinné hierarchie a jejich dopad na chování a sociální dynamiku z perspektivy evoluční psychologie a behaviorální ekologie. Výzkum vychází z analýzy několika aspektů, včetně rodičovské investice, sourozenecké rivality a kulturních vlivů, a propojuje je s širšími evolučními principy, jako je selekce příbuzných a teorie rodičovských investic.

Práce se skládá z pěti samostatných studií. První studie shrnuje teoretické a historické základy výzkumu vlivu pořadí narození. Druhá studie se zaměřuje na vztah mezi pořadím narození a dosažením vysokoškolského vzdělání. Třetí část analyzuje rodinné vztahy v kontextu pořadí narození a paternitní nejistoty. Čtvrtá studie zkoumá souvislosti mezi sourozeneckou pozicí a sexuálními preferencemi. Poslední část navazuje na výzkumy souvislosti pořadí narození a mužské homosexuality, konkrétně testuje hypotézu sexuálně antagonistických genů a jejich vliv na fertilitu.

Získaná data potvrzují, že pořadí narození významně ovlivňuje klíčové aspekty lidského vývoje a zdůrazňují důležitost interdisciplinárního přístupu ke studiu rodinné dynamiky. Závěrem práce jsou formulovány metodologické výzvy a doporučení pro budoucí výzkum, včetně širšího geografického a kulturního záběru.

Klíčová slova:

pořadí narození, sourozenecké konstelace, rodinné konstelace, evoluční psychologie, vzdělávací úspěchy, reprodukční strategie

Abstract

Birth order plays a significant role in individual development, influencing personality traits, educational achievements, and reproductive strategies. This dissertation examines sibling positions within family hierarchies and their impact on behavior and social dynamics from the perspectives of evolutionary psychology and behavioral ecology. The research is based on the analysis of various aspects, including parental investment, sibling rivalry, and cultural influences, and connects them with broader evolutionary principles, such as kin selection and parental investment theory.

The dissertation consists of five independent studies. The first study summarizes the theoretical and historical foundations of birth order research. The second study focuses on the relationship between birth order and university enrollment. The third part analyzes family relationships in the context of birth order and paternity uncertainty. The fourth study explores the connections between sibling position and sexual preferences. The final study builds on research into the relationship between birth order and male homosexuality, specifically testing the sexually antagonistic gene hypothesis and its impact on fertility.

The data confirm that birth order significantly influences key aspects of human development and emphasize the importance of an interdisciplinary approach to studying family dynamics. The dissertation concludes with methodological challenges and recommendations for future research, including a broader geographical and cultural scope.

Keywords:

birth order, sibling constellations, family constellations, evolutionary psychology, educational achievements, reproductive strategies

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Seznam publikací, které nejsou součástí disertační práce

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1 Úvod

1.1 Obecný úvod

Pořadí narození představuje klíčový faktor, který významně ovlivňuje vývoj osobnost, chování a sociální dynamiku jedince. Od prvních studií sira Francise Galtona v 19. století, který si povšiml nadreprezentace prvorozených mezi vědeckými pracovníky, až po moderní výzkumy Sullowaye (1997), Healeyho a Ellise (2007) či Kristensena a Bjerkedala (2010), se vliv pořadí narození stal předmětem rozsáhlého zkoumání napříč obory, jako jsou psychologie, evoluční biologie, behaviorální ekologie a sociologie. Tato disertační práce se zaměřuje na přínos nových poznatků do této oblasti a snaží se přispět k hlubšímu pochopení mechanismů, které ovlivňují vývoj jedinců v rámci rodinné hierarchie.

Rodinné prostředí, které zahrnuje jak sdílené, tak nesdílené faktory, je klíčové pro formování fenotypické variability mezi sourozenci. Navzdory sdílení v průměru poloviny genetické informace a obdobnému výchozímu prostředí se sourozenci mohou lišit v psychologických vlastnostech a chování stejně výrazně jako nepříbuzní jedinci (Plomin & Daniels, 2011; Sulloway, 1997). Těchto rozdílů si všimli již rané vědecké práce, které zdůrazňují vliv epigenetických a interakčních procesů v rodině na vývoj osobnosti.

Interakce uvnitř rodinného prostředí vytvářejí podmínky, které podporují jedinečný vývoj každého sourozence. Výsledkem jsou výrazné rozdíly v osobnosti a chování, přestože jednotliví členové rodiny vyrůstají ve zdánlivě podobných podmínkách (Banth & Sharma, 2014; Daniels et al., 1985; Davis, 1997; Sulloway, 1997). Kategorizace sourozenců podle jejich pozice – například jako nejstarší, prostřední, nejmladší či jedináčci – často ukazuje určité podobnosti v rámci těchto skupin (Schilling, 2001).

Evoluční psychologie interpretuje rozdíly mezi sourozenci jako adaptivní strategie optimalizace rodičovské investice. Podle Hamiltonovy teorie příbuzenského výběru (1964) a Triversovy teorie rodičovské investice (1972) je alokace zdrojů mezi potomky ovlivněna jejich potenciálním přínosem pro reprodukční úspěch. Prvorození často obdrží větší investici, protože jejich přežití může mít významnější dopad na dlouhodobé šíření genů (Kristensen & Bjerkedal, 2010; Sulloway, 1995, 1997).

Rozdíly v rodičovské investici mohou být dále ovlivněny kulturními a sociálními faktory. Například studie zaměřené na vzdělávací úspěchy prvorozených ukázaly jejich nadměrnou zastoupenost mezi studenty prestižních univerzit (Behrman & Taubman, 1986;

Black et al., 2005). Tento jev lze vysvětlit nejen větší rodičovskou podporou, ale také vyššími očekáváními a tlakem na prvorozené (Damian & Roberts, 2015a, 2015b).

Zatímco některé studie podporují hypotézu, že pořadí narození ovlivňuje osobnostní rysy, výsledky jsou často nekonzistentní. Mechanismy, které stojí za těmito rozdíly, zůstávají předmětem intenzivního zkoumání a debaty. Výzkumná komunita se dosud neshodla na tom, jak významné tyto vlivy skutečně jsou (Hauser & Sewell, 1985; Travis & Kohli, 1995). Někteří badatelé navíc upozorňují na metodologické nedostatky, které mohou vést k chybným závěrům. Například bylo navrženo, že zjištěné rozdíly mezi sourozenci mohou být výsledkem nevhodné interpretace dat nebo chyb ve výzkumném designu (Ernst & Angst, 1983; Rodgers, 2001).

1.2 Cíle disertační práce

Cílem této disertační práce je prozkoumat, jak se vliv pořadí narození projevuje ve vybraných oblastech života jedince. Zaměřuje se především na vzdělávací a reprodukční strategie a na to, jak tyto faktory zapadají do širšího evolučního a sociálního kontextu. Práce se skládá z pěti odborných publikací, které představují příspěvky k současnému vědeckému poznání:

1. **Encyklopedický přehled vlivu pořadí narození:** První publikace nabízí komplexní shrnutí teoretického rámce a historického vývoje studia vlivu pořadí narození. Zdůrazňuje interdisciplinární povahu problematiky a klade důraz na propojení psychologie, evoluční biologie a behaviorální ekologie. Významně přispívá ke konceptualizaci klíčových výzkumných otázek v této oblasti.
2. **Pořadí narození a vzdělání:** Druhá studie se zaměřuje na vliv pořadí narození na vzdělávací výsledky a pravděpodobnost dosažení vysokoškolského vzdělání. Analýza ukazuje, že prvorození mají vyšší šance na zápis na univerzitu, což odpovídá teorii preferenční rodičovské investice. Studie zahrnuje rozsáhlá data z vzorku populace.
3. **Paternální nejistota a rodinné vztahy:** Třetí práce se věnuje evolučním implikacím paternitní nejistoty a jejímu vlivu na rodinné vztahy, a to včetně souvislosti s pořadím narozením jedince (očekávali jsme odlišnosti v hodnocení sourozenců respondenty z důvodu odlišné distribuce rodičovských investic, sourozenecké rivalitě a odlišnosti v nejistotě biologické příbuznosti mezi sourozenci). Výsledky potvrzují, že matrilineární příbuzní jsou vnímáni jako laskavější než patrilineární, což podporuje predikce teorie selekce příbuzných. Naopak se oproti předpokladu nepotvrdily rozdíly

v hodnocení mladších/starších sourozenců, ačkoliv mladší sourozenci vykazují vyšší míru nejistoty ohledně svého biologického příbuzenství se staršími sourozenci, protože sami nebyli svědky jejich narození.

4. **Pořadí narození a sexualita:** Čtvrtá publikace zkoumá vztah mezi pořadím narození a sexuálními preferencemi včetně sociosexuální orientace. Výsledky naznačují, že prvorození častěji vykazují dominantní role v sexuálních interakcích, zatímco mladší sourozenci inklinují k většímu experimentování a časnějšímu zahájení sexuální aktivity.
5. **Sexuálně antagonistické geny a fertilita:** Poslední studie se zaměřuje na testování hypotézy sexuálně antagonistických genů a jejich vlivu na fertilitu. Tato studie navazuje na předchozí výzkumy, které zjistily významné vztahy mezi pořadím narození jedince a mužskou homosexualitou, přičemž tyto výsledky podporují teorii epigenetického vlivu sourozeneckých konstelací na sexuální preference. Zjištění ukazují, že hypotéza sexuálně antagonistických genů (ač v literatuře velmi vlivná) má omezenou podporu, což poskytuje nepřímou podporu hypotéze o vlivu pořadí narození. Výsledky naznačují potřebu dalšího výzkumu evolučních mechanismů ovlivňujících reprodukční strategie a genetickou variabilitu.

1.3 Struktura disertace

Práce je rozdělena do několika kapitol, které postupně analyzují jednotlivé aspekty vlivu pořadí narození. Úvodní kapitoly se věnuje teoretickému ukotvení tématu a shrnuje současné poznatky z literatury. Navazuje tedy na první publikaci, která je též zaměřená na encyklopedické shrnutí základních premis, ale je rozšířená více o empirických zdrojů dokládající dané informace. Propojuje zároveň teoretický základ i dalších výstupů této dizertační práce. Další kapitoly pak prezentují podrobnou analýzu jednotlivých publikací a jejich přínosů. Závěrečné části teoretického úvodu se zaměřují na identifikaci otevřených otázek, aplikační potenciál a interdisciplinární přesahy tématu. Na konci práce jsou zařazeny kompletní texty všech publikací.

2 Úvod do problematiky

2.1 Pořadí narození v kontextu evoluční psychologie a behaviorální ekologie

Evoluční psychologie a behaviorální ekologie se zaměřují na studium toho, jak adaptivní mechanismy a vývojové procesy ovlivňují chování a psychologické rysy člověka. Tyto disciplíny předpokládají, že individuální rozdíly v chování a kognitivních schopnostech jsou výsledkem přizpůsobení specifickým podmínkám prostředí, včetně sociálního a rodinného kontextu.

Jedním z klíčových témat výzkumu je otázka, jak rodinné prostředí formuje vývoj jedince. Rodina je základní jednotkou, ve které jedinci nejen sdílejí genetickou výbavu, ale také získávají první sociální zkušenosti, což činí z rodiny zásadní činitel pro studium behaviorálních a kognitivních rozdílů mezi jednotlivci. Behaviorální ekologie zdůrazňuje, že tyto rozdíly nejsou náhodné, ale mohou být odrazem strategií, které jedinci uplatňují pro maximalizaci svých šancí na přežití a reprodukci v daném prostředí. Evoluční psychologie pak zkoumá, jak tyto strategie vznikají v interakci genetických predispozic a environmentálních podmínek.

Rodinné prostředí představuje klíčový dynamický systém, ve kterém pořadí narození výrazně ovlivňuje vývojové dráhy jednotlivců. Přestože sourozenci sdílejí stejný domov, jejich zkušenosti se zásadně liší, protože každý vyrůstá v odlišném psychosociálním kontextu formovaném interakcemi s rodiči a sourozenci. Prvorozené dítě má výhodu exkluzivní pozornosti rodičů, kteří se teprve učí své nové roli, což často podporuje rozvoj větší sebedůvěry a odpovědnosti. Naopak později narozené děti čelí nutnosti sdílet rodičovskou péči a zdroje se staršími sourozenci, což je může motivovat k větší sociální flexibilitě a schopnosti adaptace (Adler, 1994; Plomin & Daniels, 1987; Shulman & Mosak, 1977; Sulloway, 1997).

Behaviorální ekologie tento koncept doplňuje důrazem na vliv struktury rodiny a ekologických podmínek na rozdělení rodičovských investic a přístup ke zdrojům. Faktory jako celkový počet dětí, věkové rozestupy, poměr pohlaví a dynamika vztahů mezi členy rodiny vytvářejí unikátní podmínky, které ovlivňují vývoj jednotlivců. Tyto podmínky formují strategie, které sourozenci využívají v rámci konkurence nebo spolupráce, a přispívají k rozvoji vzorců chování, jež se mohou přenášet i na širší sociální interakce mimo rodinný kontext (Plomin & Daniels, 1987; Trivers, 1974).

Základní myšlenkou teorie pořadí narození je, že rodina funguje jako hlavní prostředí formující jedince od narození. Každé dítě přichází do odlišné rodinné situace – zatímco prvorozený zažívá prostředí, kde je jediným středem pozornosti, jeho mladší sourozenci (v průměru) vyrůstají ve stabilnějším prostředí s pevně danými vazbami mezi rodiči a staršími sourozenci. Tato hierarchická struktura významně ovlivňuje postavení dětí v rodinném systému a formuje jejich psychosociální vývoj.

Rodinná struktura je tedy klíčovým faktorem pro pochopení individuálních rozdílů v chování a kognitivních schopnostech. Variabilita podmínek v rodinách vedla k formulaci řady hypotéz a modelů zaměřených zejména na vliv těchto faktorů na lidské kognitivní schopnosti a inteligenci.

2.2 Význam zkoumání vlivu pořadí narození

Zkoumání vlivu pořadí narození na chování, osobnost a sociální dynamiku je zásadní nejen z hlediska behaviorálních věd, ale také evoluční biologie, psychologie a sociologie. Pořadí narození ovlivňuje širokou škálu vlastností, od osobnostních rysů přes vzdělávací úspěchy až po reprodukční strategie, a hraje důležitou roli v rodinné a sociální dynamice.

a) Vliv pořadí narození na osobnost

Osobnostní rysy jsou významně ovlivňovány pozicí dítěte v rodinné hierarchii. Prvorození mají tendenci být dominantnější, svědomitější a více orientovaní na výkon, což odpovídá výsledkům Sullowaye (1997), který ukázal, že prvorození více ztotožňují své chování s rodiči a častěji preferují „*status quo*“. Naopak mladší sourozenci bývají otevřenější novým zkušenostem, méně konformní a častěji zkoumají alternativní sociální strategie (Healey & Ellis, 2007). Tyto rozdíly odrážejí různé rodičovské přístupy k jednotlivým dětem. Prvorozeným se dostává více individuální pozornosti, zatímco mladší sourozenci vyrůstají ve sdíleném prostředí, kde se musí přizpůsobovat interakcím s ostatními dětmi (Plomin & Daniels, 2011).

b) Vzdělávací výsledky a kariéra

Významný vliv pořadí narození je patrný také ve vzdělávacích výsledcích. Prvorození bývají nadměrně zastoupeni v elitních školách a univerzitních programech (Kristensen & Bjerkedal, 2010). Tento efekt je často připisován vyšším rodičovským investicím do prvorozených dětí a jejich většímu zapojení do intelektuálních aktivit v raném věku (Black et al., 2005). Naopak později narozené děti mohou čelit nižší míře podpory, což ovlivňuje jejich motivaci a dosažení akademických cílů.

c) Sociální dynamika a rodinné vztahy

Rodinné interakce a hierarchie jsou zásadně ovlivněny pořadím narození. Prvorození často zauímají vůdčí pozice, zatímco mladší sourozenci častěji vyjednávají o své pozici prostřednictvím humoru, flexibility a sociálního přizpůsobení (Toman, 2005). Tyto vlastnosti jsou důležité nejen v rodině, ale i v širších sociálních strukturách, kde pořadí narození může ovlivnit sociální status a skupinové interakce (Sulloway, 1997).

d) Chování a reprodukční strategie

Pořadí narození hraje zásadní roli ve vývoji reprodukčních strategií. Sulloway (1997) naznačil, že prvorození tíhnou k dlouhodobým strategiím zaměřeným na stabilitu a závazek, zatímco mladší sourozenci preferují krátkodobější reprodukční strategie, což může být důsledkem menšího přístupu k rodičovským zdrojům. Výzkumy ukazují, že mladší sourozenci zahajují sexuální život dříve (Rodgers & Rowe, 1988) a častěji vykazují vyšší rizikové chování (Argys et al., 2006). Kromě toho první a pozdější děti vykazují odlišné preference v sexuálním chování. Například BDSM praktiky, které jsou spojeny s dominantními rysy, jsou častější u prvorozených (Jansen et al., 2021).

e) Evoluční perspektiva

Z evolučního hlediska se vliv pořadí narození promítá do strategií přežití a reprodukce. Rodičovské investice jsou omezené a rozdělení těchto zdrojů mezi sourozence často reflektuje Darwinovské principy selekce (Trivers, 1972). Například větší investice do prvorozených mohou být adaptivní strategií maximalizace reprodukčního úspěchu prostřednictvím dětí s vyšší šancí na přežití a úspěch (Belsky et al., 1991).

3 Historický a teoretický základ

3.1 Přehled vývoje studie teorie pořadí narození

Metodické zkoumání vlivu pořadí narození na lidské chování a osobnost má za sebou dlouhou historii sahající až do 19. století. Výzkumy v této oblasti odhalily, že pořadí narození může ovlivňovat nejen mezilidské vztahy, ale také širší sociální a kulturní procesy. Historicky bylo pořadí narození spojováno se zajištěním privilegií a prestiže, jak ukazuje systém primogenitury, který upřednostňoval nejstarší potomky (Zajonc et al., 1979).

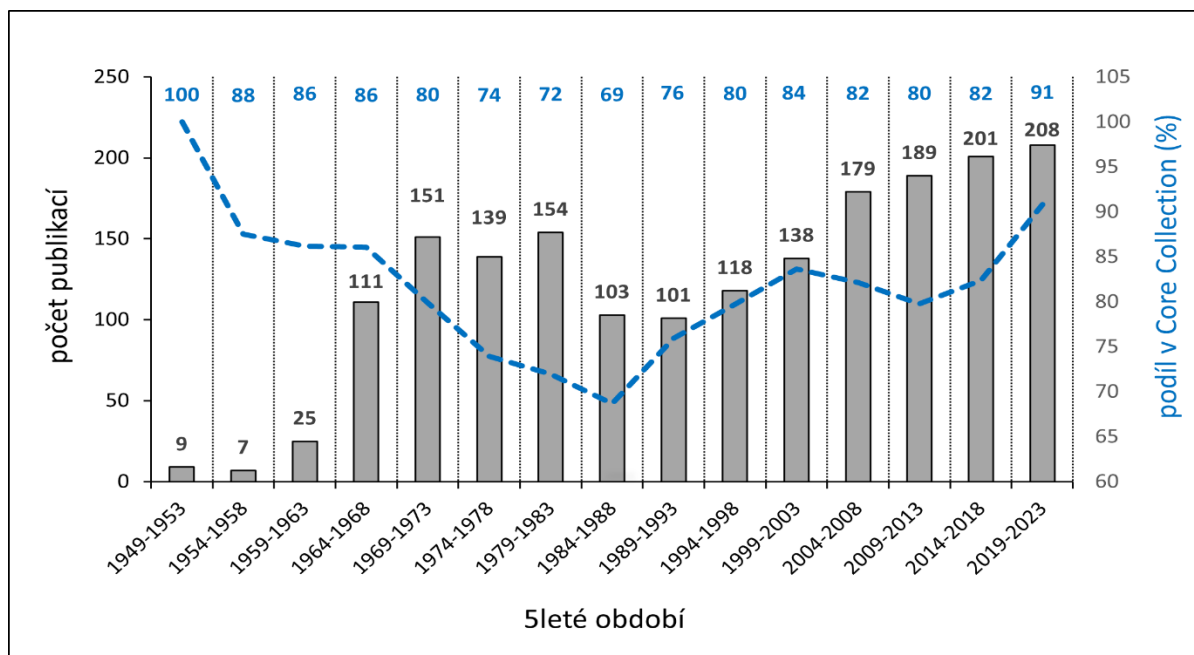
Jedním z prvních vědců, kteří se této problematice věnovali, byl Francis Galton. V roce 1874 identifikoval neobvykle vysoké zastoupení prvorozených a jedináčků mezi významnými anglickými vědci a spekuloval, že nejstarší děti mívají více příležitostí formovat

svůj životní osud (Barclay & Kolk, 2015). Na rozdíl od Galtona, který se soustředil na výhody nejstarších, Alfred Adler přistoupil k tématu komplexněji. Tento rakouský psycholog představil teorii sourozeneckých konstelací, která tvrdí, že každé pořadí narození nabízí unikátní perspektivy, jež zásadně ovlivňují vývoj osobnosti. Adler však zdůrazňoval, že tyto efekty nejsou univerzální, ale spíše pravděpodobné.

Výzkum rodinných konstelací se od druhé poloviny 20. století výrazně zintenzivnil, což vedlo k řadě publikací (Obrázek 1). Například Schachter ve svých výzkumech (např. 1963) rozvinul myšlenku, že nejstarší děti mají tendenci dosahovat akademických úspěchů a získávat společenské uznání. Současně však upozornil, že právě tyto děti mohou být více závislé na schválení okolí a náchylnější k vnějším vlivům (Gates et al., 1988). Walter Toman v 60. letech (2005) zase přinesl nové pohledy na vliv rodinného prostředí na vztahové dynamiky a osobnostní rysy. Jeho studie, ač později podrobeny kritice, významně obohatily porozumění mezilidským vztahům.

Od druhé poloviny 20. století se objevily nové modely, které se snažily systematicky vysvětlit vliv pořadí narození, a došlo k výraznému nárůstu publikovaných prací (Obrázek 1). Jedním z klíčových příspěvků byla práce Franka J. Sullowaye *Born to Rebel* (1997). V této knize autor analyzoval historické i současné poznatky a ukázal, jak pořadí narození ovlivňuje kreativitu, ambice i vztahy mezi lidmi. Přestože jeho práce čelila kritice kvůli metodologickým omezením, jde o jeden z nejvýznamnějších přínosů k porozumění této problematice.

Téma pořadí narození se stalo také oblíbeným motivem v populárně naučné literatuře, která jej často spojuje s tématy jako rodinné vztahy, osobní růst nebo komunikace. Přesto je třeba mít na paměti, že velké množství těchto textů není postavena na pevných vědeckých základech, což omezuje jejich využití v praxi. často se jedná o individuální zkušenosti a teorie, které mohou být zavádějící.



Obrázek 1. Počet článků indexovaných v bibliografické databázi WOS. (přejato z Kuba & Flegr, 2024)

Metoda získávání dat: Pomocí bibliografické databáze Web of Science byly vyhledány všechny indexované články, které splňují kritéria a obsahují termín „birth order“ v názvu.

Popis: Šedé sloupce znázorňují počet článků v kolekci Web of Science Core Collection, přičemž každý sloupec je doplněn číslem nahoře ve šedé barvě. Modrá linie ukazuje podíl článků uvedených v kolekci WOS Core Collection ve srovnání s celou databází WOS, s procenty vyznačenými nahoře v modré barvě.

Interpretace: Od roku 1950 počet článků stabilně rostl, přičemž vrcholu dosáhl v 70. letech. Poté došlo k poklesu, pravděpodobně v reakci na zvýšenou kritiku některých aspektů používaných. Nicméně od konce 90. let lze pozorovat další významný nárůst, který pokračuje až do současnosti. Vyšší podíl článků uvedených v kolekci WOS Core Collection oproti celé databázi WOS může naznačovat, že toto téma je považováno za vědecky významnější. V souladu s tímto trendem a krizí výzkumu pořadí narození podíl dosáhl minima v období 1984–1988. Od té doby však, s výjimkou několika případů, opět soustavně roste a tento růst přetrvává až do současnosti.

3.2 Prvorození vs. druhorození

Alfred Adler byl jedním z prvních vědců, kteří podrobně popisovali vliv sourozeneckých pozic na vývoj osobnosti. Jeho práce položila základy pro současné kategorizace, které rozlišují čtyři hlavní skupiny: jedináčky, nejstarší děti, prostřední děti a nejmladší děti, někdy označované jako „Benjaminové“ (Adler, 1994). Tato klasifikace zohledňuje jak pořadí narození, tak relativní pozici jednotlivce v rámci sourozenecké skupiny.

V mnoha studiích dochází ke zjednodušení těchto kategorií sloučením jedináčků a nejstarších dětí do jedné skupiny „prvorozených“ a spojení prostředních a nejmladších dětí do skupiny „později narozených“. Tento přístup vychází z předpokladu, že hlavní rozdíly jsou patrné zejména mezi prvorozenými a všemi ostatními, což je odrazem jejich jedinečné role v rodině (1997).

Nicméně někteří vědci upozorňují, že takové zjednodušení může vést ke zkreslení výsledků. Spojení prostředních a nejmladších dětí do jedné kategorie například ignoruje významné rozdíly mezi těmito skupinami, což může negativně ovlivnit interpretaci dat (Salmon, 2003; Salmon & Daly, 1998). Kategorie „prostředních dětí“, která zahrnuje všechny děti mezi nejstarším a nejmladším sourozencem, nezohledňuje různorodost zkušeností. Například třetí dítě v tříčlenné rodině má odlišné postavení než páté dítě v šestičlenné rodině, což zůstává v širokých kategoriích nezohledněno (Hartshorne et al., 2009).

Kromě samotného pořadí narození ovlivňuje výsledky i velikost sourozenecké skupiny. Větší rodiny často vykazují různé socioekonomické, náboženské či etnické charakteristiky, což může mít výrazný vliv na životní dráhu jednotlivých členů (Ernst & Angst, 1983; Schooler, 1972). Proto by při analýze sourozeneckých pozic měly být proměnné jako velikost rodiny a její kontext pečlivě zahrnuty, aby byly výsledky přesné a spolehlivé.

3.3 Specifika jednotlivých pozic v pořadí narození

Výzkumy ukazují, že každá pozice v pořadí narození je spojena s unikátními vývojovými charakteristikami a specifickými podmínkami v dětství. Tyto odlišnosti mohou výrazně ovlivnit osobnost, hodnoty a chování jednotlivců, což může být základem pozorovaných efektů pořadí narození.

3.3.1 Jedináčci

Jedinečná interakce mezi jedináčkou a jejich rodiči je klíčovým faktorem, který ovlivňuje vývojové rozdíly. Věk rodičů zde hraje důležitou roli. Starší rodiče, kteří mají často stabilnější finanční i osobní život, přistupují k rodičovství jinak než mladší rodiče. Naopak mladší rodiče mohou vykazovat nejistotu, což vede k inkonzistenci v některých aspektech výchovy.

Prvotní zkušenost mladých rodičů s rodičovstvím bývá často ambivalentní, přičemž střídají přísné požadavky s nadměrnou opatrností či nejistotou. Výzkumy naznačují, že disciplína a rutina v rodině mají tendenci se s každým dalším dítětem uvolňovat (Hilton, 1967). Prvorození děti, včetně jedináček, často dříve dosahují milníků jako chůze, mluvení či čtení díky intenzivní pozornosti rodičů (Price, 1969). Tyto časné rozdíly však nemusí mít výrazné dlouhodobé dopady na vývoj.

Sociální vztahy jedináček se často liší od dětí se sourozenci. Jejich značná expozice dospělým může ztěžovat vytváření vazeb s vrstevníky, ačkoliv se jim lépe daří v interakci s

dětmi staršími či mladšími (McArthur, 1956). Oproti prvorozeným děti jedináčci často vykazují nižší potřebu sociálních vazeb, vyšší sebevědomí a občasný sklon k egocentrismu (Eckstein et al., 2010). Absence sourozenců může navíc vést k výzvám při budování komunikačních dovedností a navazování blízkých vztahů (Polit & Falbo, 1987).

3.3.2 Prvorození

Prvorození děti, které zpočátku vyrůstají jako jedináčci, sdílejí s touto skupinou mnoho podobností, ale s příchodem mladších sourozenců se jejich dynamika výrazně mění (Eckstein et al., 2010; Sulloway, 1997). Ztráta výlučné pozornosti rodičů může být pro prvorozené zdrojem psychického stresu, často spojeného s agresí, žárlivostí či pocity „sesazení z trůnu“ (Adler, 1994). Tento psychologický otřes může zpomalit nebo dokonce zvrátit jejich vývojový pokrok, což se projevuje nižší úrovní důvěry a spolupráce ve srovnání s mladšími sourozenci (Courtiol et al., 2009).

Prvorození jsou také často zodpovědní za péči o mladší sourozence, což zvyšuje jejich odpovědnost a posiluje tendenci k perfekcionismu a ambicím. Tato zátěž, známá jako „syndrom prvorozeného“, je umocněna vyššími očekáváními ze strany rodičů a častější zpětnou vazbou (Claxton, 1994).

3.3.3 Později narození

Děti narozené po prvorozených jsou obvykle označovány jako „později narozené“. Někdy bývají dále členěny na prostřední a nejmladší sourozence, přičemž každá z těchto skupin čelí specifickým výzvám a dynamice.

a) Prostřední děti

Prostřední sourozenci se často nacházejí ve složité rodinné pozici, protože postrádají výhody prvorozených a nemají ani privilegium výlučné pozornosti nejmladších. Sulloway (1997) vysvětluje jejich situaci z evolučního hlediska jako důsledek nižší rodičovské investice, což u nich podporuje adaptabilitu a odolnost.

Výzkumy naznačují, že prostřední děti se často obracejí k přátelům jako primárnímu zdroji podpory, vykazují menší závislost na rodičích a vyšší míru loajality v mezilidských vztazích (Salmon, 2003). Nicméně jejich nižší přístup k rodičovským zdrojům, a to jak materiálním, tak emocionálním, může negativně ovlivnit jejich sebevědomí a pocit důležitosti v rodině (Eckstein et al., 2010; Kidwell, 1982). Někdy se v této souvislosti mluví o tzv. „syndromu prostředního dítěte“ (Kuba & Flegr, 2024). Tyto efekty mohou mít za následek

pozorovanou vyšší inklinaci prostředních dětí k rizikovému chování obecně (např. užívání návykových látek). Jedna recentní studie v souladu s těmito premisami zjistila, že vliv pořadí narození na riskování není lineární, ale později narození byli obecně ochotnější riskovat než prvorození, přičemž středně narození vykazovali nejvyšší míru riskování (Mu et al., 2024).

b) Nejmladší děti

Nejmladší děti, často označované jako „rodinní Benjamínci,“ čelí jedinečné rodinné dynamice. Nikdy nezažijí výlučnou pozornost rodičů jako prvorození, ale často těží z mírnější disciplíny a podpory starších sourozenců. Tento uvolněný přístup rodičů k výchově, společně s věkovými rozdíly, ovlivňuje jejich vývoj (Adler, 1994).

Nejmladší sourozenci bývají charakterizováni vyšší mírou společenskosti, přátelskosti a sebevědomí, ale také nižší intelektuální výkonností a zvýšenou náchylností k duševním onemocněním (Eckstein et al., 2010). Ačkoli jsou někdy považováni za rebely rodiny (Sulloway, 1997), jejich silné vazby k rodičům a empatie mohou tento trend zmírnit (Saroglou & Fiasse, 2003).

3.4 Vztah k teoriím příbuzenského výběru a nejistoty otcovství

Rozdíly mezi sourozenci lze částečně vysvětlit evolučními principy, které zdůrazňují roli rodičovských investic jako klíčového faktoru variability. Jelikož jsou rodičovské zdroje omezené, jejich rozdělování probíhá strategicky tak, aby bylo maximalizováno přežití potomků a zároveň úspěšnost reprodukce rodičů (Trivers, 1972). Tato omezenost zdrojů vede ke konfliktu mezi rodiči a jejich dětmi, protože zájmy obou stran nejsou vždy sladěné. Tento konflikt je důležitým mechanismem, který formuje rodinnou dynamiku i vlivy pořadí narození (Rohde et al., 2003; Trivers, 1974).

Evoluční tlaky vedly k rozvoji psychologických a motivačních mechanismů, jimiž rodiče přizpůsobují alokaci zdrojů mezi své děti podle různých okolností (Daly & Wilson, 1995). Jedním z faktorů ovlivňujících tuto alokaci je pořadí narození, které určuje míru investic na základě věku dítěte a jeho reprodukčního potenciálu. Starší děti často představují vyšší hodnotu z hlediska biologické zdatnosti rodičů, což ovlivňuje jejich výhody v přístupu k rodičovské péči (Daly & Wilson, 1987; Salmon & Daly, 1998; Sulloway, 1997).

Prvorozené děti mají zpočátku unikátní výhodu v podobě výhradního přístupu k rodičovským zdrojům, a to v období, kdy je jejich závislost na rodičích největší (Adams, 1972). Tato monopolizace rodičovské péče zahrnuje nejen materiální podporu, ale i nehmotné

zdroje, jako je pozornost a čas. Jakmile se narodí další sourozenci, tyto zdroje jsou mezi dětmi rozdělovány, což pro mladší sourozence znamená omezený přístup během raných vývojových fází (Price, 2008). Na druhou stranu nejmladší děti často těží ze zvýšené finanční stability rodičů ve vyšším věku, což jim může přinést výhody v pozdějších životních fázích, například v oblasti vzdělávání (Powell & Steelman, 1995; Steelman & Powell, 1989).

Navzdory těmto rozdílům se většina rodičů v rozvinutých společnostech snaží zajistit rovnost v podpoře všech svých dětí, jak ukazují výzkumy zaměřené na západní kultury (Hertwig et al., 2002). Empirické studie však naznačují, že i tento přístup může vést k nerovnostem. Například prvorozené děti často získávají největší investice do vzdělání, zatímco mladší sourozenci čelí omezením způsobeným předchozími alokacemi zdrojů (de Haan, 2010). I další studie ukazují, že rodiče investují více do prvorozených dětí (Sakata et al., 2022).

U prostředních dětí bývá nevýhodou, že rodiče musí jejich potřeby neustále vyvažovat mezi potřebami starších a mladších sourozenců. Tato kumulativní dynamika často staví prostřední děti do nejméně příznivé situace, což může negativně ovlivnit jejich vztah s rodiči, sebevědomí i sociální interakce (Kennedy, 1989; Kidwell, 1982; Salmon, 2003; Salmon & Daly, 1998).

3.5 Modely a hypotézy

Základní principy teorie rodičovských investic byly postupem času rozvinuty do několika specifických modelů a hypotéz, které se zaměřují na různé aspekty vlivu pořadí narození na vývoj dětí. Mezi nejvýznamnější přístupy patří:

a) Model konfluence („*Confluence Model*“)

Model konfluence, který navrhli Zajonc a jeho kolegové (Zajonc et al., 1979; Zajonc & Sulloway, 2007), vychází z předpokladu, že intelektuální prostředí v rodině se mění s každým dalším narozeným dítětem. Tento model tvrdí, že přímý vliv rodičů na vývoj dětí se liší v závislosti na jejich pořadí narození, což vede k tomu, že vyšší pořadí narození může negativně ovlivnit vzdělání a inteligenci. Hlavními faktory ovlivňujícími tento proces jsou věkové rozdíly mezi dětmi, velikost rodiny a role rodičů jako učitelů (Nuttall & Nuttall, 1979; Powell & Steelman, 1993; Zajonc, 1976). Některé empirické studie model podporují (Hester et al., 1992), avšak jeho platnost byla opakovaně zpochybněna (Downey, 1995; Hauser & Sewell, 1985; Retherford & Sewell, 1991; Steelman & Powell, 1985).

b) Model dělení zdrojů („Resource Dilution Model“)

Blakeův model dělení zdrojů (1985) se zaměřuje na omezené rodinné zdroje, jako jsou finance a čas, a jejich distribuci mezi sourozenci. Tento model navrhuje, že čím více dětí v rodině, tím méně zdrojů připadá na jedno dítě, což může negativně ovlivnit zejména mladší sourozence, například v dosažení vzdělání (Downey, 1995; Karwath et al., 2014). Prvorození děti obvykle těží z vyššího množství dostupných zdrojů, což často vede k jejich lepším akademickým výsledkům. Nicméně větší věkové rozestupy mezi sourozenci mohou tento efekt u mladších dětí částečně kompenzovat (Powell & Steelman, 1990). I když má tento model empirickou podporu (Downey, 1995), jeho aplikace závisí na velikosti rodiny a socioekonomickém kontextu.

c) Hypotéza sourozenecké konkurence a teorie rodinných nik

Hypotéza konkurence mezi sourozenci, která úzce souvisí s modelem zředění zdrojů, navrhuje, že rozdíly mezi sourozenci jsou důsledkem jak alokace rodičovských zdrojů, tak jejich vzájemné soutěže. Sulloway (1997) ve své knize *Born to Rebel* přirovnává rodinné prostředí k ekologickým nikám, kde sourozenci soupeří o omezené zdroje. Tato teorie, inspirovaná Darwinovým principem divergence, tvrdí, že rozdíly mezi sourozenci vznikají jako strategie minimalizace rivality a maximalizace přístupu k rodičovské péči (de Haan, 2010).

Sourozenci se přizpůsobují soutěži tím, že rozvíjejí odlišné zájmy a specializace, čímž snižují přímý konflikt. Tato diverzifikace je často interpretována prostřednictvím tzv. disruptivního výběru, který preferuje extrémní rysy na úkor průměrných, na rozdíl od stabilizujícího výběru (Sulloway, 1997).

4 Metodologické přístupy ve studiu pořadí narození

4.1 Studie „mezi rodinami“ a „v rámci rodin“

Výzkum vlivu pořadí narození na jedince využívá dvě hlavní metodologická paradigmaty – tzv. „*between family*“ a „*within-family*“ přístup.

Termín „*between family*“ lze do češtiny překládat jako „mezi rodinami“. Tyto studie zkoumají pořadí narození mezi jednotlivci z různých rodin. Tento design umožňuje analyzovat vliv pořadí narození na širším vzorku populace, což napomáhá odhalit obecné trendy a vzorce. Tímto způsobem lze dosáhnout širšího obrazu o možných souvislostech mezi

pořadí narození a osobnostními či behaviorálními charakteristikami. Nevýhodou tohoto přístupu však je, že rozdíly mezi rodinami – například socioekonomický status, kultura či hodnoty – mohou výsledky zkreslit a ztížit identifikaci skutečného vlivu pořadí narození.

Tzv. „*within-family*“ přístup nemá ustanovený jednotný termín v českém jazyce. Přeložit by se to dalo výrazy jako „rodinné studie“ nebo „studie uvnitř rodin/v rámci rodin“. Studie v rámci rodin se zaměřují na sourozence vyrůstající ve stejné rodině. Díky eliminaci variabilních faktorů mezi různými rodinami nabízí tento přístup přesnější pohled na to, jak pořadí narození ovlivňuje vývoj jednotlivců v rámci jednoho prostředí. Tato metodologie umožňuje lépe kontrolovat vnější vlivy a zkoumat dopad dynamiky v rodinném prostředí. Nicméně její slabinou je omezený záběr – některé vlivy mimo rodinu, například interakce s vrstevníky či širší kulturní kontext, mohou být v tomto designu opomíjeny.

Každý z těchto přístupů má své specifické výhody i omezení, což ovlivňuje interpretaci zjištěných výsledků. Oba přístupy tedy přinášejí do výzkumu pořadí narození důležité poznatky, ale často vedou k rozdílným závěrům. Tyto rozdíly jsou důsledkem odlišné povahy každé metodologie, která zkoumá vlivy z jiného úhlu pohledu (Michalski & Shackelford, 2001; Rodgers et al., 2000; Zajonc & Sulloway, 2007). Výběr vhodného přístupu proto závisí na konkrétních výzkumných otázkách a cílech studie.

4.2 Biologické versus psychologické pořadí narození

Pořadí narození lze dělit na dva hlavními typy: biologické (ordinalní) nebo funkční (psychologické). Každý z těchto přístupů přináší odlišné pohledy na dynamiku mezi sourozenci (Carette et al., 2011; Eckstein et al., 2010; Sulloway, 1997).

Biologické pořadí narození klasifikuje sourozence výhradně podle jejich chronologického pořadí v rodině – tedy na prvorozené, druhorozené, třetí dítě atd. (Shulman & Mosak, 1977). Tento přístup je základem většiny výzkumů zaměřených na pořadí narození. Některé studie však zavádějí koncept relativního pořadí narození, které se vypočítává jako poměr počtu starších sourozenců k celkovému počtu sourozenců v rodině (Hartshorne et al., 2009). Tento přístup umožňuje jemnější analýzu sourozenecké dynamiky, zejména v rodinách s větším počtem dětí. Ačkoli biologické faktory spojené s pořadím narození (zejména jako jsou fyziologicko-anatomické rozdíly), mohou jedince ovlivňovat, je jejich vliv obecně považován za méně významný ve srovnání s funkčními (psychologickými) aspekty pořadí narození (Carette et al., 2011).

Funkční pořadí narození zohledňuje psychologický a kontextový význam pozice dítěte v rodině. Na rozdíl od biologického pořadí se zaměřuje na vnímání a interpretaci této pozice, což lépe odráží skutečné zkušenosti jednotlivce během dospívání (Carette et al., 2011). Biologické a funkční pořadí narození se sice obvykle překrývají, změny v rodinné dynamice mohou způsobit odchylky. Například rozvod rodičů, úmrtí sourozence, příchod nevlastních sourozenců nebo velký věkový rozdíl mezi dětmi mohou výrazně ovlivnit osobnostní rysy dítěte. Tyto faktory mohou způsobit, že se jedinec chová způsobem, který neodpovídá jeho původní biologické pozici.

Například dítě, které ztratí staršího sourozence, může převzít některé rysy typické pro prvorozené, jako je zvýšená odpovědnost nebo vedení. Podobně příchod nevlastních sourozenců může změnit dynamiku rodiny natolik, že se mladší dítě začne chovat jako prostřední sourozenec. Funkční pořadí narození tedy nabízí komplexnější obraz o výchově a sociálním postavení dítěte v rodině (Carette et al., 2011).

4.3 Faktory ovlivňující efekty pořadí narození

Efekt pořadí narození není izolovaným jevem, ale výsledkem působení mnoha faktorů. Ty zahrnují osobní dispozice, rodinnou dynamiku a širší environmentální vlivy, jako jsou socioekonomické podmínky, kulturní normy a pohlaví sourozenců. Níže je uveden přehled faktorů, které mohou projev efektů pořadí narození modulovat. Je důležité podotknout, že mnoho výzkumů nebere v potaz ani hlavní faktory, což může vést k nepřesným či zavádějícím výsledkům.

4.3.1 Faktory vycházející z rodiny a rodičovství:

a) Rodinná dynamika

Rodinné prostředí má zásadní význam pro vývoj dítěte, přičemž faktory, jako je pořadí narození, jsou silně ovlivněny socioekonomickými a kulturními podmínkami. V raném dětství hraje větší roli kvalita vztahů s rodiči než jejich množství. Výzkumy ukazují, že děti, které mají bližší vztahy s matkou a dobré vztahy se svými sourozenci, dosahují vyšší úrovně psychické pohody a emocionální stability (Daniels et al., 1985).

b) Věk rodičů

Rodičovský věk při narození dítěte souvisí s řadou životních faktorů, jako je vzdělání, stabilita vztahu nebo socioekonomický status. Děti starších rodičů bývají spojovány s vyšším

IQ a lepšími akademickými výsledky, což je částečně způsobeno většími zkušenostmi a finanční stabilitou rodičů (Cho, 2011; Zajonc, 1976).

c) Přístup rodičů

Rodičovské postoje, včetně projevu náklonnosti a výchovných stylů, ovlivňují osobnostní vývoj a sebevědomí dětí. Například upřednostňování některých dětí může vést k pocitům zanedbávání u ostatních, což se často odráží v jejich vztazích a chování (Sulloway, 1997).

d) Proměna rodinných struktur

Mění se rodinné struktury, jako jsou rostoucí rozvodovost či nárůst neúplných rodin, ovlivňují vliv pořadí narození. Děti z neúplných rodin často čelí socioekonomickým nevýhodám, což může ovlivnit jejich akademické a sociální výsledky (Black et al., 2005).

e) Socioekonomický status a rodičovské zdroje

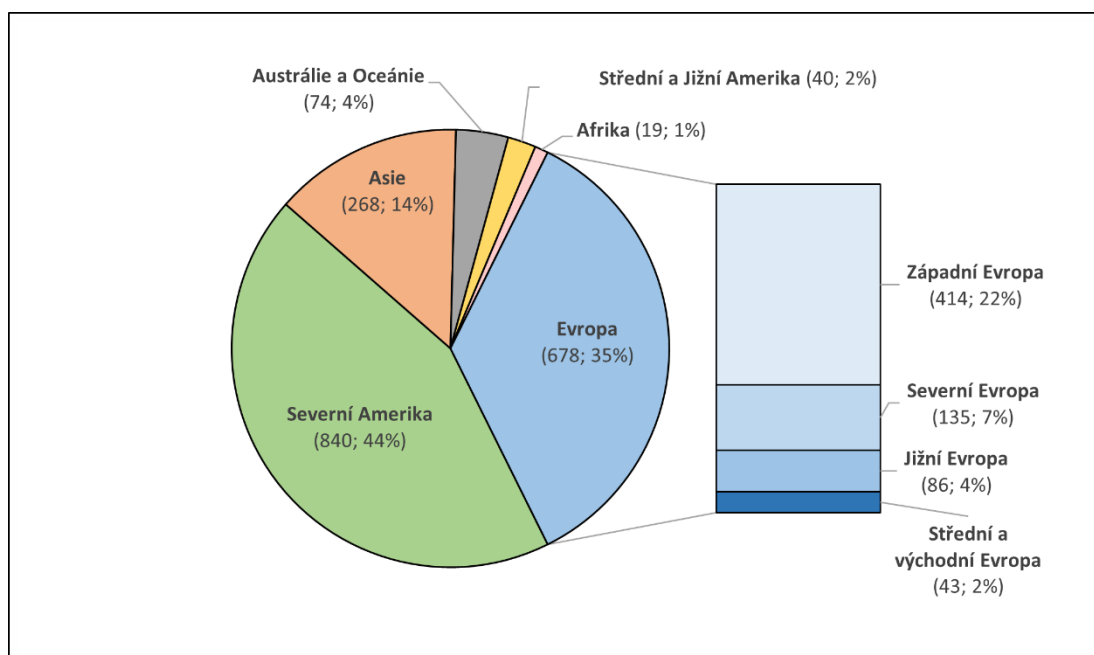
Socioekonomický status a rodičovské zdroje zásadně ovlivňují dopady pořadí narození, zejména v oblasti vzdělávacích investic a ambicí. Bohatší rodiny zpravidla více investují do vzdělání prvorozených, zatímco rozdělení zdrojů v početnějších rodinách může být nerovnoměrné, což představuje překážky v dosažení vzdělání (Downey, 1995). Tento trend je zřetelný zejména v rozvinutých společnostech, zatímco v chudších rodinách rozdíly zmírňují kompenzační mechanismy a dědické zvyklosti. Rodiče s vyšším socioekonomickým statutem mají často nižší ambice pro mladší děti, pokud prvorozený již dosáhl určitého vzdělání. Kromě toho hrají významnou roli faktory jako dětská práce nebo genderové normy, které mohou výrazně omezovat vzdělávací příležitosti v zemích, kde je dětská práce běžná.

f) Kulturní prostředí

Kulturní, národní a rasové kontexty ovlivňují projevy dopadů pořadí narození. Rozdíly v rodinné velikosti a vzdělání podle rasových skupin zdůrazňují vliv kulturního prostředí. Vybrané studie naznačují, že kulturní kontext může zásadně ovlivnit nebo dokonce zcela obrátit vliv efektu pořadí narození. Zjištění, že prvorození jedinci dosahují v průměru vyšší úrovně vzdělání, vychází především z výzkumů provedených v euroatlantické oblasti. Naopak studie z jihovýchodní Asie (například Bangladéše) ukazují opačný trend – vyšší vzdělanosti dosahují mladší sourozenci (Park & Chung, 2012). Tento jev lze vysvětlit tím, že prvorození často brzy vstupují na pracovní trh, čímž přispívají k finanční stabilitě rodiny. Díky tomu mohou mladší sourozenci získat lepší přístup ke vzdělání.

Tyto rozdíly komplikují zobecnění výsledků, neboť většina výzkumů pochází z homogenních regionů. Jak ukazuje Obrázek 2, celkem 44 % publikací vzniklo v Severní Americe a 35 % v Evropě. Naproti tomu regiony, jako je střední a východní Evropa (2 %),

Střední a Jižní Amerika (2 %) a Afrika (1 %), jsou ve výzkumu pořadí narození silně podreprezentovány. Tato nevyvážená distribuce komplikuje interpretaci výsledků a zdůrazňuje potřebu většího geografického rozptylu ve výzkumech.



Obrázek 2. Počet článků indexovaných v bibliografické databázi WOS podle regionu. (přejato z Kuba & Flegr, 2024)

Metoda získávání dat: Pomocí kolekce Web of Science Core Collection byly vyhledány všechny indexované články, které splňují kritéria a obsahují termín „birth order“ v názvu; výsledky byly filtrovány podle země/regionu (data od roku 1948 do dubna 2024). Je třeba poznamenat, že údaje vycházejí z deklarované národnosti autorů, což nemusí nutně odpovídat regionu, odkud relevantní data pocházejí; nicméně často jsou tyto údaje v souladu.

Popis: Obrázek znázorňuje podíl článků podle země/regionu. Číslo v závorkách udává konkrétní počet a procentuální podíl z celkových 1919 záznamů. Vložený obrázek poskytuje podrobnější rozdělení článků z Evropy do čtyř hlavních geografických oblastí (zařazení států do regionů je založeno na klasifikaci EuroVoc Úřadu pro publikace Evropské unie).

4.3.2 Faktory spojené se sourozenci

g) Počet sourozenců

Teorie, jako je model dělení zdrojů, naznačují, že větší počet sourozenců může vést k nižší úrovni rodičovské podpory na dítě, což může negativně ovlivnit akademický výkon (Zajonc & Markus, 1975). Naopak některé studie zdůrazňují, že větší rodiny mohou posilovat motivaci a podporovat vyšší očekávání u dětí (Kristensen & Bjerkedal, 2010).

h) Pohlaví a gender

Významnou část variability mezi pořadím narození a osobnostními rysy lze přičíst rozdílům v genderu (Bragg & Allen, 1970; Horner et al., 2012). Například ženy vykazují vyšší míru sociability než muži (Daniels, 1986). Výzkumy také naznačují, že prvorození často

vykazují rysy spojené s maskulinitou, jako je asertivita a soutěživost, a to bez ohledu na své biologické pohlaví (Sulloway, 1997). Později narození sourozenci naopak častěji disponují rysy spojenými s feminitou, jako je kooperativnost a přizpůsobivost (Rosenfeld, 1966).

Podobně se objevují i rozdíly podle genderu v rodinné dynamice. Významné rozdíly jsou často pozorovány mezi sourozenci stejného pohlaví, kde je rivalita intenzivnější, než je tomu u smíšených pohlaví (Schachter, 1982). Ženy se staršími bratry bývají vnímány jako prvorozené, a v rodinách s minoritním pohlavím mají tito jedinci často výjimečné postavení (Chandna & Bhagowalia, 2024). V méně rozvinutých zemích genderové preference ovlivňují vzdělání – prvorození synové častěji pracují, zatímco dcery navštěvují školu. Walter Toman propojuje pořadí narození a gender ve své teorii partnerské kompatibility, přičemž pohlaví sourozenců představuje klíčovou proměnnou v rodinných analýzách. Recentní studie z Polska pak reportuje rozdíly v pojmenovávání potomků s ohledem na pořadí narození jedince, přičemž efekty se liší podle pohlaví dítěte (Tomanek, 2023). Diskuse o tom, na které pohlaví má pořadí narození větší vliv, stále probíhá. Přesto je zřejmé, že pohlaví sourozenců, podobně jako jejich počet, představuje zásadní faktor v rodinných analýzách.

i) Nevlastní sourozenci a jejich vliv na pořadí narození

Integrace nevlastních či adoptovaných sourozenců do rodiny, zejména v raném věku, může výrazně ovlivnit rodinnou dynamiku a vnímání pozice jednotlivých dětí v pořadí narození (Hester et al., 1992; Zajonc, 1976). Výzkumy naznačují, že rodiče často vykazují tendenci preferovat biologické děti před nevlastními, což může ovlivnit rozdělování zdrojů a celkové vztahy v rodině (Booth & Kee, 2009). Zároveň ve společnosti v poslední době výrazně přibýlo nekompletních rodin např. kvůli rozvodu či odluky manželů (Bonesronning & Massih, 2011).

Přesto zůstává výzkum zaměřený na specifické dopady nevlastních sourozenců poměrně omezený. Tato mezera v poznání zdůrazňuje potřebu provádět důkladnější analýzy a validaci hypotéz na základě adekvátních datových souborů.

Studie, které zkoumají důsledky pořadí narození, často využívají dvě odlišné metodologie. Některé se soustředí na scénáře tzv. „úplného sourozenectví“ (*full sibship*), zahrnujícího výhradně biologické sourozence. Jiný přístup zkoumá „smíšené sourozenectví“ (*mixed sibship*), kde jsou přítomni jak biologičtí, tak nevlastní nebo adoptovaní sourozenci. Tyto různé přístupy umožňují zachytit širší spektrum rodinných struktur, ale také kladou nároky na přesnost interpretace výsledků.

j) Věkový rozestup

Věkové rozdíly mezi sourozenci významně ovlivňují jejich vztahy a vývoj. Menší rozestupy často vedou k intenzivnější rivalitě a nižší rodičovské investici na jedno dítě, zatímco větší rozdíly umožňují individuální rozvoj a lepší výsledky v jazykových a matematických schopnostech (Powell & Steelman, 1990; Zajonc, 1976).

Podle Adlera mohou věkové rozdíly přesahující pět let oslabit tradiční efekty pořadí narození, což mladším sourozencům umožňuje přijmout roli „pseudoprvozeného“. Přesto bývá vliv věkových rozestupů ve studiích často přehlížen, což může zkreslovat výsledky (Karwath et al., 2014). Speciálním případem jsou dvojčata, kde mohou být patrné rozdíly v odpovědnosti a sociální adaptabilitě podle pořadí narození (Segal, 1999).

k) Zdravotní problémy

Zdravotní postižení u jednoho ze sourozenců může zásadně ovlivnit rodinné role a narušit obvyklé funkční pořadí narození. Takové situace často kladou zvýšené nároky na rodiče a ostatní děti, což mění jejich odpovědnost a ovlivňuje vývoj osobnosti i vztahy uvnitř rodiny. Tento faktor zůstává málo prozkoumán a vyžaduje další výzkum.

5 Souhrn výzkumných oblastí a jejich propojení

5.1 Vliv pořadí narození na vzdělání a socioekonomické výsledky

Pořadí narození má důležitý vliv na vzdělávací a socioekonomické výsledky jednotlivců. První narození děti obvykle vykazují vyšší úroveň svědomitosti, odpovědnosti a disciplinovanosti, což příznivě ovlivňuje jejich úspěchy ve vzdělání (Healey & Ellis, 2007; Palmer, 1966). Tyto vlastnosti jim umožňují snadnější adaptaci na strukturované požadavky školního prostředí a podporují jejich orientaci na plnění dlouhodobých cílů. Prvorozené děti často dominují ve vzdělávacích institucích, včetně elitních škol a univerzit, kde jsou nadprůměrně zastoupeni (Bayer, 1966; Powell & Steelman, 1993). Analogické výsledky jsme zjistili i v naší studii, která se zaměřovala na analýzu studentů Přírodovědecké fakulty Univerzity Karlovy (Kuba et al., 2018). Tento trend je pravděpodobně podpořen jejich schopností efektivně řešit problémy, jejich vysokou motivací k učení a orientací na budoucí kariérní aspirace (Carette et al., 2011).

Naopak mladší sourozenci mohou být ovlivněni nižší mírou rodičovské pozornosti a zdrojů, což může negativně ovlivnit jejich akademické výsledky (Black et al., 2011). Zároveň jejich více spontánní a společenší povaha může podporovat kreativní způsoby řešení problémů, ale snižovat důležitost strukturovaného vzdělávání.

Zanedbávání a dětský syndrom CAN (*Child Abuse and Neglect*) mohou mít zásadní dopad na vzdělávací výsledky. Studie naznačují, že mladší sourozenci jsou častějšími oběťmi fyzického a psychického zneuznání, což snižuje jejich schopnost plnit školní požadavky (Karadeniz-Özbek & Kalkan, 2016; Kenny et al., 2021; Polat et al., 2010; Üçok & Bıkmaz, 2007). Tento trend se však liší podle etnicity, socioekonomického statusu a funkčnosti rodiny (Hiriscu & Pintea, 2024; Welch & Bonner, 2013). Naopak prvorození jedinci mohou častěji čelit většímu tlaku a očekáváním rodičů, což může přispívat k jejich stresu a negativně ovlivnit jejich výkony (Bosede, 2011).

Užívání návykových látek je dalším faktorem ovlivňujícím vzdělání. Mladší sourozenci a dospívající vykazují vyšší sklony k rizikovému chování, včetně závislosti na alkoholu a drogách, což vede nejen ke zhoršení jejich zdraví, ale i školních výsledků (Barclay et al., 2016; Björkegren & Svaleryd, 2017). Tento jev je často spojen s nedostatkem rodičovské kontroly a vlivem starších sourozenců, kteří mohou umožnit přístup k návykovým látkám (Argys et al., 2006; Windle, 2000). V současné době jsou značně aktuální výsledky, které rovněž ukazují, že později narození jedinci ve srovnání s prvorozenými častěji emigrují do zahraničí (Saarela & Turunen, 2024).

Výrazný vliv na vzdělání má i duševní zdraví jedince. Provedené studie ukazují, že psychické zdraví rovněž může souviset s pořadím narození. Riziko šikany, sebepoškozování a emoční nestability je vyšší u mladších dětí, což může negativně ovlivnit jejich schopnost dosáhnout školních cílů (Bjørngaard et al., 2013; Rostila et al., 2014). Tyto problémy jsou často zesíleny v rodinách s vysokým počtem dětí a omezenými zdroji (Kirkcaldy et al., 2009). Vyšší pořadí narození je také spojeno s mírně vyšším rizikem pracovní neschopnosti ze zdravotních důvodů, přičemž nejvýraznější souvislost byla nalezena právě u duševních poruch, a efekt byl obecně silnější u žen než u mužů (Reini & Saarela, 2023).

Podobně biologické a environmentální faktory, jako jsou kratší intervaly mezi porody nebo omezené mateřské zdroje, mohou ovlivnit vzdělávací příležitosti a úspěchy později narozených dětí (Ejrnæs & Portner, 2004; Kanazawa, 2012). Tyto faktory se často promítají i do socioekonomických úspěchů jednotlivců, kdy prvorození vykazují vyšší pravděpodobnost dosažení vedoucích pozic a finanční stability. Studie ukazují, že ačkoliv prvorození jedinci mají horší zdravotní stav při narození, nicméně v období dospívání se zdravotní stav obrací a

mladší sourozenci jsou častěji hospitalizováni a navštěvují ambulantní zdravotnická zařízení (Björkegren & Svaleryd, 2023).

Celkově však odborné studie ukazují, že efekty pořadí narození např. v souvislosti se vzděláním se rozvíjí skutečně až po narození jedince a nemají biologický (potažmo genetický) základ (Isungset et al., 2022).

5.2 Dopady na rodinné vztahy, altruismus a vnímání laskavosti v rodině

Rodinná dynamika je silně ovlivněna pořadím narození. První narození jedinci často přejímají dominantní roli v rodinných vztazích, což může vést k odpovědnějšímu a autoritativnějšímu chování vůči mladším sourozencům (Sulloway, 1997). Tento vztah může být někdy zdrojem konfliktů, ale také podporuje strukturovanější rodinnou dynamiku.

Mladší sourozenci bývají více společenští a adaptabilní, což podporuje harmonické vztahy a schopnost budovat pevnější sociální vazky mimo rodinu (Beck et al., 2006; Jefferson et al., 1998). Naopak první narození jsou často vnímáni jako „pilíře“ rodinné podpory a vykazují více altruistické chování, které je podpořeno jejich odpovědností a výchovou zaměřenou na plnění očekávání (Eckstein et al., 2010). Recentní výzkumy též např. ukazují, že prvorození jedinci jsou méně často fyzicky trestáni než jejich mladší sourozenci (Kim & Wang, 2023). Později narození naopak mají více rozvinutou emoční inteligenci (Villanueva Iglesias & García Martín, 2023). Výzkumy také ukazují, že náklonnost rodičů se může např. odrážet i v pojmenovávání potomků – prvorození jedinci častěji dostávají tradiční a populárnější křestní jména (Tomanek, 2023). Později narození jedinci naopak vykazují vyšší míru společenské odpovědnosti, např. i vyšší míru zájmu o ochranu životního prostředí (Otterbring et al., 2023).

Prvorození mohou být více oceňováni za svoji pomoc a odpovědnost, zatímco mladší sourozenci mohou více těžit z volnější a spontánnější výchovy (Saroglou & Fiasse, 2003). Konflikty mohou vznikat z rozdílných očekávání rodičů a rozdílných výchovných strategií, ale tyto rozdíly mohou také podporovat jedinečné kvality každého sourozence. Tyto rozdíly v rodičovské pozornosti by se hypoteticky mohly odrazit v subjektivním vnímání náklonnosti členů rodiny. Uvedená premisa bylo základním předpokladem jedné z publikací zařazené v této dizertační práci (manuskript „*The Evolutionary Roots of Familial Altruism: Paternity Uncertainty Shapes Patterns of Kindness*“). V rámci ní jsme formou dotazníkového šetření

zkoumali, které členy rodiny jedinci hodnotí jako „nejhodnější“, což by mohlo odrážet uvedené evoluční strategie.

Závěrem, pořadí narození má hluboký vliv na vztahy v rodině, kde osobnostní vlastnosti a výchovné strategie formují dynamiku altruismu, laskavosti a celkové harmonie.

5.3 Sexualita a reprodukční strategie ve vztahu k pořadí narození

Pořadí narození hraje klíčovou roli v sexuálním chování a reprodukčních strategiích jednotlivců, přičemž se promítá nejen do rozdílů v osobnostních rysech, ale i do specifických vzorců sexuální orientace a reprodukčního zdraví.

Jedním z nejvýznamnějších fenoménů v této oblasti je souvislost mezi pořadím narození a sexuální orientací, konkrétně tzv. efekt starších bratrů. Výzkumy ukazují, že homosexuální muži mají v průměru více starších bratrů než heterosexuální muži (Blanchard, 2018; Blanchard & Bogaert, 1996). Tento jev, opakovaně potvrzený napříč různými populacemi, byl interpretován prostřednictvím imunologické hypotézy. Podle této hypotézy matky, které během těhotenství opakovaně nesou mužský plod, vytvářejí protilátky proti Y chromozomovým antigenům. Tyto protilátky pak mohou ovlivnit vývoj mozku následujících mužských plodů a zvýšit pravděpodobnost homosexuální orientace (Blanchard & Klassen, 1997; Bogaert et al., 2018). Tento mechanismus se týká především později narozených mužských sourozenců, což podtrhuje význam pořadí narození. I když jsou tyto vztahy mezi pořadím narození a sexualitou podpořeny empirickými důkazy, vyžadují další hlubší zkoumání.

Kromě toho pořadí narození ovlivňuje nejen sexualitu, ale i další aspekty reprodukčních strategií. Prvorození jedinci bývají orientováni na stabilní a plánované rodičovství, zatímco později narození inklinují k pestřejšímu sexuálním zkušenostem a vyšší sociosexuální orientaci (Michalski & Shackelford, 2002). To může odrážet odlišné výchovné přístupy rodičů a rozdíly v dostupných rodinných zdrojích.

Důležité rozdíly lze pozorovat také v rizikovém sexuálním chování. Studie naznačují, že mladší sourozenci mají vyšší sklon k riskantnímu chování, včetně častější hospitalizace z důvodu intoxikace alkoholem nebo drogami (Barclay et al., 2016; Björkegren & Svaleryd, 2017). Tento trend je obzvláště zřetelný u prostředních dětí, které vykazují nejvyšší sklony k rizikovému jednání (Elton et al., 2019). S věkem se tato riziková tendence snižuje, ale může

být ovlivněna věkovým rozdílem mezi sourozenci a výchovnými strategiemi rodičů (Argys et al., 2006).

Zdá se také, že pořadím narození jsou ovlivněny i aspekty věrnosti a vztahové dynamiky. Studie naznačují, že prostřední děti mají nižší sklony k nevěře ve srovnání s prvorozenými a posledními narozenými (Salmon, 2003). Naopak prvorození a poslední narození mohou vykazovat vyšší tendenci k problematickým partnerským vztahům z důvodu jejich rozdílných strategií a očekávání.

Další oblastí, ve které se pořadí narození projevuje, je výskyt parafilií a sexuální delikvence. Výzkumy naznačují, že mladší sourozenci mají vyšší pravděpodobnost výskytu parafilií, což může být částečně spojeno s větší rodinnou velikostí a s rozdílnými dynamikami rodičovské pozornosti (Blanchard et al., 2020; Langevin et al., 2007). Tyto poznatky zůstávají předmětem intenzivního zkoumání a ukazují na potřebu dalších longitudinálních studií.

Celkově lze říci, že zejména sociosexualita je v souvislosti s pořadím narození stále nedostatečně prozkoumaná oblast, přičemž minimum studií se věnuje tématům, jako jsou preference BDSM. Proto jsme se na tyto oblasti zaměřili v další z našich publikací a analyzovali vztah mezi pořadím narození a faktory, jako je začátek sexuální aktivity, sociosexuální orientace, počet partnerů a preference dominance a submisivity (BDSM). Další publikace pak navazuje na „efekt starších bratrů“ a rozvíjí teorii sexuálně antagonistického genu, která předpokládá, že geny snižující reprodukční úspěch homosexuálních jedinců mohou zároveň zvyšovat plodnost jejich mateřských příbuzných ženského pohlaví.

6 Předmluva k zařazeným publikacím

V následujících kapitolách jsou shrnuty klíčové souvislosti jednotlivých publikací, hlavní zjištění a jejich zasazení do širšího vědeckého kontextu. Studie přispívají k pochopení evolučních strategií a behaviorální ekologie člověka prostřednictvím několika klíčových aspektů. Výsledky analyzovaných studií lze zasadit do širšího vědeckého kontextu zkoumání vlivu pořadí narození, evolučních strategií a behaviorální ekologie.

6.1 Publikace 1: Pořadí narození a jeho vliv na člověka

Tato přehledová studie se věnuje vlivu pořadí narození na psychologické, behaviorální a vzdělávací charakteristiky jedinců. Zdůrazňuje, že pořadí narození má významný vliv na osobnostní rysy a mezilidské vztahy, což je způsobeno rozdílným přístupem rodičů k jednotlivým dětem a dynamikou mezi sourozenci. Prvorození obvykle vykazují vyšší

akademické úspěchy a intelektuální schopnosti, zatímco mladší sourozenci bývají otevřenější novým zkušenostem. Studie současně upozorňuje na metodologické výzvy, které komplikují jednotné závěry o vlivu pořadí narození.

Publikace byla vydána jako součást projektu „*Encyclopedia of Sexual Psychology and Behavior*“, který vydalo nakladatelství Springer Nature Switzerland AG. Encyklopedie, editovaná Toddem K. Shackelfordem, představuje komplexní a interdisciplinární přehled aktuálních poznatků v oblasti sexuálního chování. Publikace odráží širší vědeckého zkoumání různých aspektů sexuality a nabízí mezinárodní perspektivu pokrývající teorii, výzkum i intervence.

Studie přináší inovativní pohled na vliv pořadí narození z interdisciplinární perspektivy zahrnující psychologii, evoluční biologii a sociologii. Hlavní přínos spočívá ve snaze o integraci rozporuplných poznatků z předchozích výzkumů a v identifikaci metodologických slabin, které mohou vysvětlit jejich nekonzistenci. Zohledněno je široké spektrum faktorů, včetně rodinné dynamiky a socioekonomického prostředí, což poskytuje komplexnější obraz vlivu pořadí narození na osobnost a chování.

V rámci publikace jsme kromě rešerše provedli dvě samostatné analýzy. První se věnovala analýze frekvence a množství publikací na dané téma, která ukázala, že po útlumu ve druhé polovině dvacátého století se téma opět dostává do popředí. Druhá analýza se zaměřila na kulturní zařazení publikací – z jakých států jsou dostupná data. Tato analýza ukázala drtivou převahu publikací ze západní Evropy a USA, zatímco z východní Evropy, Afriky a dalších oblastí bylo dostupné pouze minimum prací. Výsledky obou analýz jsou graficky prezentovány v teoretické části dizertační práce jako Obrázek 1 a Obrázek 2.

6.2 Publikace 2: Pořadí narození a úspěch ve vzdělávacím procesu

Ve druhé studii jsme navázali na autorovu magisterskou diplomovou práci, která se zaměřila na ověření výsledků předchozích zahraničních studií, které ukázaly, že na elitnějších univerzitách studuje vyšší podíl prvorozených jedinců, než by bylo z hlediska demografických dat očekávané. V průběhu doktorského studia jsme pokračovali ve sběru dat a následně provedli nové analýzy ověřující naše hypotézy, které souvisely s plněním grantového projektu GAUK č. 269215. Výsledky byly publikovány v časopise *Intelligence* (IF=3,3).

Tato studie se tedy zaměřuje na vliv pořadí narození na vzdělávací úspěchy českých studentů s důrazem na dlouhodobé trendy a modulační faktory, jako jsou velikost rodiny a

pohlaví. Analýza ukázala, že prvorození jsou výrazně nadreprezentováni mezi studenty Přírodovědecké fakulty Univerzity Karlovy, což podporuje hypotézu, že dostávají více rodičovských zdrojů a podpory. Tento efekt je ovlivněn velikostí rodiny, přičemž jeho intenzita roste s větší velikostí rodiny. Zároveň jsme pozorovali, že během posledních dvou desetiletí dochází k poklesu nadreprezentace prvorozených, pravděpodobně vlivem snižující se náročnosti přijímacích zkoušek.

V rámci studie jsme analyzovali data ze dvou kohort studentů biologie (1990–1995, N = 271; 2011–2017, N = 2049) a porovnali jejich výsledky s populačními daty Českého statistického úřadu. Zjištění ukázala, že podíl prvorozených studentů výrazně převyšuje jejich zastoupení v obecné populaci: v první kohortě tvořili prvorození 63,1 % oproti očekávaným 44,8 %, ve druhé kohortě pak 64,0 % oproti očekávaným 48,1 %.

Studie přináší jedinečný přínos v podobě dlouhodobého srovnání dvou kohort českých studentů s časovým odstupem více než dvaceti let, což umožňuje zohlednit vliv významných společensko-demografických změn na vzdělávací proces. Zjištěné výsledky potvrzují, že efekt pořadí narození na vzdělávací úspěchy je robustní a přetrvává i přes změny ve společnosti a vzdělávacím systému. Současně studie kvantifikuje vliv velikosti rodiny na vzdělávací úspěchy prvorozených v českém prostředí, čímž přispívá ke globální debatě o vlivu rodinné konstelace na akademické výsledky.

Tato zjištění jsou v souladu s předchozími mezinárodními studiemi, které dokládají výhody prvorozených ve vzdělávání (např. Black et al., 2011; Kristensen & Bjerkedal, 2010). Výsledky rovněž potvrzují teorii rodičovské investice, jak ji popsal Trivers (1972). Přesto je vliv pořadí narození modifikován dalšími faktory, jako je pohlaví a velikost rodiny, což vysvětluje rozpory v některých studiích.

Porovnání našich dvou kohort poskytuje unikátní příležitost vyhodnotit vliv pořadí narození v kontextu dramatických změn v přístupu k univerzitnímu vzdělání v České republice. Závěry této studie mohou přispět k tvorbě vzdělávací politiky zaměřené na podporu rovnosti příležitostí.

6.3 Publikace 3: Rodinné vztahy a altruismus

Tato studie se zaměřuje na to, jak jedinci vnímají členy své rodiny z hlediska jejich laskavosti. Výzkum je ukotven v evolučních teoriích, zejména teorii selekce příbuzných a teorii nejistoty otcovství, a testuje jejich předpoklady v kontextu moderní společnosti. Předpokládali jsme, že matrilineární příbuzní budou hodnoceni jako laskavější než

patrilinéární, což je důsledek vyšší genetické jistoty v matrilineární linii. Manuskript je v době odevzdání dizertační práce submitován v časopisu *Evolutionary Psychology* (IF=1,1).

Metodologicky jsme využili rozsáhlý vzorek 9 128 účastníků, kteří hodnotili laskavost jednotlivých rodinných členů pomocí ordinální škály s pěti stupni. Jako kontrolní skupina byli zařazeni nevlastní příbuzní, kteří nemají žádný genetický vztah k hodnotícímu jedinci. Hodnocení zahrnovalo biologické rodiče, prarodiče, sourozence a nevlastní příbuzné. Účastníci byli požádáni, aby ohodnotili laskavost každého příbuzného formou otázky „Jak moc je hodný“ na škále od „rozhodně ne“ po „rozhodně ano“. Tato metoda přináší inovativní přístup ke zkoumání daných fenoménů, neboť místo přímého dotazování rodinných příslušníků na jejich investice nebo podporu, což může být ovlivněno sociálním tlakem nebo diskomfortem, umožňuje použitá metoda účastníkům čerpat ze svého dlouhodobého pozorování rodinných interakcí, včetně jemných odchylek, které jsou externím pozorovatelům často nepřístupné. Hodnocení tak zahrnuje nejen materiální pomoc, ale také emocionální podporu.

Analýza dat byla rozdělena na několik kroků. Nejprve jsme porovnali hodnocení laskavosti mezi biologickými a nevlastními příbuznými, abychom ověřili vliv genetické příbuznosti. Následně jsme zkoumali rozdíly mezi matrilineárními a patrilinéárními příbuznými. Zvláštní pozornost byla věnována hodnocení matek a matrilineárních babiček, které byly hodnoceny jako nejlaskavější. Dále jsme analyzovali genderové rozdíly, přičemž jsme porovnávali hodnocení laskavosti rodičů a sourozenců vůči dcerám/sestrám a synům/bratrům. Zvláštní pozornost jsme věnovali analýze vlivu pořadí narození na hodnocení laskavosti sourozenců. Teorie rodinných nik ukazuje, že starší sourozenci mohou získat větší podporu od rodičů díky jejich roli v péči o mladší členy rodiny. Kramer (2005) se zabývá například přínosem starších dětí k hospodaření domácností v tradičních společnostech, což přináší širší pohled na spolupráci v rámci širší rodiny mimo přímou péči rodičů. Mladší sourozenci navíc čelí větší nejistotě ohledně biologického příbuzenství se staršími sourozenci, protože nebyli svědky jejich narození. Z toho důvodu lze očekávat, že starší sourozenci budou častěji preferovat mladší, než je tomu naopak. Sulloway (1997) a Salmon & Daly (1998) ukazují, že pořadí narození ovlivňuje vývoj osobnosti, rodičovské investice a sourozeneckou rivalitu, což může přispívat k rozdílným vnímáním a hodnocením sourozenců v rodině.

Výsledky jasně podporují teorii selekce příbuzných. Matrilineární příbuzní byli hodnoceni jako laskavější než patrilinéární, což odpovídá předpokladu, že vyšší genetická jistota v matrilineární linii ovlivňuje vnímání laskavosti. Matky a matrilineární babičky

získaly nejvyšší hodnocení, zatímco nevlastní příbuzní byli konzistentně hodnoceni jako méně laskaví bez ohledu na typ vztahu.

Naše výsledky zároveň ukazují zanedbatelné rozdíly v hodnocení mezi mladšími a staršími sourozenci, což výše uvedené předpoklady nepodporuje. Je třeba v této souvislosti zmínit nedávné výzkumy, které ukazují minimální významné rozdíly mezi sourozenci i v dalších oblastech (např. Rohrer et al., 2015). Mnohé z dříve navrhovaných efektů pořadí narození se tak jeví jako slabší, než se původně předpokládalo. Podle teorie rodinných nik se nejstarší sourozenci častěji ztotožňují s perspektivou rodičů. Toto bližší ztotožnění může vést k vyšším rodičovským investicím do nejstarších dětí, což může způsobit nižší hodnocení mladších sourozenců ze strany rodičů. Tento rozdíl v rodičovském hodnocení pak u mladších sourozenců vyvolává negativní pocity vůči starším.

Důležitým zjištěním je také fakt, že genderové rozdíly a preference matrilineárních příbuzných přetrvávají i v současné společnosti, což ukazuje na trvalý vliv evolučních tlaků na formování rodinných vztahů. Metodologickou novinkou naší studie bylo zařazení hodnocení nevlastních příbuzných jako kontrolní skupiny. Tento přístup zvýšil citlivost našeho měření a umožnil přesnější interpretaci vlivu genetické příbuznosti. Význam negativních kontrol (nevlastních příbuzných) také spočívá v tom, že umožnil odlišit, zda za rozdíly v laskavosti můžou skutečně rozdíly v nejistotě otcovství, nebo třeba role otce a matky v rodině (sociální faktory).

Tato studie přispívá k pochopení evolučních základů rodinných vazeb a altruismu a rozšiřuje poznatky o vlivu genetické jistoty a genderových rozdílů na rodinné interakce. Zjištění ukazují, že matrilineární příbuzní jsou vnímáni jako laskavější než patrilineární, přičemž matky a matrilineární babičky získaly nejvyšší hodnocení. Genderové rozdíly pak naznačují, že rodiče i sourozenci projevují více laskavosti vůči dcerám/sestrám než synům/bratrům, což může odrážet biologické a evoluční faktory. Na druhé straně výsledky nenaznačují významné rozdíly v hodnocení laskavosti mezi mladšími a staršími sourozenci, což zpochybňuje některé dřívější teorie o vlivu pořadí narození. Metodologicky významným přínosem je také zařazení rozsáhlého vzorku účastníků a využití kontrolní skupiny, což zvyšuje generalizovatelnost závěrů. V souladu s očekáváním nehraje paternální nejistota u nevlastních příbuzných žádnou roli, což se projevuje absencí významných rozdílů v hodnocení „laskavosti/altruismu“ mezi jednotlivými typy příbuzných. To vyvrací námitku, že pozorované efekty mohou být způsobeny rozdílnými sociálními rolemi jednotlivých členů rodiny namísto paternální nejistotou.

Studie otevírá nové otázky, například jaký vliv mají kulturní a sociální faktory na preference v rodinných investicích, a nabízí směr pro další výzkum v oblasti evoluční psychologie a sociální dynamiky.

6.4 Publikace 4: Pořadí narození a sexualita

Výzkum se zaměřuje na vliv pořadí narození na sexuální chování, preference a strategie. Zkoumá nejen věk při zahájení sexuálního života, ale také sociosexuální orientaci, počet partnerů a preference pro dominantní a submisivní role v sexuálních interakcích (BDSM). Výsledky ukazují, že mladší sourozenci zahajují sexuální život dříve než prvorození, přičemž vliv pořadí narození je modulován věkem matky při narození dítěte, pohlavím sourozenců a věkovým rozdílem mezi sourozenci. BDSM praktiky a preference pro dominantní role byly častější u prvorozených, zatímco sociosexuální orientace nevykazovala významné rozdíly mezi pohlavími. Manuskript je v době odevzdání dizertační práce submitován v časopisu *The Journal of Sex Research (JSR)* (IF=2,7).

Jedinečnost této studie spočívá v zaměření na málo probádanou oblast vztahu mezi pořadím narození a sexuálním chováním. Zahrnutí interakce mezi pohlavím sourozenců a pořadím narození přináší nové poznatky o dynamice rodinných konstelací. K analýze byl využit rozsáhlý vzorek 4 495 heterosexuálních respondentů pocházejících z rodin se dvěma dětmi, což umožnilo detailní pohled na vliv rodinného prostředí. Pro analýzu dat byla použita MANCOVA, která zohledňovala vlivy věku, věku matky při narození respondenta, věkový rozdíl mezi sourozenci a interakci pohlaví a pořadí narození.

Hlavní výsledky ukázaly, že druhorození zahajují sexuální aktivitu v mladším věku než prvorození. Tato korelace byla výraznější u respondentů se sourozencem stejného pohlaví, zatímco u respondentů s opačně pohlavním sourozencem byla slabší nebo zcela chyběla. Druhorozené ženy se sestrou uvedly více partnerů opačného pohlaví, ale méně partnerů stejného pohlaví; tyto efekty nebyly pozorovány u mužů. BDSM praktiky a preference byly častější mezi prvorozenými, zejména pokud měli bratra. Přestože prvorození vykazovali vyšší interpersonální dominanci v běžném životě, sexuální dominance (preferenci dominantní role v sexuálních interakcích) nebyla přímo spojena s pořadím narození. U mužů byla zaznamenána silná korelace mezi interpersonální a sexuální dominancí, zatímco u žen tato korelace nebyla signifikantní.

Tyto výsledky podporují hypotézu, že rodinné prostředí a dostupnost zdrojů hraje klíčovou roli ve formování krátkodobých reprodukčních strategií. Stresující rodinné prostředí

a omezené zdroje mohou podporovat vývoj strategií zaměřených na brzké zahájení reprodukční aktivity, což je v souladu s teorií Belskyho et al. (1991). Dále výsledky navazují na zjištění Sullowaye (1997), který zdůraznil rozdíly mezi prvorozenými a mladšími sourozenci v otevřenosti vůči novým zkušenostem a preferenci dominantních strategií. Výzkum ukazuje, že pořadí narození ovlivňuje nejen osobnost a chování, ale také reprodukční strategie, včetně hledání partnerů a experimentování v sexuálních praktikách.

Tato studie přináší nové poznatky o komplexním vztahu mezi rodinnými konstelacemi a sexuálním životem, přičemž potvrzuje, že pořadí narození je významným faktorem ovlivňujícím sexuální preference a strategie. Závěry této práce otevírají prostor pro další výzkum, zejména v oblasti genderových rozdílů a jejich interakce s pořadím narození, a nabízejí praktické aplikace například v oblasti poradenství nebo sexuální výchovy.

6.5 Publikace 5: Fertilita a hypotéza sexuálně antagonistického genu

Studie se zaměřuje na testování hypotézy sexuálně antagonistického genu, která předpokládá, že geny snižující fertilitu homosexuálních jedinců mohou zvyšovat fertilitu jejich mateřských příbuzných. Na základě dat z rozsáhlého českého vzorku bylo zjištěno, že podpora této hypotézy je omezená. Výsledky ukázaly pouze slabé důkazy o zvýšené fertilitě mateřských příbuzných gayů, přičemž efekt byl významný pouze u babiček z otcovské linie, ale jeho velikost byla minimální. Výzkum zároveň zaznamenal nižší fertilitu matek i otců lesbických žen a nižší míru reprodukce u homosexuálních mužů i žen ve srovnání s jejich heterosexuálními protějšky. Výsledky byly publikovány v časopise *Archives of Sexual Behavior* (IF=2,9).

Klíčovým přínosem této studie je inovativní metodika zahrnující data napříč více generacemi a podrobné srovnání mateřských a otcovských linií příbuzných. Analýza probíhala na vzorku zahrnujícím 7 312 heterosexuálních mužů, 459 gay mužů, 3 352 heterosexuálních žen a 79 lesbických žen, převážně z České republiky. Data byla získána prostřednictvím online dotazníku, kde respondenti uváděli informace o své vlastní fertilitě i fertilitě svých rodičů a prarodičů. Autor této dizertační práce se na publikaci podílel zejména přípravou a realizací dotazníkového šetření (jedná se o data ze stejného dotazníkového šetření, které bylo využito pro publikaci č. 4) a spoluprací při sepisování rukopisu. Zmíněná metodologie umožnila detailní pohled na potenciální genetické a evoluční mechanismy ovlivňující lidskou sexualitu a reprodukci.

Studie zapadá do širšího rámce výzkumů, které zkoumají vztah mezi pořadím narození a lidskou sexualitou. Pořadí narození, dlouhodobě zkoumané jako významný demografický a biologický faktor, bylo opakovaně spojováno s variabilitou v sexuální orientaci a reprodukčních strategiích. Jedním z nejvýraznějších a opakovaných zjištění v této oblasti je tzv. „efekt starších bratrů“. Ten uvádí, že homosexuální muži mají častěji více starších bratrů než heterosexuální muži (Blanchard & Skorska, 2022). Tento jev byl interpretován prostřednictvím imunologické hypotézy, která naznačuje, že zvýšená expozice anti-Y protilátkám v těhotenství může ovlivňovat sexuální orientaci později narozených mužských sourozenců.

Vzhledem k těmto poznatkům je zkoumání pořadí narození klíčové při interpretaci výsledků o plodnosti matek homosexuálních mužů. Ablaza et al. (2022) upozorňují, že vyšší počet starších bratrů může uměle zvyšovat zdánlivou plodnost těchto matek, protože větší rodiny pravděpodobněji obsahují homosexuální jedince. Naše studie zohledňuje tuto možnost, a proto analyzuje také vzorky prvorozených homosexuálních a heterosexuálních mužů. Tímto způsobem se snažíme vyloučit vliv rodinné velikosti jako potenciálního zkreslujícího faktoru.

Výsledky ukázaly, že u mužů nebyly zaznamenány žádné významné efekty s výjimkou vyšší fertility otcovských babiček gay mužů, přičemž velikost tohoto efektu byla velmi malá. U žen byla naopak zaznamenána nižší fertilita matek i otců lesbických žen. Výsledky potvrzují dřívější poznatky o nižší fertilitě homosexuálních mužů a žen ve srovnání s jejich heterosexuálními protějšky. Současně se výsledky shodují s recentními meta-analýzami, které rovněž nepotvrdily robustní vztah mezi sexuální orientací a fertilitou mateřských linií (Blanchard et al., 2020).

Studie rozšiřuje současnou literaturu o sexuálně antagonistických genech tím, že nenalezla důkazy pro vyšší fertilitu mateřských příbuzných homosexuálních mužů, což kontrastuje s některými dřívějšími studiemi, například Camperio Ciani et al. (2018). Tato práce tak zdůrazňuje složitost genetických a evolučních adaptací ovlivňujících lidskou sexualitu. Naznačuje také, že jiné mechanismy, jako je balancovaný výběr nebo genetická pleiotropie, mohou hrát důležitější roli v přetrvávání homosexuality v lidské populaci. Poznámka: na použitých datech jsme prostřednictvím analýz ověřili i „efekt starších bratrů“, přičemž výsledky jsou pozitivní (efekt byl v datech zjištěn, výsledky analýz zatím nejsou publikovány).

Závěry studie podtrhují komplexnost genetických a kulturních faktorů ovlivňujících reprodukci a sexualitu. Tato práce otevírá prostor pro další výzkum, který by mohl zahrnovat širší geografické a kulturní kontexty nebo podrobnější analýzy interakce genetických a

environmentálních faktorů. Výsledky poskytují cenný příspěvek k debatě o evolučních mechanismech homosexuality a jejich vlivu na reprodukční strategie v různých populacích.

7 Metodologická úskalí a kritické aspekty zkoumání pořadí narození

Zkoumání vlivu pořadí narození zůstává i přes významné poznatky problematickou oblastí, která čelí řadě metodologických a konceptuálních výzev.

Absence jednotného systému pro určování pozic v rodinném pořadí vede k nesrovnalostem mezi jednotlivými studiemi, což komplikuje interpretaci výsledků. Zaměření mnoha studií na prvorozené (Adams, 1972) přispívá k jednostrannému pohledu na tuto problematiku. Výzkumy často opomíjejí specifika v charakteristikách mladších sourozenců nebo jedináčků, čímž vzniká neúplný obraz vlivu rodinného prostředí na jedince.

Interpretace rozdílů mezi sourozenci bývají často formulovány až dodatečně na základě získaných dat, místo aby vycházely z předem definovaných hypotéz, což oslabuje teoretickou konzistenci výzkumů. Retrospektivní sběr dat a nedostatek výzkumů zaměřujících se na porovnání sourozenců z jedné rodiny (či i přímo longitudinálních studií) znemožňuje detailní sledování vlivu pořadí narození v průběhu života.

Kontrola klíčových kontextových faktorů, jako je socioekonomický status nebo kulturní normy, často není dostatečná, což může ovlivnit validitu závěrů.

Dalším úskalím je častá záměna korelací za kauzalitu. Mnoho studií tvrdí, že odhalily rozdíly v osobnosti nebo chování podle pořadí narození, avšak při detailní analýze se často ukazuje, že příčinné vztahy nejsou dostatečně robustní. Navíc některé studie byly kritizovány za manipulaci s daty nebo za přehánění významu svých závěrů, což vede k dalšímu zpochybňování reálného dopadu pořadí narození na osobnostní vývoj. To vyvolává otázky ohledně reliability těchto závěrů a upozorňuje na potřebu přísnější metodologie.

Teorie „*Admixture Hypothesis*“ (AH; česky lze přeložit jako „*hypotéza příměsi*“) představuje jednu z nejvýznamnějších kritik tradičního pohledu na vliv pořadí narození. Tato hypotéza naznačuje, že efekty připisované pořadí narození nejsou přímým důsledkem pozice dítěte v rodině, ale spíše korelací s jinými faktory, jako je věk matky, velikost rodiny nebo socioekonomický status (Kristensen & Bjerkedal, 2010; Rodgers et al., 2000). Podle této hypotézy je většina rozdílů mezi sourozenci nepřímým důsledkem těchto proměnných. AH byla poprvé formulována Pageem a Grandonem (1979) a později rozšířena Rodgersem (2001). Tato teorie zdůrazňuje, že v rámci jednotlivých rodin jsou rozdíly mezi sourozenci relativně

malé, zatímco širší rozdíly pozorované ve výzkumech vyplývají z kombinace různých rodinných typů v analyzovaných vzorcích (Powell & Steelman, 1993; Rodgers et al., 2000). Například rodiny s vyšším počtem dětí mívají nižší socioekonomický status, což může ovlivnit kvalitu výživy, vzdělání a rodičovských investic, čímž zkresluje vliv pořadí narození.

Kritici AH upozorňují na potřebu zahrnutí demografických faktorů do studií zaměřených na pořadí narození. I v homogenních populacích lze najít významné rozdíly, což zdůrazňuje důležitost přesné metodologie a kontrolování proměnných. Zastánci AH proto doporučují používat standardizované přístupy a pečlivou analýzu dat, aby bylo možné přesněji oddělit vlivy pořadí narození od dalších faktorů.

8 Směry pro budoucí výzkum

Navzdory těmto výzvám představují neprozkoumané oblasti příležitost pro další vědecké bádání. Tyto výzvy naopak spíše zdůrazňují potřebu multidisciplinárního přístupu, který by kombinoval evoluční biologii, behaviorální vědy a kulturní antropologii. Takový přístup by mohl nejen prohloubit naše porozumění vlivu pořadí narození, ale také nabídnout praktické aplikace v oblastech, jako je vzdělávací politika, rodinné poradenství nebo zdravotní péče. Zároveň by tento přístup mohl přispět k tvorbě teoreticky pevnějších modelů lidského chování, které by reflektovaly jak genetické predispozice, tak kulturní a sociální vlivy.

Jednou z klíčových otázek je, jak moderní změny v rodinné struktuře ovlivňují efekty pořadí narození. Tradiční modely, které se zaměřují na nukleární rodiny, neodrážejí rostoucí počet smíšených a neúplných rodin, kde se biologické a funkční pořadí narození může lišit. Například analýzy rodinné dynamiky v těchto strukturách vyžadují hlubší zkoumání, aby bylo možné pochopit, jak tyto nové kontexty modifikují vliv pořadí narození. Společenský vývoj rovněž naznačuje, že vliv pořadí narození na určité charakteristiky se může měnit, nebo dokonce docházet ke změně polarit efektů. To zdůrazňuje potřebu aktuálních výzkumů, které budou reflektovat měnící se rodičovské přístupy a environmentální podmínky.

Studie zaměřené na pořadí narození a sexuální chování rovněž otevřely nové otázky týkající se propojení mezi rodinnou konstelací a sociosexuální orientací. Přestože výsledky naznačují, že pořadí narození ovlivňuje sociosexuální preference, včetně BDSM praktik, není dosud jasné, jaké mechanismy tento vztah zprostředkovávají. Je zapotřebí dalších studií, které by zohlednily širší spektrum rodinných struktur a zahrnuly větší diverzitu v genderové identitě a sexuální orientaci.

Další výzvou je prozkoumání genetických mechanismů, které ovlivňují reprodukční strategie. Studie zaměřené na sexuálně antagonistické geny přinesly smíšené výsledky, což poukazuje na nutnost hlubšího zkoumání interakcí mezi genetickými predispozicemi a kulturními faktory. Otázkou zůstává, zda tato hypotéza platí i v jiných geografických a demografických skupinách, nebo zda alternativní evoluční mechanismy, jako je balancovaný výběr, mohou lépe vysvětlit podobné vzorce.

S ohledem na tyto aspekty je zřejmé, že další výzkumy a metaanalýzy jsou nezbytné pro prohloubení našeho porozumění sourozeneckým konstelacím a jejich dopadům v měnící se společenském prostředí. Tento výzkum by měl zahrnovat rozmanitější vzorky, přijmout standardizované metodologie a zohlednit široké spektrum ovlivňujících faktorů, aby poskytl komplexnější pohled na toto fascinující téma. Lepší metodologické přístupy by mohly nejen poskytnout přesnější údaje, ale také objasnit zdánlivé rozpory mezi výsledky jednotlivých studií.

9 Potenciální aplikace a interdisciplinární přesahy

Výzkum pořadí narození a jeho vlivu na lidské chování a osobnost poskytl od poloviny 20. století mnoho zajímavých poznatků, které mají významné aplikace v různých oblastech. Tyto aplikace zasahují do behaviorálních věd, vzdělávání, zdravotnictví i sociální politiky a zároveň otevírají prostor pro interdisciplinární spolupráci.

9.1.1 Aplikace ve vzdělávání a rodinné politice

Studie zaměřené na akademické úspěchy prvorozených (Publikace 2) ukázaly jejich převahu v dosaženém vzdělání. Tyto poznatky mohou být využity při navrhování vzdělávacích politik, které by zmírnily nerovnosti mezi sourozenci. Například mohou být vytvořeny programy na podporu mladších sourozenců nebo dětí z velkých rodin, které často čelí nižšímu objemu rodičovských zdrojů. Výsledky také ukazují, jak mohou být strategie rodičovského poradenství upraveny tak, aby pomáhaly rodinám efektivněji alokovat čas a zdroje.

Kromě vzdělávací politiky mají tyto poznatky přímé uplatnění i ve školských zařízeních, například formou školního poradenství a psychologické podpory. Specifické intervence zaměřené na mladší sourozence nebo děti z větších rodin by mohly zahrnovat nejen podporu v akademické oblasti, ale také prevenci rizikového chování, jako je náchylnost k

návykovým látkám nebo jiným formám maladaptivního chování. Mladší sourozenci, kteří často čelí menší míře rodičovských investic, mohou být ohroženi zvýšeným stresem a hledáním pozornosti v rizikových aktivitách. Cílené programy by mohly tato rizika snížit nebo zcela eliminovat.

V rámci školního prostředí by proto bylo možné implementovat preventivní programy, které kombinují akademickou podporu s aktivitami zaměřenými na rozvoj sociálně-emocionálních dovedností. Tato opatření mohou přispět nejen ke zlepšení vzdělávacích výsledků, ale i k celkovému posílení psychické odolnosti a zdravého vývoje dětí, což by pomohlo minimalizovat výskyt negativních efektů spojených s pořadím narození.

Integrace těchto přístupů do školních programů, včetně školního psychologického poradenství, by tak mohla přispět k vytvoření podpůrného prostředí, které zohledňuje potřeby všech dětí bez ohledu na jejich pořadí narození.

9.1.2 Klinické a terapeutické aplikace

Poznatky o vlivu rodinné dynamiky na osobnost a chování (Publikace 1) představují cenný přínos nejen pro psychoterapii a poradenství, ale také pro oblasti reprodukčního zdraví. Terapeuti mohou při práci s klienty zohlednit jejich pořadí narození jako významný faktor, který může ovlivňovat mezilidské vztahy, sebevědomí, způsob zvládání stresu a celkovou psychickou odolnost. Například prvorození, kteří často vykazují vyšší tendenci k perfekcionismu a dominantním strategiím, mohou potřebovat odlišný přístup než mladší sourozenci, kteří mohou být vnímáni jako flexibilnější, ale zároveň náchylnější k rizikovému chování.

Tyto informace mohou být zvláště užitečné při řešení partnerských problémů a sexuality. Výsledky týkající se sociosexuálních preferencí a dominantních strategií (Publikace 4) ukazují, že pořadí narození a rodinná dynamika mohou ovlivňovat, jak jednotlivci přistupují k intimitě a interakcím v partnerských vztazích. Porozumění těmto vlivům může pomoci terapeutům identifikovat vzorce chování, které ovlivňují kvalitu vztahů, a nabídnout klientům cílenou podporu při jejich řešení.

Současně výzkum sexuálně antagonistických genů (Publikace 5) poskytuje nové poznatky o genetických faktorech ovlivňujících reprodukční chování. Tyto výsledky mohou být využity k tvorbě edukačních programů, které by pomáhaly jednotlivcům lépe pochopit genetické aspekty fertility a jejich vliv na reprodukční strategie. Například osvěta o

genetických predispozicích by mohla zlepšit informovanost a pomoci jednotlivcům lépe se připravit na případné výzvy v oblasti reprodukčního zdraví.

Spojení poznatků o rodinné dynamice a genetických aspektech otevírá cestu k interdisciplinárnímu přístupu, který propojuje psychologii, genetiku a zdravotní péči. Tento přístup může nejen pomoci klientům porozumět vlivu rodinných vztahů na jejich životní dráhu, ale také nabídnout praktická řešení v oblasti prevence, diagnostiky a intervencí zaměřených na zlepšení duševního i reprodukčního zdraví. Tímto způsobem mohou být výsledky výzkumu přetaveny do konkrétních opatření, která mají potenciál pozitivně ovlivnit kvalitu života jednotlivců i rodin.

10 Shrnutí přínosů disertační práce

Tato disertační práce přispívá k pochopení vlivu pořadí narození, rodinné dynamiky a evolučních strategií na chování a životní strategie jedinců. Analyzované studie propojují behaviorální vědy s evoluční biologii, sociální psychologií a vzdělávacími výzkumy, čímž vytvářejí komplexní a interdisciplinární rámec pro pochopení lidského chování.

Jedním z klíčových přínosů je potvrzení a rozšíření dosavadních poznatků o vlivu pořadí narození na různé aspekty lidského života, včetně osobnostních rysů, vzdělávacích výsledků a sexuálního chování. Studie ukázaly, že pořadí narození hraje zásadní roli nejen v oblasti vzdělání, kde prvorození dosahují lepších výsledků, ale i v oblasti sociosexuální orientace, kde se liší preference a strategie podle pozice v rodinné hierarchii.

Dalším přínosem práce je hlubší zkoumání evolučních mechanismů, které formují reprodukční chování a rodinné vztahy. Výsledky o sexuálně antagonistických genech přinášejí nové perspektivy na vztah mezi genetikou, fertilitou a sexuální orientací, zatímco analýza vlivu nejistoty otcovství zdůrazňuje význam matrilineárních vazeb a genetické jistoty v rodinných investicích.

Disertace rovněž identifikuje klíčové metodologické výzvy v této oblasti, například potřebu longitudinálních studií a přesnějších metod sběru dat. Tyto poznatky poskytují cenné podněty pro budoucí výzkum a naznačují, jakým směrem by se mohlo dále ubírat zkoumání vlivu rodinné konstelace na lidské chování.

Z praktického hlediska disertace otevírá dveře pro aplikace v oblasti vzdělávání, zdravotnictví a sociální politiky. Výsledky lze využít při návrhu intervencí zaměřených na podporu mladších sourozenců, optimalizaci rodinných vztahů nebo osvětu v oblasti

reprodukčního zdraví. Přesahy do psychoterapie a rodinného poradenství navíc zdůrazňují, jak mohou být získané poznatky užitečné pro práci s jednotlivci i rodinami.

Celkově disertace ukazuje, že propojení behaviorálních a evolučních přístupů může přinést nový pohled na klíčové otázky lidského chování. Přínosy práce nespočívají pouze ve vědeckém obohacení, ale také v jejím potenciálu inspirovat interdisciplinární výzkum a podpořit praktické aplikace v různých oblastech lidské společnosti.

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12 Zařazené publikace

Níže je seznam publikací.

12.1 Birth Order

B

Birth Order



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Synonyms

Family constellation; Sibling constellation

Definition

Birth order refers to the sequence in which children are born into a family. It has been suggested that birth order can subtly influence personality, behavior, and interpersonal relationships due to potential differences in parental expectations, sibling interactions, and family dynamics associated with each position.

Introduction

Environmental factors significantly influence the phenotypes of both experimental animals and humans. A key factor in this context is the family environment, which plays a crucial role in shaping

character and physiological traits. This concept is integrated within evolutionary psychology, highlighting the variance in strategies toward offspring based on birth order.

Siblings, despite sharing approximately half of their genetic material from the same biological parents, and growing up in a similar family setting, often display strikingly divergent psychological profiles and behaviors. These variations resemble differences found among unrelated individuals (Plomin & Daniels, 2011; Sulloway, 1997). Such disparities are attributed not solely to genetics but are predominantly environmental, with non-shared external factors, notably peer influences, playing a significant role. It is widely agreed among researchers that unique family dynamics shape the distinct personalities and behaviors of siblings, influencing each one in varying ways.

The characteristics of siblings, classified as firstborns (including only children) and laterborns, often share similarities within these birth order categories. Therefore, it is plausible that siblings within the same family, regardless of their birth order position, may develop differing developmental and personality traits.

However, despite considerable research affirming the influence of birth order on personality, findings across studies remain inconsistent. The debate over the explanations for these variations persists, with no unified consensus on the underlying mechanisms or the extent of their effects. Some scholars argue that the observed

birth order effects may be artifacts of the methodologies employed in studies (Ernst & Angst, 1983; Rodgers, 2001). Critics of birth order theory explain differences between siblings by attributing them to variations in genetic predispositions, which, they argue, may lead to disparities in experiences, their perception, and reactions to these experiences. They further mention the influences of objectively non-shared environments, such as different peer groups. Consequently, the academic community is divided, with continued debate and lack of agreement regarding the impact of birth order on educational and academic outcomes.

Research History

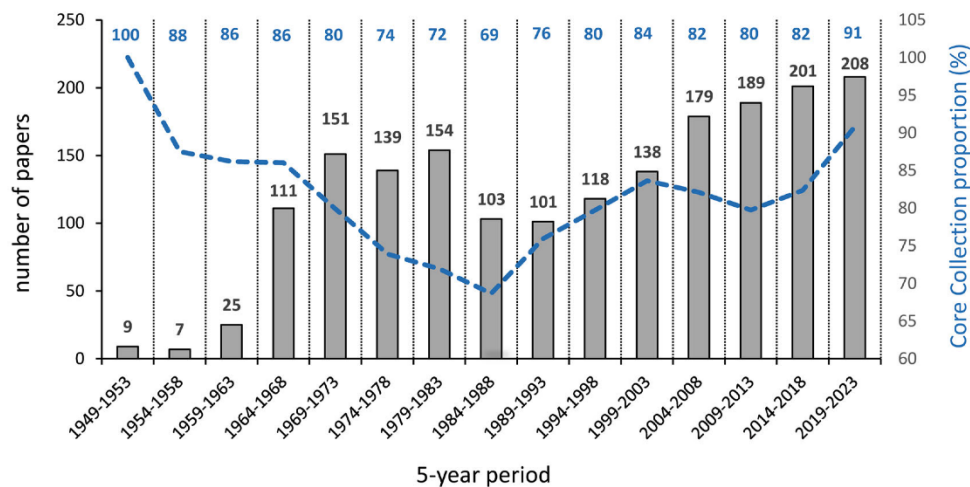
Birth order has been discussed as a factor affecting individuals for over 150 years. The examination of sibling dynamics has varied, with notable figures highlighting different aspects. Historically,

birth order has enabled some individuals to gain privileges, titles, and honors, a phenomenon exemplified by the principle of primogeniture.

In the late nineteenth century, Francis Galton (1822–1911) noted a higher representation (48%) of firstborns and only sons among English scientists, initiating discussions on birth order's influence. Galton suggested that firstborns have more control over their destiny.

Alfred Adler (1870–1937), an Austrian doctor and psychologist, is considered the pioneer of sibling constellation theory. He argued that birth order provides unique experiences and perspectives, significantly shaping personality. It's important to note that, like most contemporary experts, Adler spoke primarily of strong tendencies or probabilities rather than absolute certainties.

Research on family constellations has intensified since the second half of the twentieth century, yielding many publications (Fig. 1). Schachter's work, often contrasting Adler's views, suggests



Birth Order, Fig. 1 Number of papers indexed in WOS bibliographic database. Using the Web of Science bibliographic database, all indexed papers meeting the criteria containing the term “birth order” in their title were retrieved. The gray bars represent the number of papers in the Web of Science Core Collection, each bar accompanied by a distinct number above in gray color. The blue line indicates the proportion of papers listed in the WOS Core Collection compared to the entire WOS database, with a distinct percentage above in blue color. The figure shows

that since 1950, the number of papers has steadily increased, peaking in the 1970s. Subsequently, a decline is observed, likely in response to heightened scrutiny of methodological aspects. However, since the late 1990s, there has been another notable increase, continuing to the present. A higher proportion of papers listed in the WOS Core Collection versus the entire WOS database might indicate that the subject matter is considered more significant from a scientific perspective

that eldest children are more likely to achieve fame, attend prestigious universities, and perform academically better, but are also more dependent and susceptible to influence. Walter Toman's seminal work in 1965 analyzed the impact of family dynamics on personality and partner relationships, although methodological criticisms later emerged. However, from this period also emerged several primary models and hypotheses that attempted to elucidate the dynamics of the influence of birth order on individuals.

"Born to Rebel: Birth Order, Family Dynamics, and Creative Lives" (1997) represents a significant contribution, offering insights from over two decades of research on birth order. The author, Frank J. Sulloway, gathered a vast amount of valuable data and presented the results of analyses of not only contemporary but also many historical events and personalities in his book. Despite criticisms, particularly regarding methodology or research outcomes failing to support the theories (e.g., Richards et al., 2023), Sulloway's work remains a notable milestone in the field.

Additionally, popular science literature addresses the effects of birth order on various aspects of life, such as therapy, family relationships, personal development, and communication. However, it is important to approach these claims with skepticism, as many are not supported by scientific evidence.

Methodology and Sibling Categorization

Research on birth order faces numerous challenges, leading to its status as a contentious and debated field. Key issues include inconsistent categorization of birth order positions and a tendency for conclusions to be post hoc speculations that attempt to explain sibling differences. The literature often confuses causality with correlational variables, adding to the ambiguity. A closer inspection of certain studies sometimes shows that evidence claimed to support birth order differences is either misleading or weak. A significant focus on firstborns' personality and behavior may bias the overall understanding of

birth order effects. Due to these methodological flaws and occasional accusations of result manipulation, many critics doubt the existence of significant birth order effects, arguing they may not be as important or clear-cut as once believed.

Biological Versus Psychological Birth Order

Birth order can be classified as either ordinal (biological) or functional (psychological), with both aspects offering unique insights into sibling dynamics (Carette et al., 2011; Eckstein et al., 2010; Sulloway, 1997). Ordinal birth order assigns siblings to categories (firstborn, secondborn, thirdborn, etc.) based on their birth sequence. This method is widely used in analyses, although some studies adopt the concept of relative birth order, calculated e.g., as the ratio of the number of older siblings to the total number of siblings.

While biological factors associated with birth order may influence individuals (e.g., physiological-anatomical differences), functional birth order, which considers the context and interpretation of one's birth position, seems to have a more substantial effect (Carette et al., 2011). Typically, biological and functional birth orders coincide, but exceptions can occur due to changes in family dynamics, such as divorce, the death of a sibling, the introduction of stepsiblings, or a significant age gap between siblings. These changes can shift an individual's personality traits beyond what is traditionally expected based on birth order. Thus, functional birth order seems to provide a more accurate reflection of the individual's upbringing.

Firstborns Versus Laterborns

Building on Alfred Adler's foundational categorization, which provided a comprehensive description of sibling positions, research often utilizes four basic categories: only child, firstborn, middleborn child, and youngest child (referred to as lastborn—"Benjamin"). Individuals are classified based on their actual birth order and relative position within the sibling group.

Many researchers simplify this categorization by grouping only children and actual firstborns into a single "firstborns" category and combining

middleborn and youngest children into a “laterborns” category. This approach is based on the premise that significant differences are most pronounced between firstborns and all other positions, due to the unique status firstborns have within a family (Alabbasi et al., 2021; Sulloway, 1997).

However, some studies caution against oversimplification, noting that merging middleborn and youngest children can obscure distinct differences and potentially skew results (Salmon, 2003). The “middleborn child” category, serving as a catch-all for any child between the oldest and youngest, may not accurately reflect the diverse experiences of middleborn children in varying family sizes. For instance, a third child in a three-child family occupies a different position than a fifth child in a six-child family, a nuance lost in broad categorization.

Moreover, research has linked larger sibling groups with various socioeconomic, religious, and racial family backgrounds, suggesting that sibling set size significantly influences outcomes (Ernst & Angst, 1983). Therefore, analyses using sibling position categorization must carefully account for sibling set size to ensure accurate interpretation of results.

Between-Family Versus Within-Family Studies

The methodology behind studies exploring birth order effects is critical, encompassing two primary research designs: between-family studies and within-family studies. Each design has distinct advantages and disadvantages, shaping the research findings.

Between-family studies analyze birth order effects by comparing individuals from different families. This approach allows for a broad assessment of birth order impacts across a diverse sample, facilitating the identification of general patterns and trends. However, it may also introduce variability due to the differences in family environments and contexts, potentially confounding the results.

Within-family studies, on the other hand, focus on gathering data from siblings within the same family. This design minimizes the environmental variability present in between-family studies,

offering a clearer view of birth order effects by holding constant many external factors. While this approach provides a more controlled examination of birth order, it may not capture the full range of external influences that can affect individuals’ development and behaviors.

Both approaches offer insightful perspectives on the phenomena associated with birth order effects. However, due to the intrinsic advantages and drawbacks of each method, they may yield divergent observations and interpretations (e.g., Michalski & Shackelford, 2001).

Origins of Differences

This theory is predicated on the notion that the family serves as the primary environmental factor influencing an individual from birth. Despite cohabitation, siblings do not experience the family setting identically. Birth order places each child into a distinct psychosocial context, shaping their development pathways (Plomin & Daniels, 2011; Sulloway, 1997). The firstborn, for example, is introduced to a nascent family dynamic, monopolizing parental attention as parents adjust to their roles. Subsequent children enter a family with existing sibling relationships, necessitating the division of parental focus and resources. Parent-child and sibling-sibling interactions are heavily influenced by birth order. Furthermore, the structure of the family, including the total number of children, intervals between births, sibling genders, and gender ratios, significantly impacts these dynamics. This has led to the proposal of various hypotheses and models, especially regarding the implications for human cognition and intelligence.

Differences in Parental Approach

Differences among siblings are often interpreted in connection to varying approaches based on parental aging and experience, and attributed to Darwinian evolutionary principles, highlighting parental investment as a primary source of variance. Parental resources, being finite, necessitate strategic distribution to maximize offspring survival and, by extension, parental reproductive

success. Offspring compete for these resources, their interests diverging from parental ones, leading to parent-offspring conflict. This conflict is pivotal for understanding family dynamics and birth order effects.

Evolutionary pressures for optimal biological fitness have shaped parents' psychological and motivational mechanisms for allocating resources among offspring under constraints, leading to varied resource distribution in certain contexts. Birth order significantly influences this distribution, affected by the offspring's age and proximity to reproductive viability, thus impacting their value from a parental fitness perspective.

Specifically, firstborns enjoy a unique advantage by monopolizing parental investments from birth, receiving undivided material and immaterial resources during critical early life stages when dependency on parental care is highest. They benefit from extensive parental caregiving time, which naturally diminishes with the arrival of subsequent siblings, leaving less for younger siblings. Conversely, laterborn siblings, especially the youngest, may benefit from increased material resources, correlating with parental age and financial stability, potentially offering advantages in later life stages, such as covering college expenses. Despite this, firstborns tend to receive the highest educational investment, with younger siblings facing constrained resources due to prior allocations (de Haan, 2010; Sakata et al., 2022).

In well-resourced families, typical of developed Western societies—the primary source of most scholarly research on birth order effects—parents strive for equitable distribution among children, a finding supported by empirical studies (Daniels et al., 1985). However, this effort paradoxically results in investment disparities across birth orders, disadvantaging middleborn children due to the cumulative nature of resource allocation over time. Firstborns experience a period of exclusive resource access, while lastborns inherit the majority of parental resources after older siblings move out. Middleborn children, who share resources throughout their upbringing, may find themselves in a less favorable position. This situation can adversely affect their self-esteem, parental relationships, and external social interactions

more significantly than it does their siblings (Salmon, 2003).

Models and Hypotheses

These principles have evolved into a multitude of specific models and hypotheses, largely derived from the parental investment theory:

- **Confluence Model:** Introduced by R. Zajonc (1979), the “confluence model” is based on the segmentation of the intellectual environment within a family, positing that the direct influence of parents on offspring varies according to birth order. This model suggests a negative impact of higher birth order on education and intelligence, focusing on age gaps, family size, and the role of the teacher as pivotal factors. While some empirical studies support this model, its validity is increasingly questioned (Downey, 1995; Steelman & Powell, 1985).
- **Resource Dilution Model:** The “Resource Dilution Model” (RDM) by J. Blake (1985) examines how finite family resources, such as time and money, are distributed among siblings, affecting their educational outcomes. The model proposes that as the number of siblings increases, the resources available per child decrease, potentially disadvantaging younger siblings in educational attainment (Downey, 1995; Karwath et al., 2014). Although firstborns often receive more resources, resulting in better educational achievements, larger age gaps can mitigate this effect for younger siblings. Despite its empirical support, the model's applicability varies with family size and socioeconomic status.
- **Sibling Competition and the Family Niche Theory:** The Competitive Hypothesis, closely related to the RDM, suggests that both mechanisms likely operate simultaneously. While the RDM attributes sibling differences to parental resource allocation, the Competitive Hypothesis emphasizes the sibling perspective. Sulloway (1997), in “Born to Rebel,” compares the family environment to ecological niches, underlining sibling competition for resources (de Haan, 2010). This theory,

drawing from Darwin's principle of divergence and other evolutionary biology theories, explains sibling diversification within a family as a strategy to minimize rivalry and maximize parental resource acquisition. Such competition encourages siblings to differentiate their interests and specialize, thus reducing rivalry. This diversification is sometimes described through disruptive selection, favoring more extreme traits over average ones, unlike stabilizing selection.

Beyond Birth Order: Admixture Hypothesis

The "Admixture Hypothesis" (AH) challenges the significance of birth order effects, proposing that what are perceived as effects of birth order may actually be reflections of other closely related factors, such as maternal age and family size, rather than birth order itself (Kristensen & Bjerkedal, 2010). The AH contends that the impacts attributed to birth order are in fact proxy outcomes for variables like socioeconomic status, parental education, and nutrition quality. It suggests that differences between birth orders within individual families are minimal, and that broader observed disparities can be attributed to the mixing of diverse family types in research. Critics, including Rodgers (2001), emphasize the importance of incorporating careful demographic considerations in birth order studies, pointing out significant findings even within homogenous populations.

Specifics of Individual Birth Order Positions

Researchers have identified that each birth order position is associated with distinct developmental characteristics and unique childhood conditions, which can influence the personality and values of individuals leading to observable birth order effects.

Only Children

The interaction with parents is a crucial factor in the emergence of birth order differences, with age often highlighted in this context. It is argued that

older parents tend to approach parenting differently than younger ones, usually being financially and professionally more secure, and having more stable personal lives. Conversely, younger parents may exhibit parental inconsistency due to inexperience, leading to inconsistency in some aspects of upbringing.

The dynamics of young parents raising their first child can be notably ambivalent. They may oscillate between being overly demanding and strict, and being excessively cautious, uncertain, and inconsistent. It has been suggested that discipline and routine within the family tend to relax with each subsequent child. Studies indicate that firstborns often learn to walk, talk, and read faster than laterborn children (Chandna & Bhagowalia, 2024), likely benefiting from significant parental attention and encouragement. However, these early differences typically do not lead to substantial shifts in developmental timing with long-term impacts.

The peer relationships of only children also present unique challenges. The considerable attention they receive from adults may make establishing relationships with peers more difficult for them compared to children with siblings. They tend to relate better with either older or younger children, reflecting a trend where firstborns are more adult-oriented while laterborns are peer-oriented, a pattern statistically confirmed.

Distinct from firstborns, only children often show a lower need for affiliation, higher self-esteem, and a propensity toward egotism (Eckstein et al., 2010). These differences are primarily attributed to the absence of siblings, potentially leading to challenges in peer communication and forming close relationships.

Firstborns

Firstborns, having initially experienced life as only children, exhibit characteristics akin to them, yet with distinct variations observable across a broader demographic (Eckstein et al., 2010; Sulloway, 1997). These similarities are profound, with only children often presenting amplified firstborn traits.

The introduction of a second sibling marks a pivotal shift for a firstborn, often leading to

psychological distress manifesting as desperation, aggression, and hostility toward the newcomer. This reaction, stemming from a sense of “dethronement” signifies the firstborn’s struggle with losing undivided parental attention. The disruption in psychological equilibrium might halt or regress developmental progress, further reflecting in firstborns’ notably lower levels of trust and cooperation compared to their siblings.

Responsibilities often fall to firstborns in sibling care, entrusting them with oversight and accountability for younger siblings. This dynamic fosters a “firstborn syndrome,” where firstborns feel compelled to excel in all aspects and also present a teacher role for their siblings. Such social pressures can strain the firstborn’s psyche, notwithstanding the fact that they typically receive more parental feedback than their younger counterparts.

Laterborns

Laterborns, encompassing all siblings born after the firstborn, are divided into two primary groups: middleborns, who have both older and younger siblings, and lastborns, often referred to as the family “Benjamins,” occupying the final position in the birth order.

In contrast to firstborns, laterborns do not receive the same level of exclusive parental attention and advantages initially. While they may not experience the specific “dethronement” event that firstborns encounter, they still engage in sibling rivalry and strive for their own recognition and place within the family hierarchy.

Middleborns

Middleborns arguably navigate the most complex family dynamics. Born into a position lacking the firstborn privileges or the singular attention often afforded to lastborns, they find themselves in a unique and challenging familial role. Sulloway (1997) views this through an evolutionary lens, suggesting a survival and resilience focus, historically placing middleborns in a demanding survival scenario due to less parental investment compared to their siblings.

Research by Salmon (2003) underscores middleborns’ distinct familial and social dynamics:

they show a higher appreciation for friendships, less perceived parental favoritism, and a more significant inclination to seek support outside the family unit. Parental investment studies reveal that middleborn children receive the least attention and resources, often leading to feelings of neglect and lower self-esteem compared to their siblings. Instances of parental favoritism further highlight this, with middleborn children seldom being the favored child or the chosen confidante in times of need.

The combination of these conditions and manifestations can be referred to as the “middleborn child syndrome.”

Amidst these challenges, the external orientation of middleborn children equips them with robust communication and social skills, making them adept at building and maintaining friendships (Eckstein et al., 2010; Salmon, 2003).

It is, however, noteworthy that some researchers found no significant differences between middleborn and lastborn individuals (e.g., Alabbasi et al., 2021).

Lastborns

Lastborns, uniquely positioned as the youngest family members, navigate a distinct familial landscape defined by their status as the final child. Their developmental and social dynamics are shaped by the inherent need to compete with older siblings for parental attention and resources.

On the one hand, lastborns face the challenge of their achievements being less novel and celebrated compared to those of firstborns, due to parents having previously experienced these milestones. However, they often enjoy a more relaxed familial atmosphere, benefiting from lenient rule enforcement and greater empathy from parents, grandparents, and older siblings. This nurturing environment, coupled with the guidance provided by the age gap, significantly impacts their development.

Lastborn children exhibit the highest sociability and friendliness, high self-esteem, the lowest level of intellect (Black et al., 2011; Eckstein et al., 2010), and caution. They are most prone to alcoholism and are overrepresented among patients with mental disorders. Together with

only children, lastborn children exhibit usually the greatest risk of psychiatric illness. Adult lastborn children are most frequently chosen by their mothers as the children they have the closest emotional relationship with.

While Sulloway's theory positions lastborns as the family's principal rebels, other studies suggest their inherent friendliness, empathy, and strong parental bonds may diminish the impetus for rebellion, particularly when compared to middleborns. However, certain findings point to an increased likelihood of arrest among youngest siblings, alongside an assumption that psychopathological effects may be more pronounced in this group.

Factors Influencing Birth Order Effect

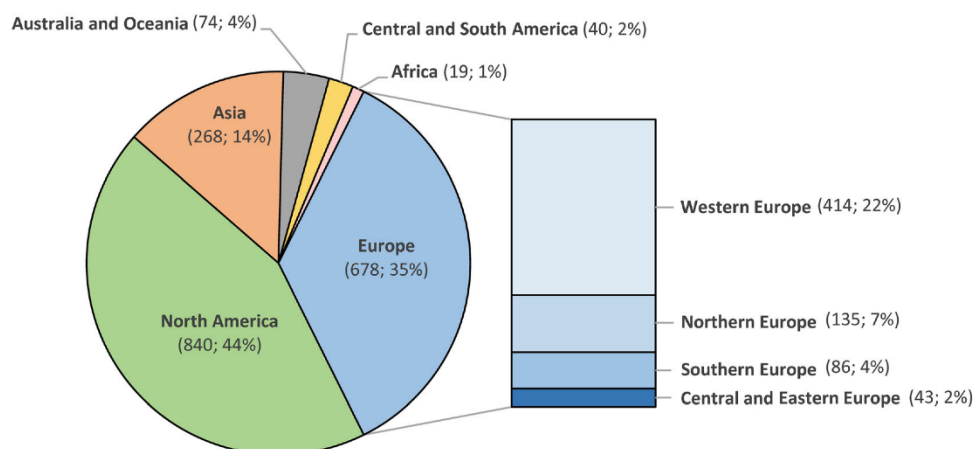
The birth order effect is influenced by various factors, including personal dispositions, family dynamics, and environmental influences. Key factors include are parents and siblings, including their sex and the spacing in age between siblings. However, additional factors such as family socioeconomic status, culture, race, and many others also play significant roles. Below is an overview of the main factors.

Factors arising from family and parenting:

- **Family Environment:** The family environment plays a pivotal role in a child's development, with factors such as birth order being highly conditional on socioeconomic conditions and cultural contexts. Particularly in early ontogeny, the quality of social contacts with parents outweighs the quantity, as evidenced by studies showing that siblings with closer relationships with their mother and better relationships with siblings exhibit higher psychological wellbeing and emotional stability.
- **Parental Age:** The timing of the birth of the first child is closely associated with life conditions, parental education, marital status, and partnership stability. While factors influencing the timing of the first child are relatively well-known, the consequences for the child remain less understood. Few studies adequately control for parental age, which is essential for a comprehensive understanding of its effects. Interestingly, the timing of family formation does not significantly impact the amount of time parents spend with their child or their overall satisfaction. It has been identified as a significant factor influencing various aspects of child development, including intelligence and educational attainment (Zajonc, 1976). Moreover, children born to older mothers tend to exhibit higher IQ, attain higher levels of education, and demonstrate better academic abilities.
- **Parental Attitudes:** Furthermore, family dynamics, such as parental favoritism and the quality of relationships, have been recognized as crucial elements impacting child development. Parental education shapes attitudes toward children's educational outcomes, yet the interaction with birth order effects is debated (Kristensen & Bjerkedal, 2010). Parental affection toward specific children, though logical due to similarities in traits, can lead to perceived favoritism, which may affect a child's development (Sulloway, 1997). Furthermore, parents serve as models for the development of a child's sexual and social roles.
- **Shifts in Family Structures:** The ongoing shifts in family structures, such as increased divorces, underscore the continued importance of the family unit in child upbringing. Divorce rates have been shown to significantly affect children's wellbeing, particularly in single-parent households, which often face socioeconomic disadvantages. Additionally, divorce rates have been associated with lower educational attainment, particularly in families with only one child or only daughters (Kristensen & Bjerkedal, 2010). However, the negative effects of divorce on children may vary based on factors such as the presence of a stepparent.
- **Socioeconomic Status (SES)** and parental resources significantly shape birth order

effects, affecting educational investments and aspirations. Wealthier families typically invest more in education, particularly for firstborns. However, resource allocation may vary non-linearly with family size, posing challenges for educational attainment (Downey, 1995) (with opposite trends observed in Western states compared to Southeast Asia, for example). Parental planning and resource depletion also contribute to differential investments across birth order. It has been documented that parents from higher socioeconomic backgrounds have lower aspirations for their laterborn children, especially if the firstborn has already achieved a certain level of education (e.g., high school). Birth order effects may be more pronounced in developed populations, while compensation mechanisms and inheritance practices mitigate disparities in poorer families. Additionally, societal factors like child labor and gender norms influence educational opportunities, particularly in countries with prevalent child labor practices.

- **Cultural Environment:** Cultural, national, and racial contexts influence the manifestations of birth order effects. Racial differences in family size and educational attainment further underscore the influence of cultural context. This factor is accentuated by frequent criticisms regarding the uniformity of countries and regions from which the papers originate. It is known that birth order effects differ according to the cultural environment therefore, creating generalizations based solely on the main trend of results could be misleading, as the distribution of papers across various countries is not equal. Disparities in the distribution of papers across regions of origin are depicted in Fig. 2. It shows that the vast majority of publications originate from North America (44%) or Europe (35%). However, upon closer analysis, only 2% of papers come from Central and Eastern Europe. Similarly, only 2% of papers are from Central and Southern America, and 1% are from Africa. These regions are thus severely underrepresented in birth order research.



Birth Order, Fig. 2 Number of papers indexed in WOS bibliographic database by region. The number in brackets represents the distinct number and percentage of the total of 1919 records. The inset figure provides a more detailed breakdown of articles from Europe into four main geographical areas (state affiliation to region is based on EuroVoc by the Publications Office of the European Union). Data Retrieval Method: Using the Web of Science

Core Collection, all indexed papers meeting the criteria containing the term “birth order” in their title were retrieved; filtered by Country/Region (data from 1948 to April 2024). It should be noted that the data are based on the authors’ stated nationality, which may not necessarily reflect the region from which the relevant data originate; however, they often align

Factors connected to siblings:

- Number of Siblings:** Confluence Model and the Resource Dilution Model suggest that having more siblings can hinder individual achievement due to shared resources, potentially lowering performance for all. This idea is supported by the quality-quantity model, which suggests a trade-off between family size and the education each child receives. Parents may choose fewer children to prioritize quality upbringing and education. The probability of attending school and the total years of education decline with each additional sibling, especially impacting the firstborn's chances of educational success. Firstborns from large families and individuals from large families, in general, have been found to demonstrate better educational outcomes and higher expectations, suggesting that larger family sizes may offer comparative advantages and intensify motivational factors (Kristensen & Bjerkedal, 2010).
- Gender:** A substantial portion of the variation in relationships between birth order and personality traits can be attributed to gender differences. For instance, women can display higher levels of sociability compared to men. Furthermore, other research indicates that firstborns show traits often associated with masculinity—such as leadership, self-confidence, assertiveness, competitiveness, and aggression—irrespective of their gender. In contrast, laterborns are more likely to possess traits viewed as feminine, including affection, cooperativeness, and flexibility. Research has shown that higher levels of differences occur, especially when siblings are of the same gender (Daňková et al., 2024). Older studies observed that the most significant differences are found in the case of two male siblings. Similarly, other authors suggest that siblings of different genders experience much less rivalry and competition than those of the same gender. They argue, for instance, that societal expectations for distinct male and female roles contribute to this dynamic. It was posited that women with older brothers are, in a sense, treated as firstborns. Others added that in families with many siblings, the minority gender may enjoy a special status, a unique relationship with parents, and thus, access to resources. In some cultures, a gender preference exists (Chandna & Bhagowalia, 2024), that may result in women having more siblings. This can be associated with the negative effects of increased sibling numbers on academic achievement. Gender-related differences are more pronounced in less developed countries. For example, a firstborn son is more likely to be employed as a child, while a firstborn daughter has a higher chance of attending school. Higher parental investments in sons than daughters have also been observed. Considering an individual's position within the family in relation to their siblings and their genders is the foundation of Walter Toman's theory focused on partner compatibility. There is ongoing debate regarding the idea, on which gender has birth order greater impact. Regardless of the direction and strength of the effect, it is clear that siblings' gender, like their number, represents another critical variable to consider in analyses.
- Stepsiblings:** The presence of stepsiblings or adopted siblings, particularly when integrated into the family from an early age, can significantly influence family dynamics and the perceived order of birth. Studies indicate a tendency among parents to favor biological offspring over stepchildren. Nevertheless, the body of research specifically addressing the impact of stepsiblings remains sparse, highlighting the imperative for more comprehensive investigations and hypothesis validation through the use of suitable data. Research exploring the consequences of birth order incorporates various methodologies, with some focusing on “full sibship” scenarios—comprising solely biological siblings—while others examine “mixed sibship,” which includes both biological and non-biological (step or adopted) siblings.
- Age Spacing:** Childhood development undergoes rapid changes, making even slight age gaps significant in shaping personality. The

level of rivalry among siblings is influenced by age spacing, with closer gaps leading to heightened competition, potentially exacerbated by shared peers. Small age gaps correlate with reduced parental investment, both financially and in terms of time spent tutoring or stimulating children (Powell & Steelman, 1990). Many scholars argue that smaller age gaps intensify the influence of birth order (Powell & Steelman, 1990; Zajonc, 1976). Studies have shown that larger age spacings are associated with richer vocabularies among siblings and better performance on mathematical or verbal tests. In relation to Adler's theories, it has been remarked that with an age spacing of over 5 years, the birth order effects weaken to the extent that a later-born child can exhibit various firstborn characteristics and be referred to as a "pseudofirstborn." However, the age spacing is often overlooked in studies, despite its recognized importance. Neglecting age spacing may introduce biases and lead to erroneous conclusions in birth order research. Despite criticisms of Zajonc's confluence model, age spacing remains a crucial factor that warrants further investigation (Karwath et al., 2014). Various methods for addressing age gaps, such as counting months or computing a family average, have been suggested. A special case of a small age gap is represented by twins, where, according to some authors, differences based on birth order can also be distinguished.

- **Health Issues:** Physical or psychological disabilities present in one of the siblings can notably alter the functional birth order within the family structure. These disabilities may lead to shifts in roles, responsibilities, and dynamics among siblings, thereby affecting their developmental trajectories and interpersonal relationships.

Examples of Birth Order Effects Observed in Humans

In the field of personality traits, extensive research has been conducted, with numerous studies published. For the sake of clarity, the effects of

birth order have been divided into the following main areas: personality traits, selected mental health problems, academic abilities and relationships, and marriage area including sociosexuality.

Personality Traits

Openness to Experience Research indicates that firstborns generally exhibit lower levels of openness compared to laterborn individuals. This inclination towards conformity and tradition is supported by many studies, while others found conflicting findings by suggest a positive correlation between firstborn status and openness. Conversely, laterborn individuals tend to display higher levels of openness, attributed to reduced parental supervision and increased autonomy. Other studies corroborate this observation. Additionally, only children typically exhibit heightened openness due to greater parental attention and resources. Other research on conformity, considering gender differences, highlights variations in conformity levels based on birth order and gender.

Conscientiousness Firstborns tend to internalize parental values and assume caregiving responsibilities, leading to higher conscientiousness compared to laterborns. Conversely, laterborn individuals typically exhibit lower conscientiousness and achievement orientation. Only children often demonstrate heightened conscientiousness and are more goal-oriented. Moreover, firstborns tend to display a more adult-oriented approach to life, characterized by reduced impulsivity and greater rigidity compared to laterborns. They also exhibit higher self-esteem and a stronger motivation to meet parental expectations, particularly evident in their educational pursuits (Altus, 1966). It was reported that firstborns had a much lower rate of disagreement with their parents, contemplating a possible link to their higher obedience, discipline, and self-control. Characteristic traits associated with firstborn children include high motivation, leadership abilities, responsibility, conscientiousness, and a strong need for recognition and approval (Eckstein et al., 2010).

Extraversion and Sociability Firstborns tend to exhibit higher levels of dominance-related

behaviors, contributing to increased extraversion. Higher extraversion among firstborns compared to laterborns is corroborated by multiple studies, even though there are some contradictory reports. Furthermore, other research suggests that firstborns may not consistently demonstrate greater dominance in all aspects of extraversion. Conversely, laterborns, benefiting from increased peer interaction opportunities, typically display higher sociability and warmth compared to firstborns. These findings are supported by various studies. Moreover, laterborn individuals, particularly secondborns in two-child families, demonstrate higher levels of sociability and social success. Additionally, only children often exhibit elevated levels of extraversion compared to individuals with siblings. Their heightened sociability may stem from receiving undivided parental attention and the absence of sibling competition. A substantial number of studies have identified firstborns as more dominant compared to their laterborn counterparts, although there is some contrary evidence. Firstborn children are also most likely to participate in sibling bullying, often as aggressors. According to numerous other studies, firstborns typically exhibit a higher need for affiliation.

Agreeableness Firstborns often strive to regain favor by displaying self-sacrificing, obedient, and conciliatory behaviors. Laterborns tend to exhibit lower levels of agreeableness compared to firstborns. Regarding only children, findings on agreeableness are less consistent. While some research suggests slightly lower levels of agreeableness due to less experience with sibling interactions, other studies find no significant differences compared to individuals with siblings.

Emotional Stability, Neuroticism, and Anxiety Previous studies have suggested that firstborn individuals tend to have lower levels of neuroticism compared to those born later, such as secondborns, middleborn, youngest, or only children. However, more recent studies show a contrary trend, indicating that firstborns are often likely to have higher levels of neuroticism compared to other birth order types, suggesting a

possible change over time due to societal evolution. Moreover, some researchers reported that firstborns exhibit higher neuroticism compared to lastborns, while others found that firstborns show higher levels of neuroticism in comparison to only children. Studies also reported that only children exhibit lower levels of neuroticism compared to individuals with siblings. According to others, only children are less emotionally stable, less resistant to psychological stress, and more vulnerable than firstborns, indicating higher levels of neuroticism. This is corroborated by research finding that only children exhibit a lower capacity for self-control, which, according to some, suggests a higher degree of neuroticism. According to both self-reports and maternal assessments, firstborns are less impulsive compared to middleborn children from families of three. In agreement with the aforementioned effects, recent studies even show that firstborns tend to exhibit lower levels of various facets of the traits associated with emotional intelligence (Villanueva-Iglesias & García-Martín, 2023).

Academic Abilities

Firstborn children often demonstrate superior intellectual abilities and higher education levels. The phenomenon is frequently attributed to increased parental attention and cognitive stimulation during early childhood. Psychological studies also suggest that differences in intellectual abilities and educational attainment by birth order can also be attributed to personality traits. Firstborns are supposed to be more often oriented toward adult values. They have a higher tendency to fulfill and identify with parental expectations, which may manifest, for example, in higher levels of obedience, self-control, and discipline.

They also demonstrate a greater need for recognition and appreciation, alongside a predisposition toward extroversion, problem-solving, methodical approaches to tasks or divergent thinking (Alabbasi et al., 2021). Furthermore, firstborns often prioritize future planning and career aspirations, showcasing intensive problem-solving skills and a strong motivation for learning (Carette et al., 2011). Recent studies have shown a positive correlation between the

degree of extroversion, in which usually firstborns score higher, and educational success. Some authors believe this may be related to the conscientiousness dimension.

The relationship between birth order and academic success is intricate, influenced by various factors including parental occupation and family size. While biological and genetic factors have been proposed to contribute to differences in academic performance, their extent of influence remains uncertain, and psychological and environmental factors are widely regarded as primary determinants of academic success concerning birth order (Black et al., 2011; Rodgers, 2001). Studies have shown positive correlations between intelligence and certain physical characteristics at birth, such as birth length and head size, albeit with variations across birth orders. However, some conflicting findings suggest that older maternal age may lead to lower birth weights, potentially influencing the academic performance of laterborns (however, there is some contradictory evidence reporting lower birth weights among firstborns).

The concept of a “rich uterine environment” for first-time mothers has been proposed, suggesting better uterine predispositions and maternal resources during the development of the first child. Conversely, laterborns may experience reduced maternal resources due to factors such as maternal age and depleted energy reserves. Moreover, studies have explored the impact of maternal physiology on cognitive abilities, with higher levels of certain types of maternal fat associated with improved cognitive outcomes in children. However, short intervals between births may deplete these reserves, potentially affecting laterborns’ academic performance. Additionally, the number of children in a family has been linked to the probability of genetic diseases and health problems, which could indirectly influence educational achievements.

A separate chapter comprises research on IQ. While a larger number of authors have already addressed the influence of birth order on achieved education, far fewer have studied its direct impact on IQ. The conducted studies yield ambiguous results. Some research has found higher IQ scores

among firstborn individuals. Black et al. (2011) identified a strong relationship between birth order and IQ with firstborn individuals having, on average, IQ scores 3 points higher compared to secondborn individuals. Sulloway refers to studies showing a less significant difference. For each decrease in birth order, there is a decrease in IQ by 1 point (Sulloway, 1997). Other authors also report a strong negative impact of higher birth order. Firstborn individuals also achieve better results when using Raven’s Progressive Matrices. Several other studies have found less pronounced (but still negative) effects of birth order. However, there are contradictory results reporting no relationship between birth order and IQ.

The assumption that firstborns are significantly more represented among gifted individuals led to the hypothesis that the more selective the school or university, the higher the proportion of firstborn graduates. Evidence from universities showed that the proportion of firstborns is usually indeed higher (Kuba et al., 2018).

Mental Health

Birth order’s impact on mental health outcomes is a subject of ongoing scientific inquiry. Studies have challenged earlier notions, indicating that birth order may primarily affect health in younger age groups or immediately after birth.

Regarding pathological phenomena like schizophrenia, findings are mixed. While some studies suggest a correlation between birth order and schizophrenia risk, others find no significant association. Social factors, such as family size and sibling dynamics, may play a role in this complex relationship.

Research indicates a heightened propensity for addictive behavior among middleborns, aligning with the observed trend of riskier behavior among younger children. Notably, laterborn adolescents demonstrate a higher frequency of hospitalizations due to alcohol and drug intoxications. Various mechanisms underlie the influence of birth order on addictive behavior. Older siblings may intentionally introduce younger siblings to such behaviors, while younger siblings may imitate or model deviant behavior. Additionally, older

siblings may facilitate access to addictive substances. Different parenting styles also contribute significantly, with parental investment declining as birth order increases, resulting in reduced time and stricter discipline, particularly in larger families.

Birth order's association with Child Abuse and Neglect (CAN) syndrome varies across studies, with some indicating a positive correlation with later birth order. Although some findings are contradictory, there is evidence suggesting a higher prevalence of CAN traits among firstborns, explained by the increased pressure and expectations placed on them by parents. Factors such as ethnicity, socioeconomic status or dysfunctionality of family may influence outcomes. Results from another study however indicate that in families with two children, the second or younger child is subjected to physical punishment more frequently than the older one (moreover, in families with only one child, the overall rate of physical and verbal punishment is higher).

Regarding depression, research findings are mixed. While some studies indicate an increased risk among firstborns and only children, others fail to establish significant correlations, highlighting the complexity of factors involved.

Furthermore, studies suggest a direct association between increasing birth order and suicidal behavior, with laterborn or specifically middleborn individuals often being the most vulnerable (see e.g., Kirkcaldy et al., 2006), as risk factors for the development of suicidal behavior include lack of parental attention, bullying, presence of mental disorders, low level of education high number of children in the family, low level of father's education, father's absence, and increasing birth order.

Similarly, the frequency of self-harm monotonically increases with increasing birth order with the middleborn usually at higher risk. The study explains this effect by riskier lifestyles among younger children, which is consistent with the more frequent hospitalizations of laterborn children due to trauma and mental illnesses.

The Influence on Partnership Life and Sexuality

There is evidence suggesting that birth order may influence marital and partnership dynamics and sexual-life-related traits, ranging from partner compatibility to homosexuality and sexual behavior.

The original work of Walter Toman introduces a comprehensive framework considering both birth order and gender, not as general constructs but as individualized factors shaping personal dynamics. Toman's emphasis on complementarity and the "duplication theorem" elucidates how individuals apply their lived experiences within familial contexts to subsequent partnerships, a theme explored further in the chapter on family constellation influences on marital and partnership life. Studies highlight the potential role of birth order in partner compatibility and relationship dynamics, suggesting that specific personality traits associated with birth order influence individuals' romantic interactions and complementarity with their partners. However, these theories and the associated research have received significant critical feedback due to often lacking evidence.

The influence of birth order on sexuality has been subject to empirical investigation, revealing distinct patterns in individuals' sexual behaviors and preferences with firstborn individuals tend to plan parenthood earlier, while laterborn individuals desire more diverse sexual experiences (Michalski & Shackelford, 2002).

Studies examining the correlation between birth order and risky sexual behavior consistently show a higher likelihood of such behavior among laterborn individuals compared to their older siblings. This inclination toward risk-taking diminishes with age, with age differences between siblings also playing a role, particularly concerning sexual activity during adolescence. Middleborn children, in particular, exhibit the highest risk propensity. Research suggests middleborn children exhibit lower propensity for infidelity compared to firstborns and lastborns (Salmon, 2003). Moreover, birth order has been associated with an increased risk of sexually

transmitted infections, particularly among middleborn individuals, attributed to their risk aversion and more liberal attitudes.

Furthermore, research has explored the connection between birth order and atypical sexual behaviors, such as paraphilias and sexual delinquency. A notable finding indicates a significant correlation between birth order and paraphilias, with laterborn children more likely to exhibit such behaviors. This association extends to sexual orientation, with homosexual and bisexual pedophiles tending to have later birth orders. Concurrently, paraphilias and sexual delinquency predominantly occur in individuals from large families, specifically they have a greater number of brothers than the general population. However, there are also contradictory results.

Limited evidence exists regarding the relationship between birth order and specific forms of sexual behavior, such as inclinations toward BDSM (bondage, discipline, dominance and submission, sadomasochism) practices. However, some sources suggest that correlations can be found even in these areas. For instance, there are reports of firstborn individuals showing significant and strong inclinations toward both dominant and submissive roles (Daňková et al., 2024).

The etiology of homosexuality remains complex, with many studies pointing to birth order as a potential factor. While findings are not definitive, research indicates a correlation between birth order and sexual orientation, particularly in males. Blanchard and Zucker (1994) noted higher birth orders among homosexual men, with older paternal age being a consistent factor. Other studies further supported this, showing increased number of older brothers among homosexual men. For thorough information regarding this topic, refer to the separate encyclopedic chapters on “Birth Order: Parental Manipulation Hypothesis” or “Birth Order: Sibling Manipulation Hypothesis.”

Conclusion

In conclusion, since the mid-twentieth century, the study of birth order theory has uncovered

substantial insights into the distinct personality differences among only children, firstborns, and laterborn individuals. While significant findings have emerged, many research failed to find significant differences or criticize the methodology of studies. Furthermore, the observed effect appears often weak.

A comprehensive approach is vital, considering various factors that may influence trait manifestation or result in role reversals among siblings. Key among these factors is the need for a rigorous methodology to address the prevalent issue of inconsistent methodologies, which have contributed to inconclusive results in past studies. Moreover, a clearer delineation of birth order distinctions is essential to enhance comparability across studies. Additionally, the influence of various factors such as the age gap between siblings, gender representation in siblingship, and the presence of stepsiblings cannot be overlooked, as they may significantly impact the observed effects.

Furthermore, while sibling constellations have implications for various aspects of life, including sexual orientation, partner choice, and interpersonal dynamics, it's essential to adjust expectations regarding the strength of the birth order effect in certain domains. Additionally, the dominance of evidence from Western civilizations (and, in recent years, from Asia) highlights the need for more research representation from regions like Central or Eastern Europe, Africa, South America, etc., to ensure broader generalizability and relevance of results and conclusions.

Finally, societal evolution suggests potential changes in the influence of birth order on certain characteristics or even polarity change of the effects, emphasizing the importance of updated research to reflect shifting parental approaches and environmental conditions.

Considering these factors, it is clear that additional research and meta-analyses are required to enhance our comprehension of sibling configurations and their effects within a changing social context. Future studies should include more varied participant groups, utilize consistent research methods, and examine a broader array of determinants to offer a more thorough exploration of this fascinating subject.

Cross-References

- Birth Order: Parental Manipulation Hypothesis
- Birth Order: Sibling Manipulation Hypothesis
- Birth Order: Sociosexuality
- Fraternal Birth Order Effect (FBOE)

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12.2 The effect of birth order on the probability of university enrolment

Intelligence 70 (2018) 61–72



Contents lists available at ScienceDirect

Intelligence

journal homepage: www.elsevier.com/locate/intell



The effect of birth order on the probability of university enrolment

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ARTICLE INFO

Keywords:

Firstborn
Family constellation
Birth-order effect
Schooling

ABSTRACT

The birth order influences various psychological characteristics ranging from personality traits to sexual behaviour. Yet while many studies suggest that firstborn children are likely to achieve a higher educational level than their siblings, other studies reported no such effect, which may be due to various modulating factors such as sex and family size. In the present study, we have therefore tested the effect of birth order on the probability of university enrolment while taking these possibly modulating factors into consideration.

We collected birth-order data from two cohorts of biology students (Study 1: students from 1990 to 1995, $N = 271$; Study 2: students from 2011 to 2017, $N = 2049$) at the Charles University, Prague, Czech Republic. The proportion of firstborns in both cohorts was compared to population data obtained from the Czech Statistical Office and controlled for sex and family size.

In both groups of students, we found a significantly higher proportion of firstborns than in the general population as represented by the official population data. In Study 1, based on general population data we expected firstborns to form 44.8% of the cohort. The actual proportion was found to be 63.1%. In Study 2, the expected proportion of firstborns was 48.1%, while the proportion actually found was 64.0%. We have also observed a considerable influence of family size on the size of the birth-order effect. In particular, the size of the birth-order effect on educational achievements of the firstborn children positively correlated with family size. Comparison between the two cohorts had also shown that over the last two decades, overrepresentation of firstborns had significantly declined, which probably reflects a decrease in the stringency of entrance examinations to the Faculty of Science over the past two decades.

Our results support previous findings regarding the advantage of firstborns in educational achievements and show that the birth-order effect is not just an epiphenomenon of family size. By comparing the two cohorts 20 years apart, this study also offers a unique opportunity to evaluate the birth-order effect in relation to sociodemographic changes over a certain time period. In particular, our study demonstrates that the birth-order effect is robust enough to withstand the dramatic changes in university attendance in present-day Czech Republic.

1. Introduction

1.1. The influence of birth order on intellectual outcomes

A family in which a person grows up significantly influences various psychological characteristics, many of which then remain relatively stable throughout adult life. Nevertheless, experience of the individual offspring often varies, primarily due to differences in parental treatment and relationships with other siblings. It has been shown that such family-related experiences are systematically linked to the siblings' birth-order.

Scholars usually differentiate between ordinal and functional birth order (Carette, Anseel, & Van Yperen, 2011; Eckstein et al., 2010). Ordinal ('biological') birth order is the actual sequence in which children were born to a particular mother. Functional ('psychological') birth order, on the other hand, takes into account specific relations between a child and its siblings. For instance, if the oldest child lives in another household, the secondborn child becomes functionally firstborn. In most cases, however, the ordinal birth order matches the functional one. Due to lack of detailed information about family relationships, ordinal birth order is frequently used as a proxy for the functional birth order. Furthermore, it is often assumed that the main

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<https://doi.org/10.1016/j.intell.2018.08.003>

Received 13 February 2018; Received in revised form 16 July 2018; Accepted 24 August 2018
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difference in family-related experiences is between the firstborn child and laterborn children, meaning that secondborn and thirdborn children etc. are all merged into a category of laterborn children, although previous research also pointed out significant differences of youngest or middleborn children (e.g., C. Salmon, 2003; C. A. Salmon & Daly, 1998). And last but not least, single children (the only children in a family) are frequently subsumed into the firstborn category.

Effects of the birth order on various dimensions of human personality and behaviour have been extensively studied. Birth order influences many aspects of human personality, but also behaviour and performance (for general review see e.g., Plomin & Daniels, 2011). A number of early studies found that the birth order has an impact on various intellect-related dimensions (e.g., Adams, 1972; Altus, 1966; Schachter, 1963; Zajonc & Markus, 1975; Zajonc, Markus, & Markus, 1979). These studies had shown that firstborns tend to have higher intellectual abilities than laterborn individuals. For instance, they achieve higher scores in tests that require divergent thinking (Runco & Bahleda, 1987) and they perform better in abstract reasoning as measured by the Raven Progressive Matrices (Belmont & Marolla, 1973) as well as in other tests that measure intellectual performance or intelligence (Adams, 1972; Bonesronning & Massih, 2011; Chittenden, Foan, Zweil, & Smith, 1968; Karwath, Relikowski, & Schmitt, 2014; Zajonc, 1976; Zajonc et al., 1979). Several studies have also focused exclusively on a possible relationship between the birth order and the IQ. Their results, however, are rather mixed. While most such studies found a higher IQ in the firstborns (Black, Devereux, & Salvanes, 2011; Glass, Neulinge, & Brim, 1974; Kanazawa, 2012; Nuttall et al., 1976; Rohrer, Egloff, & Schmukle, 2015; Schachter, 1963), the actual effect seems to be relatively small (1–3 IQ points per one birth-order level) (Black et al., 2011; Damian & Roberts, 2015a), and several other studies failed to find any birth-order effect on the IQ (Holmgren, Molander, & Nilsson, 2003; Retherford & Sewell, 1991; Rodgers, Cleveland, van den Oord, & Rowe, 2000).

A similar pattern of birth-order effect has also been observed in educational achievements. For instance, it has been repeatedly reported that firstborns are overrepresented in elite schools and universities (Bayer, 1966; Bernstein & Grambs, 1976; Farley, Smart, & Brittain, 1976; Powell & Steelman, 1993). This effect seems to be stronger in firstborns who have a larger number of siblings (Altus, 1966). On average, firstborn children achieve higher education more frequently, spend more years in school (Behrman & Taubman, 1986; Black, Devereux, & Salvanes, 2005; Booth & Kee, 2009; de Haan, 2010; Fergusson, Horwood, & Boden, 2006; Harkonen, 2014; Isungset, Lillehagen, & Ugreninov, 2017; Kantarevic & Mechoulam, 2006; Karwath et al., 2014; Kristensen & Bjerkedal, 2010; Young-Joo, 2009), tend to have better grades (Adams, 1972; Chittenden et al., 1968; Schulze & Preisendorfer, 2013), are overrepresented among prominent scientists and scholars (Schachter, 1963), and are more likely to apply to and graduate from medicine and engineering programs (Barclay, Hallsten, & Myrskylä, 2017). It has also been shown that firstborns report higher educational aspirations (Bu, 2016), which may at least in part explain their higher educational achievements. It should be noted, however, that a number of other studies did not find any influence of the birth order on the form and level of achieved education (Cho, 2011; Hauser & Sewell, 1985; Hayes & Bronzaft, 1979; Kuo & Hauser, 1996; Marteleto & de Souza, 2013).

1.2. The role of sex and family size

The effects of birth order may be modulated by various factors, including intensity and frequency of real contacts between the siblings and parents, their age, parenting experience, socioeconomic status, and culture. With respect to the effect of birth order on educational achievement, it is the sex and number of siblings (family size and

composition) that appear to be of key importance. Previous studies have shown that the effect of birth order seems to differ in relation to sex (Brim Jr., 1958; Daniels, 1986; Sulloway, 1997), whereby it is stronger in women (Black et al., 2005; Kristensen & Bjerkedal, 2010), and that the birth-order effect in women – but not in men – is influenced by the sex of their siblings (Dayioglu, Kirdar, & Tansel, 2009). Specifically, the strongest firstborn advantage was found in female same-sex sibships (Brim Jr., 1958; Hornbostel & McCall, 1980), which might be due to lower rivalry between opposite-sex siblings (Conley, 2000; Kuo & Hauser, 1996; Minnett, Vandell, & Santrock, 1983).

It has been reported that a higher number of siblings negatively corresponds with mental abilities (Kuo & Hauser, 1997; Page & Grandon, 1979). A similar effect was also observed in IQ testing (Bjerkedal, Kristensen, Skjeret, & Brevik, 2007; Holmgren et al., 2003; Rodgers et al., 2000) and a negative influence of family size on educational achievement has been confirmed in numerous other studies (Black et al., 2005; Booth & Kee, 2009; Cáceres-Delpiano, 2006; Conley & Glauber, 2006; Hauser & Sewell, 1985; Park & Chung, 2012). Many other studies, however, found no effect of the family size on children's educational achievements (Bonesronning & Massih, 2011; Dayioglu et al., 2009; de Haan, 2010; Kantarevic & Mechoulam, 2006). It is thus possible that at least some of the abovementioned inconsistencies might be due to the modulating effects of sex and family size which were not controlled for in most previous studies.

1.3. Aims of the current study

The main aim of our study was to investigate a possible influence of birth order on the probability of university enrolment while taking into account some modulating factors such as family size and sex of children. Vast majority of existing studies in this area is based on samples from the U.S. and West European countries. We have therefore started by testing whether the previously reported overrepresentation of firstborns among university students can be extended into Central European settings. For this purpose, we investigated the proportion of various types of birth order among the enrolled students in a selective university programme. We used a set of data gained from biology students at the Faculty of Science of Charles University in Prague, which is considered the most prestigious university in the Czech Republic and enrolment to the undergraduate programme in biology is highly selective (even now, only about 30–40% of applicants are accepted). In line with previous research, we had expected that the birth-order effect would be stronger in larger sibships.

Secondly, and most importantly, our aim was to evaluate possible changes to the predicted birth-order effect over the past two decades. Over the past almost three decades, the Czech population had experienced significant sociodemographic changes, which might have influenced manifestation of the birth-order effect. On the one hand, natality between the two sampling periods had significantly dropped (Sobotka, Štátná, Zeman, Hamplova, & Kantorova, 2008). We expected that this would lead to an increase in the absolute representation of firstborns in Study 2. On the other hand, profound changes in the Czech, and generally European, educational system (due to the 'Bologna Process' which was launched in 1999) resulted in a rapid increase in the number of university students (and consequently also in a lowering of the threshold for passing the entrance exams for attractive subjects including biology). The gross enrolment ratio shows that in 1990, only about 16% of Czech population aged 18–23 were university students, whereas in 2010 the proportion of university students within this age group reached 68% (source: UNESCO; <http://data.uis.unesco.org/>). Based on the results of previous studies, we had therefore expected that in Study 2, overrepresentation of firstborns would be less prominent than in Study 1.

2. Material and methods

2.1. Participants

We collected data from two cohorts of biology students at the Faculty of Science, Charles University, Prague, the Czech Republic. Study 1 was performed in 1990–1995 and consisted of 271 individuals (49% women; mean age of women = 20.29, SD = 1.84; mean age of men = 20.95, SD = 2.56). Study 2 was performed in 2011–2017 and included 2049 individuals (73.4% women; mean age of women = 20.88, SD = 2.03; mean age of men = 21.32, SD = 2.41). A total of 33 respondents who were born from multiple pregnancies or have a sibling born in the same year were excluded from all subsequent analyses because based on the available data, it was not possible to determine their birth order. The final sample thus consisted of 2016 individuals (73.4% women). We have also excluded all data about stepsiblings (in total $N = 722$) in order to match the second sample with the data from the Study 1.

All participants were informed about the aims of the study, that the study is anonymous, all obtained data would be used exclusively for research purposes, and that their participation is voluntary and they have the right to terminate it at any time. The project, including the use of anonymised data from the previous study, was approved by the Institutional Review Board of the Faculty of Science, Charles University – No. 2015/30.

2.2. General population data

The observed birth-order values were compared with reference values for the general population in the Czech Republic. Data about family size for the relevant years were obtained from the Czech Statistical Office (https://www.czso.cz/csu/czso/casova_rada_demografie).

Respondents from Study 1 were born in 1963–1977, respondents from Study 2 in 1975–1999. Data from the Czech Statistical Office indicate that proportions of firstborn children during these years fluctuated by approximately 5%. In order to compute the expected proportion of firstborns in the general population, we have thus employed weighted averages based on the number of respondents born in a particular year. Data about the proportion of the firstborn males and females in the general population were not available for the period of 1975–1999, which is why a separate analysis could not be performed. Similarly, data for the proportion of single children in the population were not available from the Czech Statistical Office, because it was expected that women could bear more children in subsequent years. This precluded us from running the analysis for firstborns without the single children.

2.3. Questionnaires

Participants were asked to fill in questionnaires which contained family-related questions including detailed information about the respondent's birth order.

In Study 1, we asked the participants about their birth order in a binary form, i.e., whether they are firstborn or laterborn. We have also asked about the number and sex of their full siblings (i.e., those who have the same biological parents).

In Study 2, we collected more detailed data including the year of birth of respondents' siblings. In this way, we collected information about the particular position which respondents occupy among their siblings (i.e., firstborn, secondborn, thirdborn, etc.). Study 2 was part of a larger project which focused primarily on testing various hypothesis from evolutionary psychology and parasitology. In the present study, we used only information about the respondents' and their siblings' sex and birth order.

2.4. Statistical analysis

For statistical testing, we used IBM SPSS Statistics 21.0 and statistical package 'R'. Deviation of the number of firstborns in our sample from distribution of firstborns in the general population was tested by Pearson's chi-squared test and the effect sizes were expressed in form of Cramer's V (in text used as " V ").

First, we analysed both samples by the birth order and sex of respondents. In Study 1, we distinguished 3 separate categories of birth order: single children, firstborns, and the laterborn children. In Study 2, we collected more detailed data about the birth order and were therefore able to distinguish the following categories: single children, firstborn children, secondborn children, and respondents born third or later in the sequence of siblings. Moreover, since results may be influenced by the family size, we have subsequently performed analyses separately for various family sizes (e.g., two-child families and birth-order proportions).

3. Results

3.1. Birth-order distribution

3.1.1. Study 1

In total, 12.9% of the participants were single children and 50.2% were firstborns (who had at least 1 younger sibling). The joint category of the firstborns including single children represented 63.1% of the sample (64.5% for men, 61.7% for women), whereby difference between the sexes was not significant ($\chi^2 = 0.23$, $df = 1$, $p = 0.63$, $V = 0.03$).

The proportion of firstborns, including single children, in the general population was 44.8%. In our sample we found 63.1% of firstborns, which constitutes a statistically significant difference ($\chi^2 = 37.70$, $df = 1$, $p < 0.001$, $V = 2.23$). A similar pattern was observed in the analyses of men and women separately (i.e., the difference is statistically significant in both sexes), although the effect size (Cramer's V) was somewhat higher in male participants (1.73 versus 1.41). Overrepresentation of the firstborns is visualised in Fig. 1.

An overview of all observed and expected values for all types of birth orders as well as testing of overrepresentation in the sample in Study 2 is presented in the Appendix in Table A1.

3.1.2. Study 2

In total, 29.2% of the participants were single children and 34.8% were firstborns (with younger siblings). The joint category of firstborns including the single children represented 64.0% of the sample (67.1% men, 62.8% women), whereby difference between the sexes was not significant ($\chi^2 = 3.11$, $df = 1$, $p = 0.08$, $V = 0.04$).

As in Study 1, we compared the proportion of the firstborns with data about the general population. The proportion of firstborns (including single children) in the general population was 48.1%, while the observed representation in Study 2 was 64.0% (results are presented in Fig. 2). Such an overrepresentation of the firstborns is highly statistically significant ($\chi^2 = 203.86$, $df = 1$, $p < 0.001$, $V = 4.54$). Similar results were found when the two sexes were analysed separately, and although the proportion is slightly higher among men than among women, the effect sizes are very similar ($V = 3.35$ in men and $V = 3.35$ in women).

In Study 2, we have also performed a comparison between the individual categories of laterborn children (the secondborn and the group of children higher up the birth-order). In general, we found a lower proportion of the laterborn children than expected (the χ^2 test is significant in all cases).

Furthermore, we observed that underrepresentation seemed to positively correlate with higher birth-order sequence (i.e., secondborn

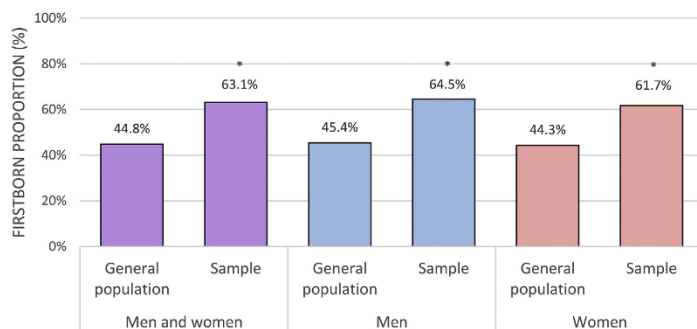


Fig. 1. Participants 1990–1995: Comparison of proportion of firstborns in the sample and in general population by participants' gender. Note: Asterisks denote statistically significant overrepresentation in comparison to data pertaining to the general population. (probably a 1.5 or 2-column fitting image; preference for colour – online only)

children were less underrepresented than thirdborn children etc.). The proportion of secondborn persons in the general population was 36.9%, while in our sample they constituted only 30.5% of the sample ($\chi^2 = 35.95$, $df = 1$, $p < 0.001$, $V = 0.80$). For men it was 26.7%, for women 31.9%, whereby difference between the sexes was significant ($\chi^2 = 4.93$, $df = 1$, $p < 0.03$, $V = 0.05$). And finally, the proportion of the third- and later born children in general population was 15.0%, while in our sample they were represented by 5.6% of the sample ($\chi^2 = 141.04$, $df = 1$, $p < 0.001$, $V = 3.14$). For men it was 6.2%, for women 5.3%, whereby difference between the sexes was not significant ($\chi^2 = 1.01$, $df = 1$, $p = 0.32$, $V = 0.02$).

An overview of all the observed and expected values for all types of birth orders and the testing of overrepresentations for the sample in Study 1 is found in Appendix in Table A2.

3.1.3. A comparison between the samples

The proportion of firstborns did not significantly vary between the two samples (63.1% in Study 1 vs. 64.0% in Study 2: $\chi^2 = 0.08$, $df = 1$, $p = 0.77$, $V = 0.01$). On the other hand, one ought to take into account a variation in the proportion of the firstborns (including single children) in the general population. The expected proportion of firstborns was 44.8% in Study 1 and 48.1% in Study 2. In Study 1, firstborns were overrepresented by 18.3%, while in Study 2 by 15.9%. This represents a 3.3% decrease in the overrepresentation of firstborns among biology students ($\chi^2 = 4.07$, $df = 1$, $p = 0.04$, $V = 0.09$).

We have also noticed considerable changes in the balance of sexes in our samples of biology students. While in Study 1 (1990–1995), males represented 51% of the students, in Study 2 (2011–2017) they accounted for just 26.6% of the sample. We have therefore performed also a separate comparison of proportions of firstborn (including single children) in men and women. These differences were not statistically

significant. In men, firstborns (including single children) accounted for 64.5% individuals in Study 1 and for 67.1% of individuals in Study 2 ($\chi^2 = 0.34$, $df = 1$, $p = 0.56$, and $V = 0.02$). In women, the proportion of firstborns was 61.7% in Study 1 versus 62.8% in Study 2 ($\chi^2 = 0.07$, $df = 1$, $p = 0.78$, and $V = 0.01$).

3.2. Birth-order proportions by family size

3.2.1. Study 1

The average number of children in the families of study participants was 2.13 (i.e., they had on average 1.13 siblings). Overall, 12.9% of the participants were single children: 10.9% men and 15% women, whereby the difference between the sexes was not statistically significant ($\chi^2 = 1.05$, $df = 1$, $p = 0.31$, $V = 0.06$).

In total, 66.1% of the participants were from the two-child families. If no birth-order effect were present, the expected proportion of the first- versus secondborn children within this subgroup would be equal. We did, however, find a significant overrepresentation of the firstborns. They formed 60.3% of the group ($\chi^2 = 7.65$, $df = 1$, $p = 0.01$, $V = 0.57$), whereby male firstborns represented 64.1% of males in this group and female firstborns constituted 56.3% of females in this group (the overrepresentation is statistically significant for both sexes).

In total, 21.0% of participants were from families with 3 and more children. In absence of a birth-order effect, the expected proportion of firstborns within this group would be 33%. Once again, however, we found a significant overrepresentation of firstborns. In total, they formed 49.1% ($\chi^2 = 6.39$, $df = 1$, $p = 0.01$, $V = 0.85$), whereby for men the proportion was 48.4% and for women 50.0%. Once the sexes were tested separately, however, differences between the firstborn representation were not significant. Overrepresentation of firstborns is visualised in Fig. 3.

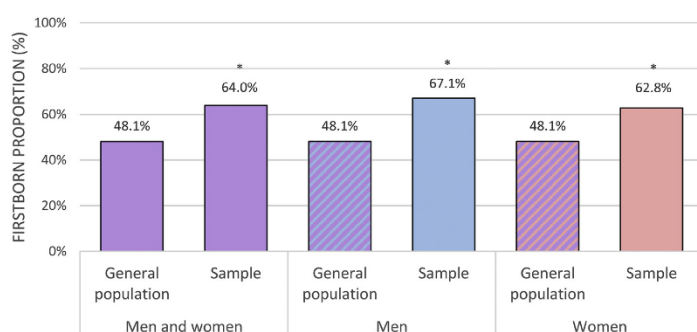


Fig. 2. Participants 2011–2017: Comparison between the proportion of firstborns in the sample and in the general population by participants' gender. Note: Asterisks denote a statistically significant overrepresentation in comparison to data pertaining to the general population. (probably a 1.5 or 2-column fitting image; preference for colour – online only)

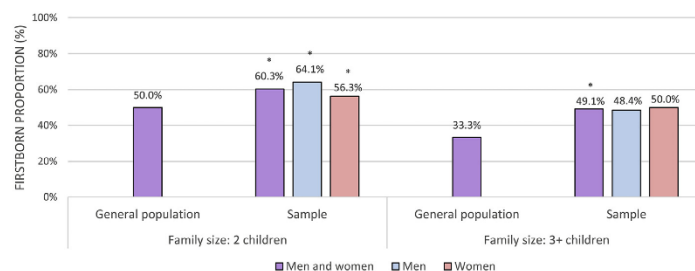


Fig. 3. Participants 1990–1995: Proportion of firstborns according to family size and gender. Note: Asterisks denote a statistically significant overrepresentation in comparison to general population data. (probably a 2-column fitting image; preference for colour – online only)

Complete data for all the tested family sizes and the testing of overrepresentation are presented in the Appendix in Table A3.

3.2.2. Study 2

The average number of children in the participants' families was 1.93 (i.e., they had on average 0.93 siblings).

Overall, 29.1% of the participants were single children (29.3% for men and 29.0% for women), whereby the difference between the sexes was not significant ($\chi^2 = 0.02$, $df = 1$, p -value = 0.90, $V = 0.00$).

In total, 53.7% of the participants were from the two-child families, which means that in absence of a birth-order effect, the expected representation of first- and secondborn children within this subgroup would be equal. We found a statistically significant overrepresentation of firstborns only in males (59.4% of firstborns). In females, the proportion of firstborns was 49.8%, and for both sexes taken together, the proportion was 52.3% ($\chi^2 = 10.00$, $df = 1$, p -value < 0.001, $V = 0.60$).

In total, 17.2% of the participants were from families with 3 and more children, i.e., families where in absence of the birth-order effect the expected representation of the firstborns would be 33% and less. In total, we found that firstborns formed 39.3% of this subgroup, which significantly differed from the expected frequency ($\chi^2 = 5.55$, $df = 1$, p -value = 0.01, $V = 0.3$). Firstborn males in this subgroup accounted for 36.1%, females for 40.6% of the sample. In contrast to analysis of two-child families, overrepresentation of firstborns was statistically significant only in women. Overrepresentation of firstborns is visualised in Fig. 4.

Complete data for all types of family sizes as well as tests for overrepresentation are presented in the Appendix in Table A4.

3.2.3. A comparison between the samples

The average number of children in respondents' families in Study 1 was slightly higher than in Study 2 (2.13 vs. 1.96 child per family). We also found considerable differences in the frequency of particular family

sizes (the following results are for both sexes jointly). The proportion of single children increased significantly, from 12.9% to 29.2%. Correspondingly, the proportion of firstborns (i.e. individuals with younger siblings) significantly decreased, from 50.2% to 34.8%. The proportion of two-child families declined by 12.4% (from 66.1% to 53.7%), and this was accompanied by a significant reduction – from 60.3% to 52.3% – in the representation of firstborns from this subgroup in our sample. The proportion of families with three and more children decreased from 21.0% to 17.2%, and overrepresentation of firstborns in our sample decreased from 49.1% to 39.3% (in this case, however, the difference is not significant).

A complete comparison for both sexes jointly and separately as well as testing of overrepresentation is presented in Table 1.

4. Discussion

As expected, in both studies we found that representation of firstborns among university students of biology is significantly higher than their proportion in the general population. Moreover, firstborns were also overrepresented when analyses were carried out separately for different family sizes. A comparison between the samples in Study 1 and 2 had shown that in the more recent cohort (in Study 2), firstborns were overrepresented somewhat less.

4.1. Overrepresentation of firstborns in our samples

Based on data about the general population, the expected proportion of firstborns including single children was 44.8% and 48.1% in Study 1 and 2, respectively. What we found, however, was that firstborns constituted 63.1% and 64.0% of university students. The observed overrepresentation of firstborns in both cohorts of biology students corresponds to findings from other countries (Bayer, 1966; Bernstein & Grambs, 1976; Farley et al., 1976; Harkonen, 2014; Powell & Steelman, 1993). Schachter (1963), for instance, reported that the

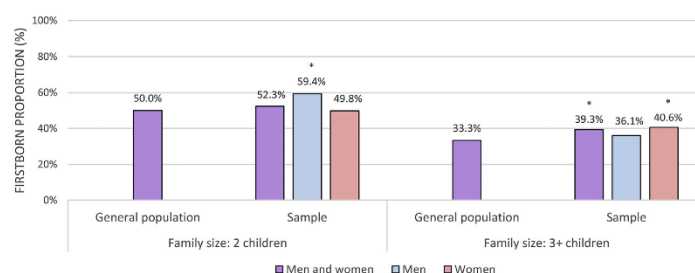


Fig. 4. Participants 2011–2017: proportion of firstborns according to family size and gender. Note: Asterisks denote a statistically significant overrepresentation in comparison to general population data. (probably a 2-column fitting image; preference for colour – online only)

Table 1
Comparison between Sample 1 and Sample 2 by birth order and family size.

Family size	Birth order	Sample 1 (1990–1995)		Sample 2 (2011–2017)		χ^2	p-value	sV
		Observed	Observed	Observed	Observed			
(N of children)		(N)	(%)	(N)	(%)			
Men and women								
All	Single children	35	12.9	588	29.2	31.83	0.00	0.12
	Others	236	87.1	1428	70.8			
	Firstborns 1	136	50.2	701	34.8	24.33	0.00	0.10
	Others	135	49.8	1313	65.2			
	Firstborns 2	171	63.1	1290	64.0	0.08	0.77	0.01
	Others	100	36.9	726	36.0			
2	1.0	108	60.3	565.0	52.3	3.97	0.05	0.06
	2+	71	39.7	515.0	47.7			
3+	1.0	28	49.1	136.0	39.3	1.95	0.16	0.07
	2+	29	50.9	210.0	60.7			
Men								
All	Single children	15	10.9	157	29.3	19.68	0.00	0.17
	Others	123	89.1	378	70.7			
	Firstborns 1	74	53.6	202.0	37.8	11.42	0.00	0.13
	Others	64	46.4	333.0	62.2			
	Firstborns 2	89	64.5	359	67.1	0.34	0.56	0.02
	Others	49	35.5	176	32.9			
2	1.0	59	64.1	167.0	59.4	0.64	0.42	0.04
	2+	33	35.9	114.0	40.6			
3+	1.0	15	48.4	35.0	36.1	1.49	0.22	0.11
	2+	16	51.6	62.0	63.9			
Women								
All	Single children	20	15.0	429	29.0	11.90	0.00	0.09
	Others	113	85.0	1048	71.0			
	Firstborns 1	62	46.6	499.0	33.8	8.85	0.00	0.07
	Others	71	53.4	978.0	66.2			
	Firstborns 2	82	61.7	928	62.8	0.07	0.79	0.01
	Others	51	38.3	549	37.2			
2	1.0	49	56.3	398.0	49.8	1.33	0.25	0.04
	2+	38	43.7	401.0	50.2			
3+	1.0	13	50.0	101.0	40.6	0.86	0.35	0.06
	2+	13	50.0	148.0	59.4			

The χ^2 test indicates the difference between Sample 1 and Sample 2.

Firstborns 1 = firstborns excluding single children; Firstborns 2 = firstborns including single children.

The number of degrees of freedom (df) is for all test equal to 1.

Significant values are marked bold and 0.00 denote $p < 0.001$.

proportion of firstborns was 12% higher than expected in college and 21% higher than expected among graduate school students (regardless of the family size). Comparison between the sexes shows that in both of our samples, the firstborn effect was stronger in men than in women (Study 1: 64.5% of men, and 61.7% of women; Study 2: 67.2% of men, and 62.8% of women). On the other hand, several previous studies had reported a more pronounced birth order effect on educational achievement in women (Black et al., 2005; Kristensen & Bjerkedal, 2010). At the moment, we have no reasonable explanation that would account for the discrepancy between our results and those that had previously been reported, which is also why future studies should confirm the robustness of this phenomenon.

4.2. The effect of family size

It has been argued (Powell & Steelman, 1993; Rodgers et al., 2000) that overrepresentation of firstborns at universities is due to the fact that education-oriented parents (or wealthier families in general) tend to have less children. To test the possibility that the birth-order effect may be an epiphenomenon of family size, we have also performed analyses separately for various family sizes. In general, we concluded that the effect of birth order on educational achievement is noticeable

in both studies irrespective of family size. Our data also suggests, however, that the effect is stronger in larger families. For instance, in Study 1 we found in our sample 60.3% of firstborns from two-child families (the expected proportion was 50%; effect size – Cramer's $V = 0.57$), but in families with 3 and more children, the observed proportion of firstborns was 49.1% (the expected proportion was $< 33\%$; $V = 0.85$). In Study 2, analogous results were 52.3% ($V = 0.07$) of firstborns from two-child families and 39.4% ($V = 0.30$) of firstborns from families with 3 and more children. Especially in Study 1, our results thus show a similar trend as in the Altus study (Altus, 1966), which found that among university students, the proportion of firstborns from two-child families was 63%, 50% from three-child families, and 50.5% from four-child families.

Some studies, however, indicate that if the family size is controlled for, the birth-order effect is no longer significant (e. g., Kanazawa, 2012). Similarly, Cho (2011) found a birth-order effect on educational achievement only in larger families. A possible explanation of this pattern might perhaps be found in a study by Hester, Osborne, and Nguyen (1992), which had shown that children from larger families had higher expectations of good grades. They hypothesised that in larger families, there are more opportunities for mutual comparisons among siblings and that may lead to a stronger birth-order effect.

Irrespective of the birth order, numerous studies report that a higher number of siblings has a negative effect on various factors which are directly and indirectly related to educational achievements (Black et al., 2005; Booth & Kee, 2009; Kuo & Hauser, 1997; Page & Grandon, 1979; Park & Chung, 2012), such as intelligence (Bjerkedal et al., 2007; Holmgren et al., 2003; Rodgers et al., 2000). Similar results were also found in the Czech Republic, where Hirschova and Kreidl (Hirschova & Kreidl, 2012) in their study found a negative effect of larger family size on mathematical skills and knowledge of natural sciences.

4.3. A comparison between the two cohorts

Over the past three decades, the demography of university students in the Czech Republic had undergone various important changes. A comparison between the two cohorts allowed us to test the dynamics of the birth-order effect. We expected a decrease in the overrepresentation of firstborns due to changes in the Czech (and European) educational system which took place since 1999 (in connection with the 'Bologna Process'). As mentioned in the Introduction section, the gross enrolment ratio shows an increase of university students from about 16% of Czech population aged 18–23 in 1990 to 68% in 2010 (source: UNESCO; <http://data.uis.unesco.org/>).

Such a rapid increase in student numbers was necessarily accompanied by a relaxation of demands on the applicants. While in the years when data were being collected for Study 1 (1990–1995), only about 70 students enrolled in the biology programme each year, during the period investigated by Study 2 (2011–2017), the biology programme annually accepted approximately 350 students. We have therefore expected that in Study 2, overrepresentation of firstborns would be less prominent. What we found is that both cohorts show a similar proportion of firstborns (63% and 64%, including single children), but a direct comparison between these values could be misleading since due to a smaller number of children per family, the proportion of firstborns in the population had in the meantime increased by 3.3% (44.8% in Study 1 vs. 48.1% in Study 2). Once this is taken into account, we see that in Study 2, overrepresentation of the firstborns among biology students is significantly smaller than in Study 1. Our results therefore confirm our initial hypothesis regarding a decrease of firstborn children in the student population over time.

Also in line with our expectation is a shift in the category of single children which we had observed. In Study 1, single children accounted for 12.9% of the cohort, whereas in Study 2, their number increased to 27.1%. Proportion of single children in the population has been rising due to a lower natality in general (in our samples, the average number of children per family decreased from 2.13 to 1.96). The proportion of two-child families declined from 66.1% to 53.7% (the proportion of firstborns from such families correspondingly went down from 60.3% to 52.3%), but – somewhat surprisingly – the number of students from families with three and more children dropped only from 21.0% to 17.2% (and the proportion of firstborns from such families decreased from 49.1% to 39.3%). It seems that the demographic shift had affected families with two children the most: the proportion of firstborns from such families declined substantially and it seems that such families may have to some extent 'transformed' into single-child families encountered in Study 2. In other words, the proportion of firstborns with younger siblings decreased between Study 1 and Study 2 from 50.2% to 34.9%.

This shift may well be due to significant improvements in the standard of living in the Czech Republic, which was connected with the profound socioeconomic changes the country had experienced in the aftermath of the fall of the Communist regime in 1989 and a subsequent transition to market economy. It has been repeatedly observed abroad that wealthier families tend to have less children (Perusse, 1993;

Vining, 1986). Single children born to such families can draw on more resources, which in turn leads to better educational achievements. Some existing studies and models suggest, however, that when it comes to intellectual achievements, firstborn children with younger siblings actually have an advantage over single children and tend to achieve higher education more frequently (e. g., Kristensen & Bjerkedal, 2010). This is often explained by the basic principles of Zajonc's 'confluence model', which shows that firstborn children with younger siblings profit from a 'teaching effect' (Zajonc, 1976; Zajonc & Bargh, 1980) in the sense that the older sibling is often in a position of a teacher with respect to a younger sibling or siblings. This process leads to repetition and better comprehension of the learned subject matter, resulting in the older sibling's eventual better educational outcome.

4.4. Possible mechanisms of the birth-order effect on educational achievements

Despite intensive research of various birth-order effects in recent years, concrete mechanisms responsible for these phenomena are yet to be convincingly argued for and described.

In the context of the effect of birth order on educational achievements, two theoretical models are particularly relevant: i) The confluence model, which explains this effect by reference to the intellectual environment in which a child is being reared (Hester et al., 1992; E. V. Nuttall & Nuttall, 1979; Zajonc et al., 1979), and ii) resource dilution model, which emphasises the dilution of the resources among children and includes not only financial means, but also for instance time which parents spend with each child (Blake, 1985; Downey, 1995). According to both models, firstborns (including single children) have an advantage over laterborn children. Several studies have confirmed that firstborns receive from their parents a higher proportion of available resources (including financial ones) than their younger siblings (Bradley, 1982; de Haan, 2010). It should be noted, however, that neither of the two models briefly outlined here can be seen as a generally accepted explanation of the birth-order effect.

Differences in educational outcomes are often attributed to various personality traits related to performance in the educational process. Educational achievement is a complex issue, affected by various sociological determinants, such as socioeconomic status, but also psychological factors, such as personality and intellectual potential. And since the birth order seems to have an effect on various personality dimensions, it is possible that overrepresentation of firstborns among university students is due to characteristic differences in personality traits that provide an advantage in educational processes (Altus, 1966; Belmont & Marolla, 1973; Palmer, 1966). Such personality traits include higher scores in orientation to adults' attitudes (McArthur, 1956), tendency to identify with parents' expectations (Belmont & Marolla, 1973), higher obedience, self-control and discipline (Palmer, 1966), a more serious and methodical attitude to life (Price, 1969), success-orientation (Lampi & Nordblom, 2010), responsibility (Adams, 1972; Steelman & Powell, 1985), and need of external validation and appreciation (Hornbostel & McCall, 1980). In all these characteristics, firstborns score higher than laterborn individuals and it could lead to their higher educational achievements. On the other hand, several recent studies report no effect of birth order on personality, which indicates that the link between educational achievement and birth order may be due to other mechanisms (Damian & Roberts, 2015a, 2015b; Rohrer et al., 2015).

Overrepresentation of firstborns among university students could also be due to their higher intellectual or cognitive abilities. Firstborn children tend to be better problem-solvers (Carette et al., 2011), they perform better in tests oriented on quantitative aptitude (Altus, 1966), in exercises that require planning, mental flexibility, and working

memory (Holmgren et al., 2003). As mentioned above, a number of studies had directly tested a possible relationship between the birth order and the IQ, and while most reported a higher IQ in the firstborns (Black et al., 2011; Glass et al., 1974; Kanazawa, 2012; Nuttall et al., 1976; Rohrer et al., 2015; Schachter, 1963), the actual effect size is usually relatively small (1–3 IQ points per one birth order level). Some studies, on the other hand, did not find any such effect (Holmgren et al., 2003; Retherford & Sewell, 1991; Rodgers et al., 2000).

Regarding a possible relation between birth order and intellectual abilities, some researchers point out that differences in the IQ in relation to birth order may be due to a random distribution of the IQ within the population and possible birth-order effect in this area should be studied within individual families rather than across families (Retherford & Sewell, 1991; Rodgers et al., 2000). Other studies, however, seem to show that the effect is present even when an 'across families' design is used (Black et al., 2011). For more information about various methodological issues in birth-order research, see other works (e. g., Black et al., 2005; Downey, 1995; Hester et al., 1992; Rodgers, 2001; Rodgers, Cleveland, van den Oord, & Rowe, 2001; Travis & Kohli, 1995).

Chittenden et al. (1968) suggested an alternative explanation for the overrepresentation of firstborns among university students. His account is based on a simple observation that majority of existing research has been based on recruiting volunteers and since firstborns tend to display a higher level of conscientiousness, they may also volunteer to participate in research more frequently. In our studies, the questionnaires were administered during an examination and most students completed the surveys (in average about 98%). It is thus unlikely that attendance bias can explain the pattern observed here.

Based on our data, we cannot tell apart all the factors which contributed to the observed effect. Moreover, differences in personality characteristics and in intellectual abilities are not mutually exclusive. They may in fact work in concert. Their relative contribution is thus an issue that could be taken up by future studies.

4.5. Limitations

It has been argued that the birth-order effect may be an epiphenomenon of some other factor, such as family size or parental age (so-called 'admixture hypothesis') (de Haan, 2010; Guo & VanWey, 1999; Kristensen & Bjerkedal, 2007; Page & Grandon, 1979; Rodgers, 2001; Rodgers et al., 2000). Our study had tested for the possible effect of family size, but data regarding parental age were not available and it is a variable that could be further investigated in future studies.

Moreover, while single children are frequently subsumed into the firstborn category, there is no clear consensus in the literature regarding this approach and previous research has reported differences between single children and firstborns with siblings (e. g., Belmont & Marolla, 1973). It would be thus of interest to investigate whether or how the observed patterns change when single children are excluded from the analyses. Unfortunately, data on the proportion of single children in the population is not available, because some of their mothers are still in reproductive age and may have therefore bear more children. Nevertheless, we clearly indicate the proportion of single children in our samples, which would allow researchers to perform additional comparison at some point in the future when the relevant population data are available.

Furthermore, most existing research had investigated simple birth order without considering the difference in age among siblings (i.e., the age-gaps) or the presence of stepsiblings in the family. Most authors either do not mention stepsiblings or simply include them in their

samples. We believe, however, that it is an important and possibly confounding variable which may well influence the difference between the results of the previous studies. We have used a conservative approach and excluded stepsiblings from our data analysis. Taking this additional factor into account was beyond the scope of the present study and such an investigation would require a higher number of participants. In our research, the number of participants in some categories, such as families with a high number of children, was relatively low, which may have resulted in imprecise estimates. Our results do, however, show trends that have been observed in previous studies, which suggests that the effect is robust.

In our study, we have not been able to test for a possible effect of the socioeconomic status. Nevertheless, there are several reasons why we think that this effect is likely to be a weak predictor in the studied population. First of all, income and wealth dispersion (as measured by Gini index) in the Czech Republic is about 0.26, which is relatively low value in comparison to other countries (source: OECD; <http://www.oecd.org/social/income-distribution-database.htm>). Secondly, education at state universities such as the Charles University is free, which is why the effect of economic background of the family can be expected to be limited. And finally, we found the birth-order effect in families of various sizes, including larger families, whereby a larger family size negatively correlates with the family's socioeconomic status (Bayer, 1966; Perusse, 1993; Vining, 1986).

5. Conclusions

Majority of existing research on the birth-order effect investigated the phenomenon at one particular time, which did not enable researchers to assess possible fluctuations related to sociodemographic changes. Our study compared two groups 20 years apart, which offers a unique opportunity for evaluation of the birth-order effect in relation to significant sociodemographic changes. Our results show that the first-born advantage in university enrolment is robust even in the face of dramatic changes in university attendance which took place in the Czech Republic in the last 20 years. Moreover, our results indicate that the birth-order effect is not just an epiphenomenon of the family size. Finally, majority of existing research on the birth-order effect was carried out in just handful of societies (mostly in the US). Our analyses thus demonstrate that the effect of birth-order on educational achievements can be observed also in different cultural settings, namely Central European ones.

Acknowledgements

The authors would like to thank Julie Nekola Nováková, Martin Hůla, and Robin Kopecký for their help with data collection, Petr Tureček for his help with the statistical analysis, Anna Pilátová for extremely helpful language editing, and two anonymous reviewers for a constructive feedback. The authors' work was supported by the Charles University of Prague (GAUK 269215) and by the project 'Sustainability for the National Institute of Mental Health', grant number LO1611, with a financial support from the Ministry of Education, Youth, and Sports of the Czech Republic under the NPU I program. The funders had no role in the study design, data collection and analysis, decision to publish, or the preparation of the manuscript.

Declaration of interest

None.

Appendix A. Appendix

Table A1

Participants 1990–1995 by gender and birth order.

Birth order	Observed (N)	Observed (%)	Observed 2 (N)	Observed 2 (%)	Expected (%)	χ^2	p-value	V
Men and women								
Single children	35	12.9	171	63.1	44.8	36.70	0.00	2.23
Firstborns	136	50.2						
Laterborns	100	36.9	100	36.9	55.2			
Total	271							
Men								
Single children	15	10.9	89	64.5	45.4	20.29	0.00	1.73
Firstborns	74	53.6						
Laterborns	49	35.5	49	35.5	54.6			
Total	138							
Women								
Single children	20	15.0	82	61.7	44.3	16.23	0.00	1.41
Firstborns	62	46.6						
Laterborns	51	38.3	51	38.3	56			
Total	133							

The firstborn group contains only firstborns with younger siblings (single children are not included).

Values for 'observed 2' are for a joint category of firstborns including single children.

The χ^2 test column indicates the observed proportion in the sample against the expected proportion based on data obtained from the Czech Statistical Office.

The number of degrees of freedom (df) is for all test equal to 1.

Significant values are marked bold and 0.00 denote $p < 0.001$.

Table A2

Participants 2011–2017 by gender and Birth order.

Birth order	Observed (N)	Observed (%)	Observed 2 (N)	Observed 2 (%)	Expected (%)	χ^2	p-value	V
Men and women								
Single children	588	29.2	1290	64.0	48.1	203.86	0.00	4.54
Firstborns	702	34.8						
Secondborns	614	30.5	726	36.0	36.9	35.95	0.00	0.80
Third and higher	112	5.6			15.0	141.04	0.00	3.14
Total	2016							
Men								
Single children	157	29.3	359	67.1	48.1	77.39	0.00	3.35
Firstborns	202	37.8						
Secondborns	143	26.7	176	32.9	36.9	23.77	0.00	1.03
Third and higher	33	6.2			15.0	32.73	0.00	1.42
Total	535							
Women								
Single children	429	29.0	928	62.8	48.1	128.37	0.00	3.34
Firstborns	499	33.8						
Secondborns	471	31.9	549	37.2	36.9	15.93	0.00	0.41
Third and higher	78	5.3			15.0	109.42	0.00	2.85
Total	1477							

The firstborn group contains firstborn children with younger siblings (single children not included).

Expected data for men and women separately is not available; we have therefore used the general proportion for the genders.

Values for 'observed 2' relate to a joint category of firstborns including single children.

The χ^2 test indicates the observed proportion in the sample against the expected proportion based on data obtained from the Czech Statistical Office.

The number of degrees of freedom (df) is for all test equal to 1.

Significant values are marked bold and 0.00 denote $p < 0.001$.

Table A3
Participants 1990–1995 by family size, gender, and birth order.

Family size	Observed	Observed	Birth order	Observed 2	Observed 2	Observed in total	Expected	χ^2	p-value	V
(N of children)	(N)	(%)		(N)	(%)	(%)	(%)			
Men and women										
1	35	12.9	1.0	35	100.0	12.9				
2	179	66.1	1.0	108	60.3	39.9	50.0	7.65	0.01	0.57
			2+	71	39.7	26.2	50.0			
3+	57	21.0	1.0	28	49.1	10.3	< 33.3	6.39	0.01	0.85
			2+	29	50.9	10.7	> 66.6			
Total	271									
Men										
1	15	10.9	1.0	15	100.0	10.9				
2	92	66.7	1.0	59	64.1	42.8	50.0	7.35	0.01	0.77
			2+	33	35.9	23.9	50.0			
3+	31	22.5	1.0	15	48.4	10.9	< 33.3	3.16	0.08	0.57
			2+	16	51.6	11.6	> 66.6			
Total	138									
Women										
1	20	15.0	1.0	20	100.0	15.0				
2	87	65.4	1.0	49	56.3	36.8	50.0	1.39	0.01	0.15
			2+	38	43.7	28.6	50.0			
3+	26	19.5	1.0	13	50.0	9.8	< 33.3	3.25	0.07	0.64
			2+	13	50.0	9.8	> 66.6			
Total	133									

The expected value expresses the proportion of each birth order separately for each family size.

The 'observed 2' values express birth-order proportions for each family size separately.

The χ^2 test indicates the observed proportion in the group compared to the expected proportion.

The number of degrees of freedom (df) is for all test equal to 1.

Significant values are marked bold and 0.00 denote $p < 0.001$.

Table A4
Participants 2011–2017 by family size, gender, and birth order.

Family size	Observed	Pbserved	Birth order	Observed 2	Observed 2	Observed	Expected	χ^2	p-value	V
(N of children)	(N)	(%)		(N)	(%)	in total (%)	(%)			
Men and women										
1	586	29.1	1.0	586	100.0	29.1				
2	1080	53.7	1.0	565	52.3	28.1	50.0	2.31	0.13	0.07
			2+	515	47.7	25.6	50.0			
3+	346	17.2	1.0	136	39.3	6.8	< 33.3	5.55	0.01	0.30
			2.0	99	28.6	4.9	> 33.3			
			3+	111	32.1	5.5	> 33.3			
Total	2012									
Men										
1	157	29.3	1.0	157	100.0	29.3				
2	281	52.5	1.0	167	59.4	31.2	50.0	10.00	0.00	0.60
			2+	114	40.6	21.3	50.0			
3+	97	18.1	1.0	35	36.1	6.5	< 33.3	0.33	0.57	0.03
			2.0	29	29.9	5.4	> 33.3			
			3+	33	34.0	6.2	> 33.3			
Total	535									
Women										
1	429	29.0	1.0	429	100.0	29.0				
2	799	54.1	1.0	398	49.8	26.9	50.0	0.01	0.92	0.00
			2+	401	50.2	27.1	50.0			

(continued on next page)

Table A4 (continued)

Family size	Observed	Pbserved	Birth order	Observed 2	Observed 2	Observed	Expected	χ^2	p-value	V
(N of children)	(N)	(%)		(N)	(%)	in total (%)	(%)			
3 +	249	16.9	1.0	101	40.6	6.8	< 33.3	5.86	0.02	0.37
			2.0	70	28.1	4.7	> 33.3			
			3 +	78	31.3	5.3	> 33.3			
Total	1477									

The expected value represents the expected proportion of each birth order separately for each family size.

The 'observed 2' values indicate the birth-order proportions for each family size separately.

The χ^2 test presents testing of the observed proportion in the group against the expected proportion.

The number of degrees of freedom (df) is for all test equal to 1.

Significant values are marked bold and 0.00 denote $p < 0.001$.

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12.3 The Evolutionary Roots of Familial Altruism: Paternity Uncertainty Shapes Patterns of Kindness

The Evolutionary Roots of Familial Altruism: Paternity Uncertainty Shapes

Patterns of Kindness

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Abstract

This study tested the predictions of the paternity uncertainty (PU) theory by exploring its impact on perceptions of familial kindness. Drawing from the Kin Selection Theory, which suggests individuals favor those with closer genetic ties, we anticipated that matrilineal family members would be rated as kinder than their patrilineal counterparts due to the inherent paternity uncertainty in the latter. Using an ordinal 5-point scale, 9,128 participants rated the kindness of various family members. Step relatives served as a control group, given their zero-relatedness coefficient. Our findings robustly supported the PU theory, with biological mothers rated as the kindest, followed closely by matrilineal grandmothers. Conversely, all step-relatives received similar ratings, which were notably lower than those of biological members. Separate analyses for male and female participants revealed that both parents and siblings were rated as kinder to daughters/sisters compared to sons/brothers. This gender-based variation may be attributed to the inherent biological risk that offspring and cousins through a son might not be genetically related to the family, a risk absent in daughters. The results of our study demonstrated that patterns of kindness among family members are consistent with the predictions of paternal uncertainty theory, even in contemporary society.

Keywords

Kin selection theory, family members, stepfamily, kindness, altruism, evolution.

30 **1 Introduction**

31 **1.1 Kin Selection**

32 The Kin Selection Theory suggests that individuals are inclined to support those to whom they are
33 more genetically related, as this investment aids in propagating shared genes (Hamilton, 1964). This
34 concept is encapsulated in Hamilton's rule, which states that altruistic behavior is favored by natural
35 selection when the product of the genetic relatedness (r) and the benefit to the recipient (B) exceeds the
36 cost to the altruist (C). Assistance to closer kin is preferred over aid to more distant relatives because closer
37 kin are likely to share a greater proportion of identical genes than those more distantly related. The
38 evidence for kin selection theory is robust and spans various species, demonstrating behaviors that support
39 the survival and reproductive success of relatives. Observations in social insects like bees, ants, and wasps
40 are often cited, where workers, who are genetically related to the queen and her offspring, forego their
41 own reproduction to support the colony (e.g., Nowak, Tarnita, & Wilson, 2010). Similarly, in mammals,
42 including humans, behaviors such as altruism, cooperative breeding, and other forms of kin-directed help
43 support the theory (Silk, 2009).

44 Focusing on parental investment, Trivers' (1972) evolutionary theory posits that parents are
45 biologically predisposed to allocate resources in a manner that maximizes the reproductive success of their
46 offspring. This theory has been empirically supported by studies such as those by Bereczkei et al. (2002),
47 which found that parents tend to invest more resources in children who possess traits suggesting higher
48 reproductive value. Geary (2000) further explores this concept, highlighting how parental investment
49 strategies are influenced not only by available parental resources but also by factors such as offspring health
50 and their potential for future reproductive success. These findings underscore the adaptive nature of
51 parental investment decisions, driven by the goal of optimizing the number of copies of own genes
52 transmitted to the next generation through offspring or kin.

53 Regarding grandparental investment, the extension of inclusive fitness theory suggests that
54 grandparents also play a crucial role in resource allocation, aimed at enhancing the survival and well-being
55 of grandchildren. Euler and Weitzel (1996) demonstrated that grandparental investment is significantly
56 influenced by the certainty of genetic relatedness. Pollet, Nelissen, and Nettle (2009) further investigated
57 this phenomenon, revealing that grandparents' investment strategies are also shaped by cultural and socio-
58 economic factors, indicating a multifaceted approach to supporting the offspring's offspring. It is no
59 coincidence that Allen et al. (2019), in their literature review, pointed out that the most frequently studied
60 topic in grandparenthood research involves grandparents providing care for their grandchildren. These
61 studies highlight the evolutionary significance of grandparental investment in human societies.

62 **1.2 The Theory of Paternity Uncertainty**

63 The paternity uncertainty theory is vital in comprehending the varied strategies individuals employ
64 for allocating resources among offspring and other family members. Originating from the basic premise
65 that males face an inherent challenge in confirming the biological paternity of their offspring, this theory

66 underscores a fundamental discrepancy in reproductive certainty between the sexes. Unlike maternity,
67 which is visibly confirmed through pregnancy and childbirth, paternity lacks direct physiological evidence,
68 fostering a unique set of psychological and behavioral responses in males (Buss, 1995; Daly & Wilson, 1982).

69 The evolutionary implications of paternity uncertainty are profound, influencing male mating
70 strategies and paternal investment. It was suggested that men may exhibit behaviors such as mate
71 guarding, increased jealousy, and a preference for certain cues of fidelity in partners as adaptive responses
72 to mitigate the risks associated with paternity uncertainty (Buss, 1988; Symons, 1979). This concept is
73 further elaborated e.g. by Anderson, Kaplan, & Lancaster (1999), who highlighted the evolutionary
74 implications of extrapair parenting and the ensuing paternity uncertainty on sexual selection and the
75 coevolutionary arms race between males and females. Phenomena such as mate guarding and engaging in
76 repeated mating instances with one's partner are strategies aimed at mitigating paternity uncertainty.

77 The prevalence of extra-pair paternity (EPP), or the frequency at which offspring are conceived
78 outside of monogamous pairings, varies widely among human populations and other species, depending
79 on biological predispositions and cultural practices. In modern human populations, estimates of EPP rate
80 vary, typically ranging from 1% to 10%, though these figures can be higher or lower depending on the
81 specific community and social norms (Anderson, 2006). Genetic studies and paternity tests have provided
82 direct evidence for these rates (Voracek et al., 2008). Looking into our ancestry, evidence suggests that non-
83 monogamous mating strategies were common among early humans and our hominin relatives. This is
84 inferred from comparative analyses of testes size, mating behaviors observed in closely related primates,
85 and the genetic diversity within human populations (Potts, 1999). Such analyses suggest a mixed
86 reproductive strategy of both men and women that includes both intra-pair and extra-pair matings. These
87 findings challenge the notion of strict monogamy in human evolution and highlight the role of EPP as a
88 factor in genetic diversity and social dynamics. Further studies enriching this discussion include Hrdy (2009),
89 who examines the role of alloparents in human evolution, and Hill and Hurtado (1996), who provide insights
90 into the cooperative breeding strategies among the Ache hunter-gatherers. They demonstrate that
91 understanding human and non-human animal social structures requires considering a broad spectrum of
92 reproductive strategies and kinship behaviors.

93 **1.3 Societal and Cultural Dimensions of Paternity Uncertainty**

94 Beyond individual mating strategies and distribution of parental care, paternity uncertainty
95 significantly influences also social structures, and legal and cultural norms (Geary, 2000). The paternity
96 certainty has been linked to the degree of paternal investment across different societies, with higher
97 certainty correlating with greater paternal involvement (Hartung, 1985).

98 Research has also demonstrated that PU can significantly affect the allocation of resources within
99 families, with paternal care often contingent upon the degree of certainty regarding biological relatedness
100 (Geary, 2005; Platek, 2003). Several studies have stated that matrilineal family members might receive

101 more investment than patrilineal ones, which could be explained by the potential paternity uncertainty
102 associated with the latter (Colclasure, 2021; Bishop et al., 2009; Gaulin et al., 1997; Tanskanen et al., 2023).
103 Similarly, grandparents are typically more certain of their biological relationship with their daughter's
104 children than with their son's children and, therefore, are expected to invest more in the former (Sear &
105 Coall, 2011). This differential investment might lead to differences in perceptions between matrilineal and
106 patrilineal family members.

107 Inheritance and lineage effects, pivotal aspects of human societies, are also deeply intertwined with
108 PU. The assurance of paternity has historically influenced inheritance laws and the transmission of wealth
109 and status, highlighting the importance of lineage continuity in various cultures (Hartung, 1985; Voland,
110 1998). Empirical evidence further supports the idea that individuals tend to allocate resources preferentially
111 based on perceived relatedness, emphasizing the evolutionary rationale behind kin selection and altruistic
112 behavior toward relatives (Burnstein, Crandall, & Kitayama, 1994). This can be exemplified by inheritance
113 regulations, where property is passed from a man to his sister's offspring rather than to his own children,
114 despite the assumption that his children would share a closer genetic relationship (e.g., Fortunato, 2012).
115 The 'paternity threshold model' aligns this behavior with inclusive fitness theory, suggesting that as the rate
116 of extra-pair paternity (EPP) rises, ensuring inheritance through female relatives becomes more
117 advantageous. Similarly, it is often presumed that a man would prioritize caring for his sister's offspring,
118 given the higher certainty of shared genetic ties through the maternal line.

119 1.4 Familial evaluations and kindness

120 The degree of relatedness, affected by factors including parental uncertainty, is expected to
121 influence the extent of altruistic or spiteful behavior that family members display towards each other.
122 Recipients perceive variations in the frequency and intensity of such behavior as differences in the kindness
123 of individual family members. Thus, the rated kindness of individuals can serve as a proxy for their altruism
124 or spite, as subjectively evaluated from the perspective of the behavior's recipient.

125 This logic is based on several previous studies that have addressed the issue of kindness in contexts
126 that are relevant to potential investments in offspring and relatives. For example, Eisenberg et al. (2006)
127 found a significant link between prosocial reasoning and behaviors towards family, suggesting kindness
128 reflects familial investment motivations. Madsen et al. (2007) observed an increase in altruistic behaviors,
129 which indicate kindness, towards close relatives, thereby supporting the kin selection theory. Warneken
130 and Tomasello (2009) showed that even young children display altruistic behavior towards family.
131 Furthermore, the grandmother hypothesis (Hawkes, O'Connell, and Blurton Jones, 1997) posits that
132 grandmothers have played a crucial role in the evolutionary history of humans by providing invaluable
133 support in the rearing of grandchildren. This would logically extend to grandmothers receiving very high
134 ratings, reflecting their integral contribution to familial and social structures. Building on the theories of
135 kinship selection, mating strategies, and the grandmother hypothesis, we would expect maternal

136 relatives—particularly maternal grandmothers—to receive the highest ratings in familial evaluations due
137 to their greater certainty of genetic relatedness and historically significant caregiving roles.

138 Research consistently demonstrates a matrilineal advantage in the quality of grandchild–
139 grandparent relationships. Bonds between grandchildren and maternal grandparents are generally closer,
140 more meaningful, and more fulfilling compared to those with paternal grandparents (Matthews & Sprey,
141 1985; Somary & Stricker, 1998). Scholars often attribute this advantage to the role women play in
142 maintaining family ties and performing 'kinkeeping' activities (Hagestad, 1985, 1986; Rossi & Rossi, 1990).

143 Research also suggests that differences in the ratings of individual siblings could be influenced by
144 their birth order, with first-borns often receiving more attention and resources, potentially leading to higher
145 evaluations. Kramer (2005) investigates, e.g., the contributions of older children to household economies
146 in traditional societies, offering perspectives on the broader kin cooperation beyond direct parental care.
147 Furthermore, younger siblings have a higher degree of uncertainty regarding their biological kinship with
148 older siblings because they did not witness the births of their siblings from the same parents. Consequently,
149 older siblings are more likely to have a stronger preference for younger siblings than vice versa. Studies by
150 Sulloway (1996) and Salmon & Daly (1998) indicate that birth order can affect personality development,
151 parental investment, and sibling rivalry, suggesting that these factors contribute to the varied perceptions
152 and evaluations of siblings within families. Reflecting on these insights, a substantial sample size could
153 reveal variations in sibling ratings.

154 **1.5 Objectives**

155 The aim of our study was to investigate how altruism varies among different family members and
156 to interpret these variations through the prism of paternity uncertainty theory. We introduced a novel
157 method where the proxy for altruism — kindness displayed by various family members—was directly
158 assessed by the recipients of such kindness. Instead of directly questioning family members about the
159 support they receive or provide, which might lead to bias or discomfort, we asked participants to rate their
160 agreement with statements like 'maternal great-grandmothers are kinder than other people.' This
161 approach, in contrast to assessments of kindness or willingness to invest made by external observers,
162 enables family members to utilize a broader spectrum of information, including subtleties not accessible to
163 outsiders. Moreover, having observed their family members' behavior over long periods (their entire life),
164 they are positioned to consider specific family dynamics, such as the extent to which kindness is expressed
165 among all members. They are thus able to recognize not only material assistance but also more subtle forms
166 of support, such as emotional backing. As a result, this method holds the potential to be more sensitive. As
167 a result, this method holds the potential to be more sensitive, capable of uncovering even the most delicate
168 effects attributable to paternity uncertainty. Our research expands beyond the usual focus on grandparents
169 to examine a broader range of relatives, including parents and siblings of both genders, investigating how
170 paternity uncertainty influences rated kindness within the family. To discern how much actual kinship

171 differences versus other factors like cultural norms or access to resources affect kindness variations among
172 family members, we included step-relatives lacking any biological kinship as a negative control, in our study.

173 **2 Methods**

174 **2.1 Participants**

175 We collected data using an internet questionnaire distributed as a Qualtrics survey. Respondents
176 were recruited using a Facebook-based snowball method (Kaňková, Flegr, & Calda, 2015) by posting an
177 invitation on the 'Lab Bunnies' ('Pokusní králíci' in Czech) Facebook page
178 (www.facebook.com/pokusnikralici). This page is dedicated to Czech and Slovak volunteers interested in
179 participating in various evolutionary psychological experiments and assisting with the recruitment of other
180 participants. Initially, the community therefore consisted of scientific enthusiasts which could be
181 considered a specific research sample. Then these individuals shared the questionnaire with their friends,
182 and as it spread further to friends of friends, the sample gradually became more representative of the
183 broader internet population. At the beginning of our study in 2016, the group had over 10,000 volunteers,
184 and it grew to exceed 20,000 by the study's conclusion in 2021.

185 Regarding this research project, participants were invited by our team and Labbunnies community
186 members to participate in an anonymous online study "examining personal and societal beliefs, attitudes,
187 and opinions, including perspectives on various superstitions, prejudices, and conspiracy theories".
188 Participants were briefed about the study's goals on the first page of the electronic questionnaire, where
189 they received the following details: "The questionnaire is anonymous, and the data obtained will be used
190 solely for scientific purposes. Your participation in this project is voluntary, and you have the liberty to
191 withdraw at any moment by closing this web page. While you may opt to skip any questions you find
192 uncomfortable, complete data sets are most valuable. If you consent to participate in the research, please
193 click the 'Next' button." Additionally, both during recruitment and at the start of the questionnaire,
194 participants were informed that it would delve into topics such as sexuality, health, and religious beliefs.
195 The sole incentive offered to participants was feedback on their performance in personality and aptitude
196 tests. Entry into the study was limited to individuals who affirmed they had read and comprehended this
197 information and confirmed they were at least 18 years old.

198 This project, including the procedure for obtaining electronic consent for participation, was
199 approved by the Institutional Review Board (IRB) of the Faculty of Science at Charles University – No.
200 2015/30.

201 **2.2 Questionnaire**

202 The survey gathered data for several unrelated projects, investigating the effects of various
203 biological and social factors on behavior, health, cognitive performance, and attitudes within the internet
204 population. It comprised over one thousand items, took a median time of 127 minutes to complete. For the

205 current study, only data pertaining to the participant's sex and their kindness ratings of various family
206 members were utilized.

207 The questionnaire asked respondents to evaluate the kindness of their various family members,
208 including both biological and step-relatives. They were asked to rate their agreement with statements such
209 as, "Is this person on average kinder than other people?" followed by a list of family members. Ratings were
210 given on a scale from 0 to 4, with 0 indicating strong disagreement and 4 indicating strong agreement.
211 Respondents were guided to rate only the family members they genuinely had, resulting in a lower count
212 of ratings for step-family members compared to parents.

213 **2.3 Descriptive statistics**

214 We collected data from a total of 14,817 respondents between June 4, 2016, and January 18, 2021.
215 Prior to statistical analysis, less than 1% of the data was filtered out due to appearing suspicious (e.g.,
216 exceedingly high or low body height, body mass, age, or unusually short survey completion times). About
217 two-thirds of the respondents progressed to the part of the questionnaire that involved rating family
218 members.

219 The analyses only included respondents who rated at least one family member, resulting in a final
220 dataset of 9,128 respondents. This group comprised 3,503 men with an average age of 36.24 (SD=12.21)
221 and 5,625 women with an average age of 35.55 (SD=12.72). The majority of respondents were highly
222 educated, with 51.6% holding a university degree. Although 55.8% of respondents reported growing up in
223 smaller settlements (towns with fewer than 50,000 inhabitants), they now primarily reside in larger
224 settlements, with 59.2% living in cities with more than 50,000 inhabitants.

225 Regarding family characteristics, a detailed breakdown of respondents having each rated family
226 member (biological or step) is illustrated in Figure 1 under respective labels. Additional information about
227 siblings includes that 22.1% of respondents reported having no biological siblings they grew up with during
228 childhood. About 55.6% reported having only one sibling, 17.0% two siblings, and 5.3% three or more
229 (47.5% have at least one biological brother, 44.1% a sister). Around 14.6% of respondents indicated they
230 grew up with at least one stepsibling during their childhood. Male respondents reported an average of 0.6
231 brothers and 0.53 sisters, while female respondents reported an average of 0.55 brothers and 0.52 sisters.

232 **2.4 Data Analysis and Statistics**

233 We first calculated average ratings for each type of family member using IBM SPSS Statistics 21.0
234 and then listed them from highest to lowest. We grouped family members into five categories based on
235 paternity uncertainty and kinship rate.

236 Due to the uneven distribution of ratings for family members, nonparametric tests were utilized for
237 statistical analysis. The Independent-Samples Mann-Whitney U Test was employed to investigate
238 differences in how male and female participants rated family members. To assess the significance of
239 disparities between dyads of all family members within a matrix (e.g., biological mother vs. matrilineal

240 biological grandmother), paired-samples Wilcoxon signed-rank tests were applied. Effect sizes were
241 denoted by Cohen's d (referred to as " d " in the text).

242 Given the extensive number of tests conducted, there was a potential for encountering false
243 positive results. To mitigate and measure this risk, the Benjamini-Hochberg procedure (Benjamini &
244 Hochberg, 1995) was applied for each of the five groups, setting the false discovery rate at 0.1. Additionally,
245 the Bonferroni-Holm correction for multiple tests (Holm, 1979) was used to further ensure the reliability
246 of our findings.

247 **3. Results**

248 **3.2. Differences in rated kindness between family members**

249 Figure 1 shows the percentage of participants who had each type of family member and displays
250 the average kindness ratings for different family members. The results comparing kindness ratings between
251 pairs of family members are presented in Figure 2.

252

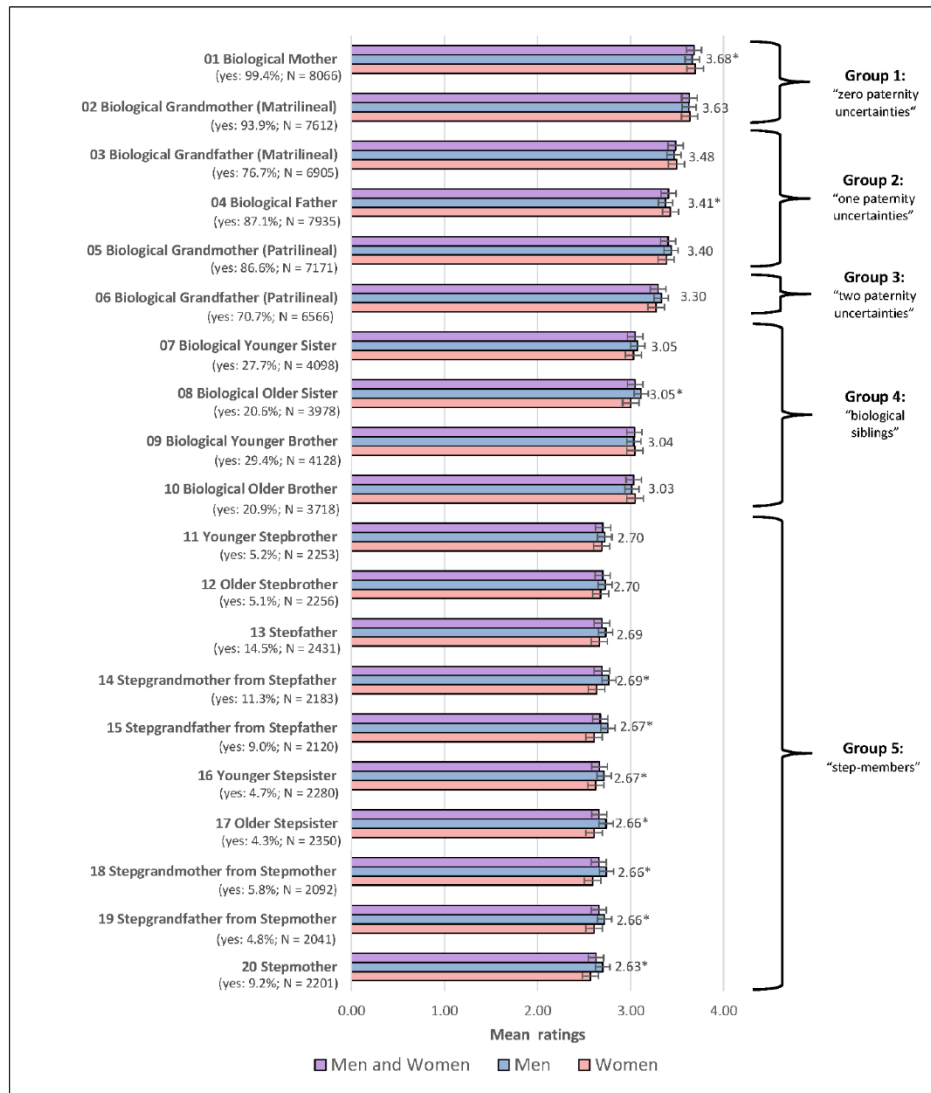


Figure 1. Average Kindness Ratings for Different Family Members.

The numbers beside the bars show the combined average rating from both male and female participants. Asterisks (*) indicate ratings where differences between male and female participants' responses were significant, even after applying the Benjamini-Hochberg procedure. The percentages under each family member's label show how many participants said they have that family member; the N's represent number of raters. The figure displays standard errors as bars above and below the mean value.

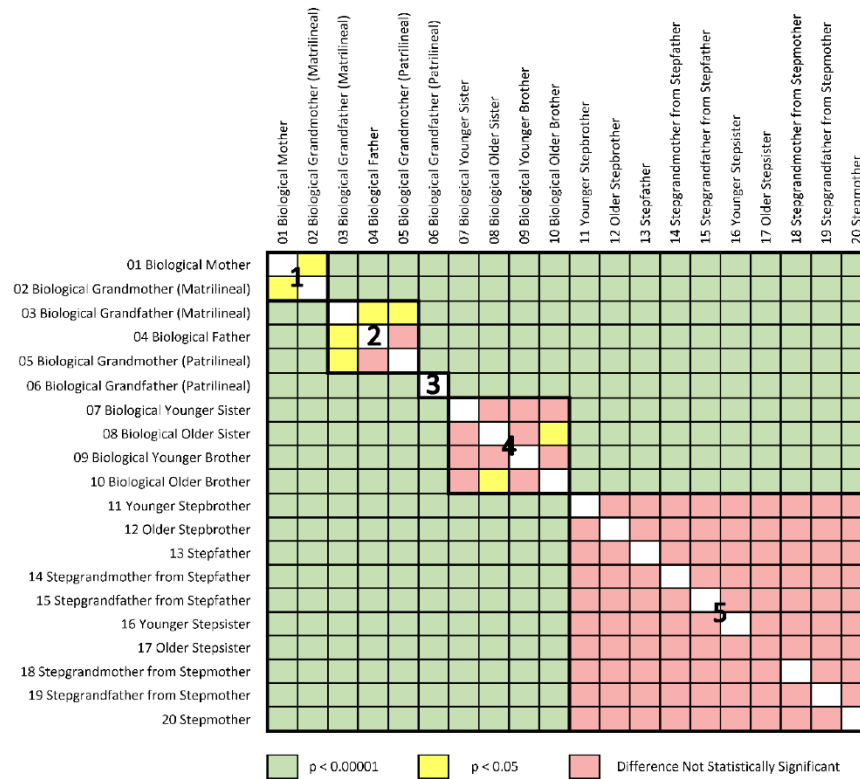


Figure 2. Matrix of Wilcoxon Test Results for All Family Member Dyads.

Ratings were aggregated across both male and female participants. The identifiers 1–5 highlight the main five groups of family members, with p-values adjusted through the Bonferroni–Holm correction to account for multiple testing scenarios.

The findings presented in the figures strongly support paternity uncertainty theory based on the average ratings for family members. Respondents rated their mother as the kindest family member (mean rating = 3.68), closely followed by their matrilineal grandmother (mean rating = 3.63). Although both are part of Group 1, characterized by zero paternity uncertainty, a significant statistical difference was noted between them ($p < 0.0001$, $d = 0.05$). Group 2, featuring biological family members with one level of paternity uncertainty, saw the matrilineal grandfather receiving the highest kindness rating (mean rating = 3.48), followed by the father (mean rating = 3.41) and the patrilinea grandmother (mean rating = 3.40). Significant differences within Group 2 were only found between the matrilineal grandfather and the others (vs. father: $p < 0.001$, $d = 0.05$; vs. patrilinea grandmother: $p = 0.0001$, $d = 0.06$). Group 3, characterized by two levels of paternity uncertainty, included only the patrilinea grandfather, eliminating the possibility for

278 further in-group comparisons. He received a mean kindness rating of 3.30. Group 5 encompassed various
279 stepfamily members, acting as a control group due to their uniform kinship ratings (close to zero) and
280 paternity uncertainty (around 1.0). Compared to biological relatives, stepfamily members were generally
281 rated lower in terms of kindness. Within the stepfamily, there was a range in kindness ratings, with the
282 younger stepbrother receiving a 2.70 and the stepmother the lowest at 2.63. In this group, no differences
283 in kindness reached statistical significance.

284

285 **3 Discussion**

286 Our findings align with previous research on kinship ratings and paternity uncertainty, confirming
287 that the maternal grandmother often receives the highest kindness rating among grandparents, whereas
288 the paternal grandfather is typically rated the lowest (Bishop et al., 2009; Euler & Weitzel, 1996; Tanskanen
289 et al., 2023). The observation that mothers received the highest ratings, followed by maternal
290 grandmothers, likely reflects the combined influence of paternity uncertainty and the closer genetic
291 relationship between mothers and their offspring compared to that between grandmothers and
292 grandchildren.

293 **Parents and grandparents**

294 The finding that mothers are rated as kinder than fathers aligns with existing research. Hrdy (2009)
295 highlighted that women often develop closer emotional connections with children, largely due to their
296 direct involvement in childcare. However, the situation in stepfamilies contradicts this explanation, as
297 stepfathers—who are typically less involved in childcare than stepmothers—receive higher kindness
298 ratings. The discrepancy between biological families and stepfamilies indicates that paternity uncertainty
299 may offer a more comprehensive explanation for these differences in ratings than merely childcare roles.
300 This theory is also supported by the observation that matrilineal grandparents, as well as mothers,
301 consistently receive higher kindness ratings compared to fathers. Notably, within stepfamilies, stepfathers
302 are viewed as kinder than both matrilineal grandparents, further emphasizing the potential influence of
303 paternity uncertainty on perceptions of kindness within families.

304 While Kin Selection Theory receives substantial support, it has also encountered criticism, especially
305 from advocates of group selection theory. These critics propose that altruistic behaviors can evolve to
306 benefit entire groups, even without directly benefiting kin (Wilson & Wilson, 2007). Another alternative
307 explanation, particularly pertinent to human societies, highlights the role of socialization and cultural
308 factors in kin care. This viewpoint suggests that behaviors towards kin, especially in humans, are not solely
309 dictated by genetic relatedness but are also significantly shaped by social norms and cultural practices. For
310 example, the expectation that women and female kin are socialized to care for relatives points to a cultural,
311 rather than purely biological, basis for altruism towards kin (Eagly & Wood, 1999). Our findings, which
312 reveal a contrasting pattern of kindness distribution between biological relatives and step-relatives, suggest

313 that biological relationships, as described by kin selection theory, rather than cultural norms or group
314 selection, play a pivotal role in shaping family member interactions.

315 Observing that grandparents, particularly grandmothers, are rated significantly higher in kindness
316 than fathers strengthens our findings and aligns with the grandmother hypothesis proposed by Hawkes,
317 O'Connell, and Blurton Jones (1997). This hypothesis emphasizes the critical role of post-reproductive
318 individuals, especially grandmothers, in enhancing the survival and well-being of grandchildren. Empirical
319 support for this hypothesis comes from Sear and Mace (2008), who found that grandmothers have a
320 positive impact on child survival in traditional societies, and Volland and Beise (2002), who outlined the
321 evolutionary benefits of grandmothers in historical populations. This context likely contributes to the high
322 rating of grandmothers (3.63), placing them second only to the biological mother (3.68) in rated kindness.

323 The idea that human behavior is universally shaped by evolutionary pressures is nuanced by the
324 variability of kinship systems and mating strategies across different cultures. For example, Orthodox Jewish
325 communities, with their high paternity certainty due to strict social and marital norms, still follow
326 matrilineal descent for religious identity and inheritance (Biale, 1995), indicating the strong influence of
327 cultural and religious factors over evolutionary logic in determining lineage. Similarly, patrilineal biases in
328 rural China and among the Kyrgyz, which support male lineage for property and social status (Murphy, 2001;
329 Werner, 2009), show how economic and environmental conditions can influence social structures, aligning
330 with evolutionary strategies for resource distribution and kinship support. However, the paternity
331 uncertainty hypothesis does not fully explain caregiving behaviors across genders and in patrilineal
332 societies, suggesting that other factors, such as social structures and cultural norms, play a significant role.
333 Studies highlight the importance of biological drives and social closeness in kin relationships (Pashos &
334 McBurney, 2008, Pashos, 2017), challenging the reduction of kin caregiving to simple evolutionary
335 narratives. This diversity in human social and kinship systems underlines the need for a multidisciplinary
336 approach, integrating both biological and cultural perspectives to fully understand human social
337 organization. Such an approach complements the narrative of evolutionary psychology, which suggests that
338 universal patterns in human behavior are shaped by evolutionary pressures.

339 To address the potential impact of extra-pair paternity (EPP) rates on the observed behavioral
340 patterns, we note that even low single-digit percentages of EPP could exert significant selective pressure,
341 influencing the evolution of altruistic behaviors that discriminate between family members based on
342 paternity uncertainty. These behaviors likely affected fundamental life-history parameters, such as survival
343 probabilities and resource allocation within families. Precise modeling of the necessary EPP rates would
344 require knowledge of population sizes, as genetic drift could play a substantial role in smaller populations.
345 However, determining whether such EPP rates were realistic during the relevant evolutionary period
346 remains challenging due to limited data on the conditions under which these adaptations arose. While EPP
347 rates in modern societies are substantially lower, the historical rates may have been much higher, creating

348 stronger selective pressures that shaped these behaviors. Importantly, this suggests that the behavior we
349 observe today may no longer be adaptive in contemporary contexts but rather a legacy of past selective
350 pressures.

351 **Siblings**

352 Similarly to the situation with parents and grandparents, lower kindness ratings for siblings, and
353 the observed differences between male and female siblings, can be explained by the paternity uncertainty
354 theory. In this case, uncertainty arises from the possibility that one or both siblings may not be the biological
355 children of both parents, potentially due to extramarital relationships or adoption. This uncertainty is
356 inherently greater among siblings because it applies to both individuals, thus doubling the potential for
357 non-shared parentage. Essentially, when evaluating the shared parentage of oneself and a sibling, the
358 opportunities for discrepancies in biological relation—whether through extramarital birth or adoption—are
359 objectively doubled.

360 Of course, sibling kindness ratings might also be interpreted within the context of family dynamics
361 theories, particularly considering differences in birth order. Sulloway (1996) posited that sibling rivalry and
362 competition significantly contribute to differences among siblings. The family niches theory suggests oldest
363 siblings often align more closely with parental roles, presumably receiving greater investment. Similarly,
364 other studies suggest that rivalry and competition are significantly less pronounced between siblings of
365 different genders compared to same-gender siblings Conley, 2000; Kuo & Hauser, 1996; Minnett, Vandell,
366 & Santrock, 1983). This difference is often attributed to societal norms and expectations that define distinct
367 roles for males and females, reducing direct competition between them. This dynamic could foster
368 resentment in younger siblings towards their elders, potentially lowering their kindness ratings. However,
369 our findings of negligible differences in ratings between younger and older siblings (ratings 3.03-3.05) do
370 not support these predictions.

371 Moreover, it's important to acknowledge recent research showing minimal significant differences
372 among siblings across various domains (e.g., Rohrer, 2015; Bernardi, Palladino, and Costantini, 2020). Thus,
373 many birth order effects previously proposed appear to be at best weaker than initially thought. According
374 to the theory of family niches, oldest siblings more frequently identify with the parental perspective. This
375 closer identification can result in higher parental investment in them, leading to lower parental assessments
376 of younger siblings. Consequently, this disparity in parental assessment engenders negative feelings among
377 younger siblings towards their older counterparts.

378

379 **Male and female family members**

380 Distinct from other studies, we specifically analyzed the impact of paternity uncertainty on the
381 kindness of male and female family members. Our data showed that daughters consistently gave higher
382 ratings to their biological parents than sons did. The observation that daughters tend to rate their parents

383 more favorably than sons can be understood within the context of the paternity uncertainty (PU)
384 framework. In essence, when parents invest in their daughters, they are indirectly investing in their
385 grandchildren, with whom they have a guaranteed genetic relationship. This contrasts with investment in
386 sons, where there's a risk that the grandchildren might not be biologically related to the grandparents.
387 Therefore, the higher ratings of parental kindness by daughters align with evolutionary strategies favoring
388 the transmission of genetic material through more certain maternal lines.

389 Brothers tend to rate their older sisters as nicer than the sisters rate their older sisters. This pattern
390 is unlikely to be explained by paternity uncertainty theory; however, it can be explained by the theory of
391 unequal returns of investment to male and female siblings. According to this theory, it's more strategic to
392 invest resources in the gender that yields a higher return on the same investment in terms of reproductive
393 success. In polygamous, economically stratified societies where a man's ability to acquire a wife significantly
394 depends on his material resources, this means investing in males rather than females. As noted by Holden
395 et al. (2003), in such societies, resources allocated to brothers can increase their reproductive success (and
396 the investor's inclusive fitness) more effectively than the same resources would for sisters.

397 Such a type of resource transfer is especially expected from older sisters. Generally, daughters
398 benefit more from transferring resources to any sibling compared to sons, who would likely diminish their
399 own probable reproductive success through such transfers. At the same time, older siblings are typically
400 better positioned to invest in their younger siblings than vice versa.

401 **Stepfamily members**

402 Our findings that stepfamily members receive lower kindness ratings align with existing studies
403 indicating that relationships within stepfamilies may not be as stable or intimate as those within biological
404 families (Ganong & Coleman, 2014). This is particularly true for stepmothers, who often receive the lowest
405 ratings. However, it is crucial to recognize the impact of widespread biases and stereotypes on these
406 perceptions. As Miller, Cartwright & Gibson (2018) highlighted, stepmothers are frequently viewed as less
407 affectionate, committed, and competent than biological mothers, regardless of the lack of empirical
408 evidence to support such views. Our results mirror previous research that demonstrates negative biases
409 towards non-biological parents in evaluations of kinship.

410 The consistently higher ratings of all stepfamily members by men compared to women (as depicted
411 in Figure 1) remains unexplained. It's plausible that these disparities are not rooted in the paternity
412 uncertainty theory and might require insights from disciplines beyond evolutionary psychology, such as
413 sociology or psychological science. We can, for example, hypothesize that step-siblings may be more
414 inclined to be kind to male siblings, particularly because they tend to be physically stronger than female
415 siblings and could pose a greater threat of harm.

416 The ratings among stepfamily members were relatively small, even when accounting for the
417 stepmother's relatively low rating. It suggests that rather than the familial roles or biological

418 predispositions, it's the degree of relatedness, influenced by factors like paternity uncertainty, that shapes
419 either the actual kindness family members show to each other or, at the very least, how they perceive each
420 other's kindness.

421 **Strengths and Limitations**

422 One of the main strengths of this study is its large, diverse participant pool. We harnessed the
423 power of the Facebook snowball method, in which study participants and members of the Labbunnies
424 community shared invitations across their social networks. This strategy yielded a population substantial in
425 size and extraordinarily diverse in composition—a level of diversity surpassing that observed in other
426 studies addressing similar topics. Participants completed a lengthy questionnaire without any financial
427 compensation, which effectively filtered out "professional survey fillers" and internet bots. Furthermore,
428 the comprehensive nature of the two-hour questionnaire naturally weeded out less committed individuals,
429 who typically abandon such surveys within the first 10 minutes. As participants were not informed in
430 advance that the questionnaire included an assessment of their relatives' kindness, we successfully
431 circumvented a significant potential source of bias—specifically, participant bias, where people with
432 predominantly positive (or negative) attitudes towards their relatives might disproportionately participate.

433 However, the study does have its weaknesses. While self-selection bias was avoided, as rated
434 relatives couldn't influence their involvement in the study, the raters themselves volunteered. Therefore,
435 the patterns observed may predominantly apply to families comprising individuals who are more curious
436 or altruistic. Kindness ratings relied on factors beyond actual kindness, chiefly the raters' relationships with
437 these individuals, which were influenced by the rated individuals' kindness towards the raters. Potential
438 influencing factors, such as family constellation or age differences among the raters and rated individuals,
439 that were not tracked, might also affect the results. Our questionnaire aimed to cover a wide range of
440 familial relationships, but did not specifically include half-siblings. This exclusion was due to practical
441 considerations, primarily the diverse and complex nature of half-sibling relationships, which would have
442 significantly increased the number of categories under study. Exploring the dynamics with half-siblings in
443 future research will be valuable. While participants were asked to rate members of their own family, it is
444 possible that some participants might have generalized their ratings even without personal experience with
445 a certain type of relative. However, the fact that differences in kindness ratings were observed only among
446 biological relatives—and not among step-relatives, who serve as negative controls—strongly suggests that
447 the observed pattern reflects paternity uncertainty rather than indirect effects or biases.

448

449 **4 Conclusion**

450 This study introduces a novel, sensitive, and high-throughput method to investigate how paternity
451 uncertainty influences perceptions of familial kindness, an indicator of altruism within families. Our results
452 cohere with established research and support paternity uncertainty theory. By employing a large and

diverse sample, we were able to include step-relatives as a control group, which allowed us to explore sex-based variations in kin altruism in greater detail. This variation aligns with the theory's prediction regarding the differential paternity certainty between offspring and maternal/paternal relatives. However, we emphasize the need for further studies to confirm the broader validity and applicability of this method in evolutionary psychology research.

5 Others

Data accessibility. The datasets are available in the Figshare Digital Repository: <https://doi.org/10.6084/m9.figshare.23895888.v1>.

Authors' contributions. R.K. and J.F. conceived and designed the study and participated in data collection. R.K. (with substantial assistance from J.F.) performed the analysis and wrote the first draft of the manuscript. Both authors agree to be accountable for the content of this work.

Competing interests. We declare no competing interests.

Funding. The authors' work was supported by the Charles University of Prague (GAUK 269215). The funders had no role in the study design, data collection and analysis, decision to publish, or the preparation of the manuscript.

Acknowledgements. The authors would like to thank Kateřina Sýkorová, Robin Kopecký and Lenka Příplatová for their help with preparation of the questionnaire and data collection.

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12.4 Born to lead or submit? How birth order shapes sexual preferences and behavior

Born to Lead or Submit? How Birth Order Shapes Sexual Preferences and Behavior

2

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13

14 **Abstract**

15 Birth order influences personality and behavior, but its role in human sexuality is
16 underexplored. This study investigated its relationship with sexual activity onset, sociosexual
17 orientation, number of partners, and preferences for sexual dominance and submissiveness
18 (BDSM).

19 Data was collected via an online questionnaire from 4,495 heterosexual respondents in two-
20 child families. MANCOVA analysis identified significant associations between sexual
21 variables and birth order, sibling age gap, sex-birth order interaction, age, and maternal age at
22 responder's birth. Exploratory analyses, controlling age and maternal age, revealed that
23 secondborns initiated sexual activity at an earlier age. A negative correlation between birth
24 order and age at first sexual experience was significant for individuals with same-sex siblings
25 but was weaker or absent for those with opposite-sex siblings. Secondborn women with a sister
26 reported more opposite-sex partners, and those with a sister reported fewer same-sex partners;
27 these effects were not observed in men.

28 No significant relationship was found between birth order and sociosexual orientation in
29 women, and only a weak association was observed in men. BDSM preferences were more
30 common among firstborns. Similarly, firstborns engaged in BDSM-related practices more
31 frequently, but a significant effect was limited to those with a brother. While firstborns
32 exhibited higher interpersonal dominance in everyday life, sexual dominance (preference for a
33 dominant role in sexual interactions) was not associated with birth order. Interpersonal
34 dominance exhibited a strong positive correlation with sexual dominance in men, whereas no
35 significant correlation was observed in women.

36 **Keywords**

37 Family constellation, birth order, siblings, firstborns, sexual behaviour, sexual preferences

38

Introduction

39 In terms of personality development, the family environment plays a fundamental role and
40 shapes many psychological traits. Due to differences in parental treatment, sibling relationships,
41 and sibling rivalry, birth order influences various psychological traits. Numerous studies
42 investigated the effect of birth order on many dimensions of human life, including personality
43 traits (Paulhus et al., 1999; Sulloway, 1997; Healey, & Ellis, 2007), intelligence and IQ (Black
44 et al., 2011; Rohrer et al., 2015), education achievements (Kuba et al., 2018), partner choice
45 and relationships (Hartshorne et al., 2009), or sexual orientation (reviewed in Blanchard, 2018).
46 Nevertheless, the relationship between various important facets of behavior related to sexual
47 life and birth order has not yet received sufficient attention.

48 Sulloway (1997) hypothesized that firstborns and laterborns differ in their engagement in long-
49 term or short-term sexual strategies. In comparison with laterborns, firstborns identify more
50 strongly with their parents and the status quo, which is why in their case one can expect a greater
51 representation of long-term sexual strategies (involving long-term commitment). Sulloway
52 (1997) also noted that short-term sexual strategies (involving mainly short-term relations and
53 sex with little commitment) can generally be expected among laterborns. This is based on a
54 more general observation that a stressful family environment and uncertain emotional bond
55 with parents lead to changes in reproductive strategy. Such conditions lead to an early onset of
56 puberty and premature development of sexuality, earlier onset of sexual life, instability in
57 relationships, and therefore also a higher number of partners and limited investment in raising
58 children (Belsky et al., 1991; Draper & Harpending, 1982; Wiersen et al., 1993). Due to
59 obtaining less parental resources than firstborn children and because of the effects of sibling
60 rivalry, it can be expected that this would affect especially laterborn children. Furthermore,
61 Sulloway (1997) also anticipated that in laterborn individuals, one would encounter greater
62 sexual experimentation associated with short-term sexual strategies. This hypothesis found

63 support in more recent research on birth order effects, which demonstrated, for instance, higher
64 risk-taking (Argys et al., 2006; Sulloway & Zweigenhaft, 2010) or greater openness to new
65 experiences (Healey & Ellis, 2007) in laterborn individuals.

66 *First Sexual Experience*

67 Previous research has shown that firstborns tend to be more conservative than laterborns (c.g.,
68 Barni et al., 2006). In fact, some older studies reported that firstborns tend to be more
69 conservative than their laterborn siblings especially in relation to sexuality (Kilpatrick &
70 Cauthen, 1969). In line with the Sulloway's (1997) hypothesis, this could lead to a later onset
71 of sexual activities. There are several studies on the effect of birth order on age at first sexual
72 experience. Generally, these studies have shown that with increasing birth order position, the
73 age of onset of sexual life decreased and adolescent sexual activity increased (Argys et al.,
74 2006; Milne & Judge, 2009; Haurin and Mott, 1990; Rodgers & Rowe, 1988; Rodgers et al.,
75 1992).

76 *Sociosexuality and Number of Partners*

77 Several empirical studies focused on a possible relationship between birth order and sociosexual
78 orientation (SOI). According to Sulloway's (1997) hypothesis, laterborns are likely to achieve
79 higher SOI scores and report a higher number of sexual partners. In line with the prediction,
80 Michalski and Shackelford (2002) found that laterborns expressed a desire for more sexual
81 partners in the future, but a comparison between SOI scores did not show any difference
82 between firstborns and laterborns. That study used only basic dichotomous categorizations of
83 siblings (firstborns, laterborns). Salmon (2003), on the other hand, did not treat laterborns as a
84 homogenous group and divided them for the purpose of her study in two separate groups:
85 middleborns and lastborns. The middleborns, who receive the least parental investment and feel
86 less parental support (Kennedy, 1989; Kidwell, 1982), often seek alternative social and

87 emotional support outside their family, especially in friendships (Salmon & Daly, 1998).
88 Salmon (2003) assumed a similar trend in partnerships. Her study had shown that women, but
89 not men, in the middleborn position scored lower on SOI. It should be noted, though, that men
90 in general tend to resort to short-term sexual strategies more often than women do (Buss &
91 Schmitt, 1993) and score higher on SOI (Gangestad et al., 2007). It is thus possible that these
92 sex differences have a stronger effect on men than the birth order and the correspondingly
93 higher variance in SOI scores masks the effect of birth order in men.

94 Michalski and Shackelford (2002) also observed that firstborns reported a significantly higher
95 number of sexual partners than laterborns, which contradicts Sulloway's (1997) hypothesis. To
96 the best of our knowledge, no other studies examined the association between the number of
97 sexual partners and birth order.

98 *Sexual Dominance and Submissiveness*

99 High dominance is linked to emphasis and assertiveness: a dominant person likes to control and
100 criticize others, enjoys group activities, and often takes leadership positions. A number of
101 studies have shown that firstborns are more dominant than laterborns (Phillips et al., 1988;
102 Sulloway, 1997; Beck, 2006; Perlin & Grater, 1984). Strong empirical evidence also indicates
103 that interpersonal dominance is linked to sexual dominance (Jansen et al., 2021). Based on this,
104 one could hypothesize that firstborns may be more sexually dominant and in activities that
105 include Bondage, Discipline and Sado-Masochism (BDSM) prefer the dominant role. To the
106 best of our knowledge, though, no studies explored the area of sexual dominance and
107 submissiveness (such as BDSM preferences) in connection with birth order as yet.

108 **The Aims of the Study**

109 In the present study, we tested the hypothesis that firstborns and laterborns, specifically
110 secondborns, differ in their sexual behavior, desires, and preferences. First, based on previous

111 research, we tested a hypothesis that secondborn individuals have their first sexual experience
112 earlier in life than firstborns. Second, we examined the association between birth order and
113 sociosexual orientation, including the lifetime number of sexual partners. In accordance with
114 Sulloway (1997), we expected firstborns to be more sociosexually restricted and have fewer
115 sexual partners. Finally, we examined the association between birth order and sexual
116 dominance. We tested our hypothesis that firstborns, who tend to be more dominant than their
117 younger siblings, are more likely to be sexually dominant as well.

118 Due to the relatively limited amount of empirical research regarding birth-order effects on
119 sexual behavior and preferences, only a few studies so far considered the sex of the sibling in
120 their analysis, although it is known that the sex of a sibling is an important parameter of the
121 family structure, and it can affect birth-order effects in general. We have therefore anticipated
122 (and tested) that, due to different sibling dynamics, there could be a difference between
123 individuals from same-sex and opposite-sex sibling dyads.

124 To test these hypotheses and investigate potential effects of a sibling's sex, we conducted a
125 large-scale online cross-sectional questionnaire study involving over 50,000 participants.

126 **Method**

127 We collected data via an online questionnaire distributed as a Qualtrics survey. The
128 questionnaire was in Czech, and it was disseminated with the help of members of the Lab
129 bunnies (in Czech "Pokusní králíci") community. The Lab bunnies is a citizen science project
130 run by our research team, which reaches via our website (<https://pokusnikralici.cz/>) and
131 Facebook page (<https://www.facebook.com/pokusnikralici>) over 20,000 people interested in
132 participating in various scientific studies. The questionnaire was also advertised in various
133 electronic and classical media, including TV and magazines by posting an invitation to

134 participate in a “study testing certain evolutionary psychological and parasitological
135 hypotheses, containing many questions related to sexual life” (Flegr and Kuba, 2016).

136 On the first page of the online survey, the subjects were informed that their participation was
137 voluntary and anonymous, that they could terminate it at any time, and that the collected data
138 were confidential and would be used for research purposes only. Participants confirmed that
139 they are older than 15 year, they read the information, and consented to participation in the
140 study by pressing the corresponding button. The project, including the method of obtaining an
141 electronic consent with a participation in the study, was approved by the institutional review
142 board of the Faculty of Science, Charles University (Komise pro práci s lidmi a lidským
143 materiálem Přírodovědecké Fakulty Univerzity Karlovy), No. 2015/01.

144 *Measures*

145 *Respondents' birth order and control variables*

146 Participants provided information about their age and sex as recorded on their birth certificates
147 (0 = female, 1 = male), as well as details about their family structure and history. Respondents
148 reported their mother's age at the time of their birth, their birth order (1 = firstborn, 2 =
149 secondborn), and the sex and age of their sibling.

150 *Respondents' sexuality*

151 We collected detailed data about respondents' sexuality using the large and detailed Sexual
152 Preferences and Behaviors Inventory (Flegr & Kuba, 2016). For the purpose of the present
153 study, participants' sexual orientation, behavior, desires, and preferences were characterized by
154 responses to a subset of 28 questions related to sexuality. Participants also answered questions
155 about their sexual orientation, first sexual experiences (they reported age at first kiss, age at
156 first noncoital sexual experience, and age at first sexual intercourse), and the lifetime number

157 of opposite-sex and same-sex sexual partners rated on a 9-point scale (adapted from Behavior
158 facet items in SOI-R).

159 Submissive and dominant sexual preferences and behaviors were assessed using ten questions
160 measuring arousal in response to either one's own or someone else's fear, danger, pain,
161 powerlessness, and humiliation. Responses were rated on a 6-point verbally anchored scale
162 (from 1 = "not at all" to 6 = "very strongly"). Examples of complementary questions include:
163 "Are you sexually aroused by your own powerlessness?" and "Are you sexually aroused by
164 somebody else's powerlessness?"

165 The internal consistency of the measures was excellent, with a Cronbach's alpha of 0.88 across
166 all 10 questions. Separate analyses by sex and preference type demonstrated similarly high
167 reliability in all subsets: for the five dominance-related questions, Cronbach's alpha was 0.854
168 for men and 0.876 for women, while for the five submissiveness-related questions, it was 0.898
169 for men and 0.892 for women.

170 To evaluate submissive and dominant sexual preferences, we developed two indices. The
171 BDSM Index was calculated as the sum of responses to all BDSM-related questions, providing
172 an overall measure of BDSM tendencies. The Sexual Dominance Index was derived as the
173 difference between the sum of responses to all dominance-related questions and the sum of
174 responses to all submissiveness-related questions. Respondents also answered using two seven-
175 point scales anchored at 1: exclusively traditional sex and 7: also including bondage-discipline
176 activities, and 1: exclusively traditional sex and 7: also including sadism-masochism activities.

177 The survey included the 9-item Revised Sociosexual Orientation Inventory (SOI-R) (Penke &
178 Asendorpf, 2008) to measure respondents' sociosexuality. To acquire results comparable with
179 the results of previously published studies (Flegr, 2017; Flegr & Kuba, 2016), (Behavior and

180 Desire items were rated on 9-point Likert scales and Attitude items on 6-point Likert scale).

181 Cronbach's Alpha was 0.815 for men, 0.841 for women.

182 *Interpersonal dominance*

183 Additionally, we measured interpersonal dominance using the 11-item International Personality

184 Item Pool – Dominance Scale (Goldberg, 1999; Goldberg et al., 2006). Cronbach's Alpha was

185 0.820 for men, 0.816 for women.

186 *Participants*

187 The original sample contained data of 53,538 subjects. For inclusion in the study, we selected

188 only individuals from two-child families who shared both biological parents with their sibling,

189 had no stepsiblings, and grew up in the same household as their biological sibling. To ensure

190 clarity and reliability of the results, we excluded respondents who were part of multiple

191 pregnancies, had a sibling with a mental or physical handicap, or reported the early death of a

192 sibling. These criteria were met by 16,961 (31.7%) respondents from the original sample.

193 Further inclusion criteria required respondents to be aged 20–40 years (35,784; 66.9% of the

194 original sample). We then excluded respondents who identified as nonheterosexuals (2,948;

195 5.5% of the original sample) or who did not report their sexual orientation (27,121; 50.7% of

196 the original sample). For the statistical purposes of the present study, we retained only those

197 who answered all or most of the questions analyzed in this paper. Additionally, we filtered out

198 less than 1% of the data that appeared suspicious (e.g., implausible body height, body mass, or

199 age, or unreasonably short survey completion times).

200 After applying all these criteria, the final sample comprised 4,495 individuals (8.4% of the

201 original sample).

202 Two-child families were chosen as a model family type for several reasons. Based on

203 demographic information and our previous studies, we anticipated that families with two

204 children would be most represented. Moreover, in any family, there is only one firstborn,
 205 regardless of its size, whereas larger families naturally have many later-born individuals.
 206 Consequently, most later-born individuals come from larger families. This introduces the
 207 possibility that differences between firstborns and later-borns might not stem from birth order
 208 itself but rather from the effects associated with family size (e.g., Powell & Steelman 1993).
 209 By limiting the analysis to families with only two siblings, we minimize these potential artifacts
 210 and reduce confounding effects related to family size (Kuba et. al., 2018). Furthermore,
 211 focusing on two-child families simplifies the analysis of the effects of sibling gender. In such
 212 families, each respondent has either a brother or a sister as their sole sibling, making it possible
 213 to clearly examine the influence of sibling gender. In contrast, larger families often include both
 214 brothers and sisters, complicating or even confounding the analysis of sibling gender effects.
 215 Thus, the analysis focused on dyads consisting of firstborn and secondborn siblings.

216 The final sample included 1,864 female respondents (mean age = 27.73, SD = 5.294), of whom
 217 886 had a sister (mean age = 27.85, SD = 5.310) and 978 a brother (mean age = 27.62, SD =
 218 5.280). Of the 2,631 male respondents (mean age = 30.44, SD = 5.634), 1,377 had a brother
 219 (mean age = 30.18, SD = 5.572) and 1,254 a sister (mean age = 30.72, SD = 5.690).

220 In terms of the birth order, the final data set contained the records of 1,084 firstborn women
 221 (24.1% of total, 58.2% of female respondents), 780 secondborn women (17.4% of total, 41.8%
 222 of female respondents), 1,554 firstborn men (34.6% of total, 59.1% of male respondents), and
 223 1,077 secondborn men (24.0% of total, 40.9% of male respondents).

224 *Statistical Analysis*

225 Statistical analyses were conducted using R software version 4.0.4 and RStudio version
 226 1.4.1106. MANCOVA was performed in R using the `manova()` function. By default, this
 227 function applies a Type I sum of squares decomposition and utilizes the Pillai-Bartlett trace, a

228 robust multivariate test statistic for evaluating the effects of independent variables. The Pillai-
 229 Bartlett trace is particularly robust to violations of assumptions such as multivariate normality
 230 and is commonly recommended when analyzing complex models. To account for violations of
 231 multivariate normality and multicollinearity, significance values for MANCOVA were also
 232 calculated using bootstrapping with 10,000 samples. This analysis was conducted in R using
 233 the `boot` package (Canty and Ripley, 2022). Associations between ordinal and binary data were
 234 assessed using the nonparametric partial Kendall's correlation test (Siegel & Castellan, 1988),
 235 as implemented in the software Explorer v. 1.0 (Flegr and Flegr, 2021). This nonparametric test
 236 evaluates the strength and significance of associations among binary, ordinal, and continuous
 237 variables, irrespective of their distributions. Importantly, this test is exact in principle, allows
 238 for the control of confounding variables, and is robust to the presence of outliers and the overall
 239 distributional shapes of the variables. In all tests, the firstborns were coded "1," and
 240 secondborns "2." A positive τ thus corresponded to a positive association between a particular
 241 variable and higher birth order (secondborns), while a negative τ corresponded to a positive
 242 association between a particular variable and lower birth order (firstborns).

243 We controlled for the effect of respondents' age and the age of their mothers at their birth. This
 244 adjustment was necessary because many sex-related variables, particularly those with a
 245 cumulative nature, such as the number of sexual partners, are influenced by an individual's age.
 246 Additionally, parental age—especially maternal age—has been shown to affect the
 247 psychological development of offspring. Since later-born individuals inevitably have older
 248 mothers compared to firstborns, controlling for maternal age helps to account for its potential
 249 impact on the observed associations.

250 Given that the primary test revealed significant effects of the studied factors and their
 251 interactions, we report results in the exploratory part of the study—focused on identifying
 252 variables responsible for the observed effects—without corrections for multiple testing

(Althouse, 2016). However, due to the large sample size, nearly all significant results remained significant even after applying such corrections.

Characteristics related to sexuality, such as sociosexual orientation, sexual desires, and behavior, are known to be strongly associated with the respondent's sex. Similarly, in our study, MANCOVA revealed significant effects of sex and its interactions with other factors on the variables under investigation. Therefore, in the exploratory part of the study, we performed all analyses separately for male and female respondents. Additionally, we conducted separate analyses for women with a sister, women with a brother, men with a brother, and men with a sister.

The dataset for this study is publicly accessible on Figshare (Kuba, Flegr, & Daňková, 2023).

A technical note: In this article, the term "effect" is used in its statistical not colloquial sense, referring to the difference between the true population parameter and the null hypothesis value. Causal interpretations are only discussed in the Discussion section.

Results

Descriptive statistics for the variables of interest are presented in Table 1.

Table 1. Descriptive Statistics

Variable	Women						Men					
	Firstborns			Secondborns			Firstborns			Secondborns		
	n	Mean	SD	n	Mean	SD	n	Mean	SD	n	Mean	SD
Respondent's age	1084	27.7	5.19	780	27.77	5.44	1554	30.37	5.56	1077	30.55	5.74
Mother's age at own birth	1067	23.55	3.52	761	27.55	4.08	1522	23.52	3.72	1054	27.31	4.00
Age at first kiss	1079	14.9	2.44	777	14.72	2.5	1531	15.16	3.46	1066	14.79	3.51
Age at first non-coital sexual experience	1063	16.06	2.46	762	15.93	2.66	1502	16.71	3.34	1052	16.49	3.37

Age at first coital sexual experience	1076	17.55	2.44	770	17.44	2.53	1538	18.78	3.02	1068	18.65	3.12
Sociosexuality (SOI)	1084	30.95	11.69	780	30.81	11.34	1554	37.49	11.21	1077	36.35	11.04
Lifetime number of opposite-sex sexual partners	1082	5.58	2.39	780	5.69	2.41	1553	5.44	2.38	1073	5.36	2.35
Lifetime number of same-sex sexual partners	986	1.35	1.00	709	1.32	0.97	1461	1.16	0.74	1003	1.12	0.56
Number of casual sexual partners	1084	3.02	2.38	780	3.15	2.36	1554	3.04	2.35	1077	3.00	2.31
Interpersonal dominance	1084	42.36	10.01	780	40.47	9.65	1554	45.81	10.14	1077	44.32	9.75
Sexual submissiveness index	1084	20.27	9.98	780	19.28	9.62	1554	19.81	9.96	1077	18.66	9.43
Sexual dominance index	1084	-2.93	5.64	780	-2.78	5.55	1554	2.08	5.14	1077	1.62	5.04
Performing bondage/discipline sexual activities	1051	2.88	2.05	742	2.58	1.98	1497	2.83	1.99	1041	2.71	1.97
Performing sadistic/masochistic sexual activities	1041	2.13	1.68	741	1.95	1.61	1488	2.13	1.68	1030	1.95	1.57

272

273 To test whether birth order affects sex-related variables, we used a MANCOVA test with the
274 factors sex, birth order, sibling's sex, and their interactions, along with the covariates age,
275 maternal age, and age gap between siblings. The dependent variables included age at the start
276 of sexual activity, number of opposite-sex sexual partners, SOI (Sociosexual Orientation
277 Inventory), number of same-sex sexual partners, BDSM index, sexual dominance index, and
278 engagement in BDSM sexual practices. The variables were not normally distributed and
279 collectively did not meet the assumptions of multivariate normality or absence of
280 multicollinearity. Therefore, we also calculated significance values using bootstrapped
281 MANCOVA (last columns in Table 2). The results closely corresponded to those obtained using
282 the parametric method. Specifically, we observed significant effects of sex, birth order, age,
283 maternal age, the age gap between siblings, and the interaction between sex and birth order.
284 Additionally, the bootstrapped MANCOVA results suggested a potential trend for the three-
285 way interaction among sex, birth order, and sibling's sex on the outcome variables ($p = 0.103$).

286 Table 2. Results of MANCOVA

	Pillai	F _(7,3912)	p	p ₂	CI _{95Lower}	CI _{95Upper}
Sex (1)	0.286	223.839	0.000	0.000	0.000	0.000
Birth_order (2)	0.008	4.342	0.000	0.002	0.000	0.016

Sibling's sex (3)	0.001	0.436	0.880	0.303	0.002	0.915
Age (4)	0.178	121.009	0.000	0.000	0.000	0.000
Maternal age (5)	0.009	4.984	0.000	0.001	0.000	0.004
Age_gap (6)	0.004	1.970	0.055	0.044	0.000	0.372
Sex:Birth_order (1,2)	0.004	2.267	0.027	0.032	0.000	0.275
Sex:Sibling's sex (1,3)	0.000	0.196	0.986	0.402	0.008	0.953
Birth_order:Sibling's sex (2,3)	0.001	0.455	0.867	0.314	0.002	0.917
Sex:Birth_order: Sibling's sex	0.003	1.429	0.189	0.103	0.000	0.632

287 The Pillai statistic indicates the effect size, while the p-value represents significance computed
288 using parametric MANCOVA. The p_2 column represents significance calculated through
289 bootstrapped MANCOVA with 10,000 samples. Significant results are highlighted in bold. P-
290 values smaller than 0.00005 are reported as 0.000.

291 The exploration of sexual life-related variables contributing to the effects detected by
292 MANCOVA was conducted using the multivariate nonparametric partial Kendall correlation
293 test. **Table 3** reveals significant associations between numerous sexual life-related variables
294 and birth order in both women and men. When analyzed separately for respondents with
295 opposite-sex and same-sex siblings, the results (presented in **Table 4**) indicate that birth order,
296 the respondent's sex, and the sibling's sex all played important roles. This is despite the
297 corresponding three-way interaction ($p = 0.103$) not reaching the formal threshold for statistical
298 significance.

299 The negative association between birth order and age at first sexual experience remained
300 significant in both groups of respondents with a same-sex sibling. In contrast, in subjects with
301 an opposite-sex sibling, this association was much weaker or even disappeared.

302 Sociosexual orientation was not significantly related to the birth order in women and was only
303 weakly negatively associated with the birth order in men, where it was lower in the secondborns
304 (Table 2). When the number of subjects was artificially decreased by splitting the group of men
305 by the sex of their sibling, the association lost its significance (see Table 3).

Tables 2 and 3 showed that firstborn men were more likely to prefer both dominant and submissive sexual stimuli compared to secondborn men. The association of birth order with sexual dominance and submissiveness went in the same direction and was of similar strength in both men and women. These associations were strong and significant in men regardless of the sex of their sibling and in women with an opposite-sex (male) sibling but absent in women with a same-sex sibling. In fact, being firstborn was more strongly associated with preference for BDSM (especially sexual dominance) in women with a brother than in men with a sibling of either sex. As expected, interpersonal dominance was higher in all four groups of firstborns than in the corresponding secondborns.

Table 3. Association Between Sexuality-related Variables and Birth Order by Respondents' Sex

	All			Men			Women		
	Birth order	Age gap	Male sibling	Birth order	Age gap	Male sibling	Birth order	Age gap	Male sibling
Respondent's age	0.012	-0.105	-0.030	0.017	-0.104	-0.040	0.004	-0.109	-0.019
Mother's age at own birth	0.386	0.068	-0.005	0.381	0.074	-0.006	0.393	0.060	-0.003
Age at first kiss	-0.060	-0.020	-0.007	-0.061	-0.021	-0.009	-0.061	-0.019	-0.002
Age at first non-coital sexual experience	-0.048	-0.032	0.000	-0.046	-0.027	0.003	-0.055	-0.045	-0.005
Age at first coital sexual experience	-0.050	-0.039	-0.002	-0.041	-0.049	-0.005	-0.065	-0.029	0.003
Sociosexuality (SOI)	-0.017	-0.003	-0.006	-0.032	-0.009	-0.017	0.005	0.004	0.011
Lifetime number of opposite-sex sexual partners	0.015	-0.003	0.004	0.000	0.016	-0.010	0.038	-0.028	0.023
Lifetime number of same-sex sexual partners	-0.010	-0.002	0.013	-0.001	-0.008	0.010	-0.019	0.004	0.016
Number of casual sexual partners	0.024	-0.007	0.006	0.011	0.001	0.003	0.043	-0.019	0.012
Interpersonal dominance	-0.067	0.035	0.007	-0.062	0.033	0.004	-0.078	0.033	0.007
BDSM index	-0.039	0.023	0.004	-0.041	0.015	-0.006	-0.036	0.034	0.017
Sexual dominance index	-0.008	-0.007	0.002	-0.016	-0.003	-0.010	0.008	-0.011	0.011
Performing bondage/discipline sexual activities	-0.045	0.016	0.000	-0.030	0.007	-0.011	-0.066	0.027	0.016
Performing sadistic/masochistic sexual activities	-0.045	-0.002	0.009	-0.038	-0.005	0.005	-0.055	0.003	0.013
Sex	-0.007	0.015	0.005	NA	NA	NA	NA	NA	NA
Education	-0.053	-0.035	-0.003	-0.037	-0.032	0.002	-0.080	-0.039	-0.012

^a Birth order is coded as 1 for firstborns and 2 for secondborns, meaning that a negative Tau indicates that firstborns score higher on the variable specified in the header of the respective row. The effect of respondents' age and the age of their mother at their birth was controlled for. Significant results ($p < 0.05$) are highlighted in bold.

Table 4. Association Between Sexuality-related Variables and Birth Order by the Sex of Respondents and Their Siblings

	Men with Sister		Men with brother		Women with sister		Women with brother	
	Birth order	Age gap	Birth order	Age gap	Birth order	Age gap	Birth order	Age gap
Age	0.025	-0.080	0.012	-0.123	-0.034	-0.103	0.037	-0.115
Mother's age at own birth	0.380	0.077	0.384	0.072	0.391	0.090	0.396	0.032
Age at first kiss	-0.049	-0.027	-0.072	-0.017	-0.084	-0.024	-0.040	-0.016
Age at first non-coital sexual experience	-0.031	-0.059	-0.061	0.003	-0.091	-0.041	-0.025	-0.048
Age at first coital sexual experience	-0.027	-0.046	-0.054	-0.053	-0.108	-0.015	-0.026	-0.042
Sociosexuality (SOI)	-0.036	0.006	-0.027	-0.021	0.025	-0.001	-0.012	0.009
Lifetime number of opposite-sex sexual partners	-0.001	0.026	0.001	0.008	0.055	-0.035	0.025	-0.023
Lifetime number of same-sex sexual partners	-0.003	0.020	0.001	-0.035	0.013	-0.017	-0.045	0.021
Number of casual sexual partners	0.009	0.017	0.014	-0.013	0.048	-0.015	0.040	-0.023
Interpersonal dominance	-0.063	0.052	-0.060	0.016	-0.064	0.023	-0.091	0.041
BDSM index	-0.043	0.000	-0.039	0.030	0.015	0.030	-0.083	0.037
Sexual dominance index	-0.007	0.000	-0.023	-0.004	-0.016	0.006	0.027	-0.023
Performing bondage/discipline sexual activities	-0.014	-0.019	-0.043	0.032	-0.021	0.025	-0.108	0.027
Performing sadistic/masochistic sexual activities	-0.037	-0.033	-0.039	0.020	-0.036	0.003	-0.070	0.002
sex	NA	NA	NA	NA	NA	NA	NA	NA
education	-0.042	-0.035	-0.032	-0.029	-0.066	-0.031	-0.094	-0.046

^a Birth order is coded as 1 for firstborns and 2 for secondborns, meaning that a negative Tau indicates that firstborns score higher on the variable specified in the header of the respective row. The effect of respondents' age and the age of their mothers at their birth was controlled for. Significant results are highlighted in bold.

Results presented in tables 3 and 4 suggest that interpersonal dominance correlated with our birth order and the same is true for BDSM index. In contrast, the sexual dominance index does not correlate with the birth order. To examine the relationships between birth order, interpersonal dominance, sexual dominance, and the BDSM index, we conducted two ANCOVA tests. The dependent variables were the BDSM index and the sexual dominance index, while the explanatory variables included sex, birth order, interpersonal dominance, age, mother's age at the time of birth, and the interactions sex:birth order, sex:interpersonal dominance, and sex:interpersonal dominance:birth order. The results (Table 5) showed that interpersonal dominance positively correlated with birth order and age, whereas sexual

dominance positively correlated with age and, depending on sex, also with interpersonal dominance. Separate analyses by sex revealed that the correlation with interpersonal dominance was strong and positive in men (Tau = 0.104, $p < 0.00005$) but absent in women (Tau = -0.006, $p = 0.698$).

Table 5 ANCOVA results – association of interpersonal dominance with BDSM-related variables and birth order

Variable	BDSM Index				Sexual Dominance Index			
	Sum Sq	Df	F	P	Sum Sq	Df	F	P
(Intercept)	11606	1	124.481	0.000	658	1	23.816	0.000
Sex	92	1	0.992	0.319	0	1	0.008	0.929
Birth_order	182	1	1.952	0.162	29	1	1.058	0.304
Age	1380	1	14.80	0.0001	158	1	5.714	0.0169
Mother's age at own birth	71	1	0.7628	0.383	14	1	0.510	0.475
Interpersonal dominance	3746	1	40.183	0.000	31	1	1.126	0.289
Sex:Birth_order	46	1	0.491	0.484	18	1	0.640	0.424
Sex: Interpersonal dominance	63	1	0.670	0.413	325	1	11.778	0.0006
Sex: Birth order:Interpersonal dominance	59	1	0.635	0.426	57	1	2.065	0.151
Residuals	409776	4395			121435	4395		

Significant results are highlighted in bold. P-values smaller than 0.00005 are reported as 0.000.

346 **Discussion**

347 In this cross-sectional study, we investigated the relationship between birth order and various
348 aspects of human sexuality. Data were collected through an online questionnaire survey. From
349 the responses, we selected participants based on predefined criteria, with a primary focus on
350 heterosexual individuals from two-child families. Our findings indicate that birth order is
351 significantly associated with the age at first sexual experiences, the lifetime number of sexual
352 partners, and submissive–dominant sexual preferences and behavior. The results also suggest
353 that the age gap between siblings and the respondent's sex may influence certain variables
354 related to sexual behavior and preferences.

355 *First sexual experience*

356 Our findings reveal that birth order is associated with the age at first sexual experience in both
357 women and men, with second-born individuals initiating their sexual experiences at a younger
358 age than first-born individuals. These results align with our initial expectations and are
359 consistent with previous studies (Argys et al., 2006; Haurin & Mott, 1990; Rodgers & Rowe,
360 1988; Rodgers et al., 1992), which have similarly demonstrated that younger siblings tend to
361 begin their sexual lives earlier than their older siblings.

362 Aside from previously known and published phenomena, our study had also shown that a
363 significant association between earlier onset of sexual life and being secondborn can be
364 demonstrated only in respondents with same-sex siblings (Table 4). One can thus speculate that
365 in opposite-sex siblings, competition for parental attention and the resulting sibling rivalry is
366 reduced due to the differences in the traditional male and female roles. In same-sex siblings,
367 this mechanism does not apply and there is empirical evidence of a higher level of sibling
368 rivalry between them (Minnett et al., 1983). Younger siblings may thus have a tendency to
369 match or even outstrip their older siblings, which is why they engage in sexual activity at an

370 earlier age. Nevertheless, earlier beginning of sexual life might also be based on other motives
371 and causes. According to Kilpatrick and Cauthen (1969), firstborn children tend to be more
372 conservative regarding sexuality. To differentiate themselves from their older siblings,
373 secondborns may adopt a more liberal attitude toward sexual activities, potentially leading to
374 an earlier initiation of such behaviors. Previous research has shown that sibling de-
375 identification is particularly pronounced among same-sex siblings (Schachter et al., 1978).

376 What may also be relevant is social learning, which is stronger in same-sex sibling dyads due
377 to a greater similarity (Bandura, 1977, as cited in East & Jacobson, 2001). In this case, the older
378 sibling represents a model for the younger sibling's behavior. Secondborns may thus imitate
379 the firstborns' behavior, including engagement in intimate relationships. Moreover, firstborn
380 children can introduce their younger siblings to other sexually active friends (thus
381 strengthening social learning) or to potential sexual partners. They can also share information
382 about their sexual life. Due to the age difference between the older and younger sibling, there
383 is thus a shift in timing, which is why the younger siblings acquire their first sexual experiences
384 at a younger age.

385 In contrast, the analysis of associations of birth order with engagement in BDSM activities
386 during sex revealed a differing effect of sibling's sex. Both second-born men and women
387 reported engaging in BDSM activities more frequently, but only when their first-born sibling
388 was male. Among second-born women, however, the association was notably stronger and,
389 unlike second-born men, extended from BDSM activities also to the BDSM index, which
390 reflects BDSM preferences.

391 *Sociosexuality and number of partners*

392 Our assumption that secondborn individuals require less commitment to engage in sexual
393 activities (and have less restricted sociosexual orientation) than the firstborns was not

394 supported by our results. This is consistent with the results of a study by Michalski and
395 Shackelford (2002), which showed that firstborns and laterborns did not differ in their SOI-R
396 scores. It is unclear, however, to what extent their results are relevant given the dichotomous
397 categorization of siblings they had used. A simple dichotomous categorization in firstborns and
398 laterborns (as used, e.g., by Michalski and Shackelford, 2002) is not appropriate without a
399 preliminary analysis of differences between the middleborns and lastborns. Salmon (2003)
400 showed that in middleborn women, the degree of sociosexuality differs from both firstborns
401 and lastborns, and implied that the same effect might have also been observed in men had the
402 study been based on a larger sample. Unfortunately, Salmon did not provide more detailed data
403 to compare the SOI-R scores of firstborns and lastborns.

404 The absence of significant association may be either due to the actual absence of the effect of
405 birth order on sociosexual orientation in two-child families (data from other studies are not
406 available for comparison) or it could be due to the specific design of our study. As mentioned
407 above, the influence of birth order as a psychosocial factor is generally weaker than the impact
408 of biologically determined effects (Kuba & Flegr, 2024). If the effect of birth order on
409 sociosexuality in specific families is weak, the association may be undetectable even with a
410 large dataset if one uses a between-family study design. Our results show that the number of
411 sexual partners differs depending on the birth order only in women. Moreover, the sex of a
412 sibling is a key factor. Secondborn women with a sister reported a significantly higher total
413 number of sexual partners of the opposite sex and a higher number of casual sexual partners
414 than the firstborns. Such associations were not found in women with a brother; in this group,
415 we observed only a lower number of same-sex sexual partners. Our assumption that
416 secondborns are more promiscuous than firstborns was thus supported only in a specific
417 subpopulation of women.

418 These results contradict the findings of a study by Michalski and Shackelford (2002), where
419 firstborns reported a significantly higher number of sexual partners than laterborns did. But
420 their results, as noted above, might be distorted by the dichotomous categorization they used.
421 If middleborns differ from individuals in other sibling positions by a lower level of
422 sociosexuality (Salmon, 2003), one can also expect them to have fewer sexual partners
423 (Ostovich & Sabini, 2004). In this case, the use of a summary category of laterborns may skew
424 the results. Moreover, Michalski and Shackelford (2002) performed analyses that did not
425 differentiate between male and female respondents, which might have also affected the results
426 due to sex differences in both sexuality and the effects of family constellation on variables
427 related to sex life.

428 Our study showed no evidence of a Fraternal Birth Order effect in men, as second-born men
429 reported the same number of same-sex sexual partners as first-born men. The fraternal birth
430 order effect (FBOE) describes the relationship between the presence of older brothers and the
431 sexual orientation of younger brothers. It was shown that with each additional older brother,
432 the likelihood of a younger brother being homosexual increases by approximately 30%
433 (Blanchard et al, 2021). However, it is important to note that all participants in this study
434 identified as heterosexual. Therefore, the number of same-sex partners reported did not reflect
435 homosexual orientation but was more likely associated with certain personality traits, such as
436 sensation-seeking. Interestingly, we observed an inverted Fraternal Birth Order effect in
437 women, with later-born women reporting fewer same-sex sexual partners compared to first-
438 born women. A more detailed analysis revealed that this inverted effect is primarily driven by
439 women with a brother; among women with a sister, the effect was absent or even reversed,
440 with first-born women reporting a slightly, though nonsignificantly, lower number of same-sex
441 sexual partners.

442

Sexual dominance and submissiveness

443 The results of our study, as well as other research (Beck, 2006; Perlin & Grater, 1984; Phillips
444 et al., 1988), indicate that firstborns manifest a higher interpersonality dominance than
445 secondborns do. Our study shows that the degree of preference for BDSM sex is associated
446 with the birth order in both sexes. Both firstborn women (with opposite-sex siblings) and
447 firstborn men with either male or female siblings are more aroused not just by sexually
448 dominant stimuli but also by sexually submissive stimuli than the secondborns are. Our study
449 also shows that firstborns prefer BDSM sexual stimuli and activities to a greater extent than
450 the secondborns in cases where there is at least one male offspring in the family. Although
451 firstborns of either sex manifest a higher interpersonal dominance, their sexual preferences do
452 not shift from submissiveness to dominance. Secondborns reported comparable levels of
453 preference for both sexual dominance and submissiveness. This suggests that the observed
454 differences in such sexual preferences are most likely not due to the higher dominance of the
455 firstborns (and lower dominance of the secondborns).

456 At first glance, the stronger affinity of firstborns for unconventional sexual activities such as
457 BDSM may seem inconsistent with their typically dominant psychological traits, particularly
458 their identification with parental models and the resulting tendency toward more conservative
459 behavior. However, it is important to consider that these traits often stem from the parenting
460 approach firstborns experience. Parents, often driven by inexperience and heightened caution,
461 tend to impose stricter rules and higher expectations on their firstborns. This heightened
462 scrutiny creates a more controlled and disciplined environment for the firstborn compared to
463 their younger siblings. Such excessive control can foster both adaptive and maladaptive coping
464 mechanisms and a skewed perception of power dynamics in relationships, which may manifest
465 in preferences for BDSM (Lingiardi and McWilliams, 2015).

466 Another possible explanation comes from the disinhibition hypothesis of BDSM (Lammers
467 and Roland, 2015). This hypothesis suggests that individuals in leadership roles or positions of
468 power are more likely to disregard various norms, including sexual norms. Since firstborns
469 tend to achieve higher education levels (Kuba et al., 2018) and often occupy higher social or
470 professional positions than later-borns, they may exhibit a greater tendency toward BDSM
471 preferences and behaviors.

472 Our results also suggest that, at least in women, sexual dominance and dominance as
473 personality traits may develop independently during the ontogeny of human personality.

474 To the best of our knowledge, this study is the first to examine dominant and submissive sexual
475 preferences in the context of birth order. There is extensive empirical research on BDSM
476 practitioners, which describes their behavior, preferences, and personality characteristics, but
477 a notable lack of studies investigating the origins of these preferences and the potential
478 influence of family dynamics. The observed effects were relatively strong compared to other
479 birth order effects on variables related to sexual life. However, in formal terms, they still
480 represent weak effects according to Cohen's classification. Further research on this subject is
481 therefore needed.

482 **Strengths and Limitations of the Study**

483 The birth-order effect has often been debated as a possible epiphenomenon arising from other
484 factors, such as parental age or family size (Guo & VanWey, 1999; Rodgers et al., 2000). In
485 our study, the substantial sample size of 53,538 participants allowed us to address these
486 potential confounders with precision. Specifically, we restricted our analysis to respondents
487 with only one biological sibling (and no stepsiblings), thereby eliminating the influence of
488 family size and the unique dynamics of middleborns on the associations studied. Furthermore,
489 maternal age at the time of the respondent's birth—a frequently cited confounding variable—

490 was rigorously controlled, ensuring that our findings are not attributable to these external
491 factors.

492 Most existing research has focused solely on ordinal birth order, often overlooking factors like
493 the early death of a sibling, the presence of a stepsibling, or a sibling with a mental or physical
494 disability. Such circumstances can significantly alter family dynamics and redefine the
495 functional birth order, potentially introducing confounding variables that may explain
496 discrepancies in prior findings. To address this, we adopted a conservative approach, excluding
497 respondents who reported these family circumstances, ensuring that our analyses remained
498 robust and unaffected by these complex influences.

499 The observed associations between birth order and sexuality-related variables were statistically
500 significant but of relatively low strength. For example, Kendall's τ for the relationship between
501 birth order and age at first sexual experience ranged from -0.09 to -0.04, corresponding to
502 Cohen's f values of 0.141 to 0.063. This modest effect size is consistent with expectations in
503 birth order research, where birth order as a psychosocial factor influencing behavior typically
504 exhibits small effects. Even studies employing within-family designs—where sibling
505 comparisons naturally control for both measured and unmeasured inter-family variables—
506 report only moderate associations. For instance, Haurin and Mott (1990) found correlation
507 coefficients ranging from |0.16| to |0.32|, roughly equivalent to Kendall's τ values between 0.10
508 and 0.21. Although the effect of birth order on the timing of sexual initiation appears to be a
509 relatively universal phenomenon (Rodgers & Rowe, 1988; Rodgers et al., 1992), its magnitude
510 remains modest even under robust methodological conditions.

511 **Conclusions**

512 Our results indicate that both birth order and the sex of a sibling are significantly associated
513 with variables related to sexual behavior and preferences. These associations differ between

514 men and women and are detectable even with a less sensitive between-subjects (or between-
515 family) design. Our results confirmed that firstborns, especially those with a same-sex sibling,
516 start sexual life later than secondborns. As anticipated, differences in sociosexuality between
517 firstborns and secondborns likely exist, at least in men. However, they are much weaker than
518 the differences in preferences for BDSM activities and BDSM behavior. To the best of our
519 knowledge, differences in BDSM preferences have not been previously studied or even
520 hypothesized. From a methodological perspective, our findings underscore the importance of
521 controlling not only for the sex of the participants but also for the sex of their sibling(s) and
522 potentially the age gap between siblings. These variables likely play a significant role in
523 shaping family dynamics and could introduce confounding effects that warrant careful
524 consideration in future research on birth order.

525

526

Declarations

527 **Acknowledgements:** The authors would like to thank Anna Pilátová for extremely helpful
528 language editing.

529 **Authors contributions:** All authors contributed to the study conception and design. Data
530 collection was conducted by IID, RK, and JF. Data analysis was performed by IID. The first
531 draft of the manuscript was written by HD and RK. All authors commented on previous
532 versions of the manuscript and read and approved the final manuscript.

533 **Financial Support:** The authors' work was supported by the Charles University of Prague
534 (GAUK no. 1568619). The funders had no role in the study design, data collection, and
535 analysis, decision to publish, or the preparation of the manuscript.

536 **Conflict of interest:** The authors have not disclosed any conflict of interest.

537 **Availability of data and material:** The dataset used in this article can be accessed on Figshare
538 at <https://doi.org/10.6084/m9.figshare.21857112.v1>

539 **Ethics approval:** The study was approved by the institutional review board of the Faculty of
540 Science, Charles University (Komise pro práci s lidmi a lidským materiálem Přírodovědecké
541 fakulty Univerzity Karlovy), approval no. 2015/01.

542 **Consent to participation:** Informed consent was obtained from all individual participants
543 included in this study.

544 **Use of AI:** The authors utilized GPT-4o, a language generation model developed by OpenAI,
545 for proofreading and linguistic refinement of the manuscript. No modifications were made to
546 the tool's original configuration or corpus. GPT-4o was accessed on 10.12.2024 for the
547 described purposes.

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12.5 Fertility of gay and straight men, women, and their relatives: Testing the sexually antagonistic gene hypothesis

Archives of Sexual Behavior
https://doi.org/10.1007/s10508-024-02827-3

ORIGINAL PAPER



Fertility of Czech Gay and Straight Men, Women, and Their Relatives: Testing the Sexually Antagonistic Gene Hypothesis

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Received: 10 May 2023 / Revised: 2 February 2024 / Accepted: 5 February 2024
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Abstract

One proposal for the persistence of homosexuality in the human population is the sexually antagonistic gene hypothesis, which suggests that the lower fertility of homosexual individuals, especially men, may be compensated by higher fertility of their relatives of the opposite sex. To test this hypothesis, we have collected data from 7,312 heterosexual men, 459 gay men, 3,352 heterosexual women, and 79 lesbian women mainly from Czechia. In an online survey, participants answered questions regarding their own as well as their parents' and grandparents' fertility. For men, we obtained no significant results except for higher fertility of gay men's paternal grandmothers, but the magnitude of this effect was very small. For the female sample, we recorded lower fertility of lesbian women's mothers and fathers. In line with our expectations, both gay men and lesbian women had lower fertility rates than their heterosexual counterparts. Our results are consistent with recent studies which likewise do not support the sexually antagonistic gene hypothesis.

Keywords Sexually antagonistic gene hypothesis · Homosexuality · Gay · Lesbian · Fertility · Christians

Introduction

Human homosexuality is by many researchers considered to be an evolutionary paradox. Both male and female homosexuality are heritable, i.e., affected by genes (Ganna et al., 2019), and both gay men and lesbian women have significantly fewer offspring than their straight counterparts (Camperio Ciani et al., 2015; Coome et al., 2020; Fořt et al., 2024; King et al., 2005).¹ Nevertheless, homosexuality is a relatively common trait in various human populations (Barthes et al., 2015; Crapo, 1995). Over the past decades, researchers formulated several evolutionary hypotheses aimed at explaining the persistence of homosexuality in the human population despite the decreased direct reproduction rates of homosexual individuals, which one would expect to be associated with reduced spread of homosexuality-associated alleles (e.g.,

Apostolou, 2013; Barthes et al., 2013; Camperio Ciani et al., 2004; Miller, 2000; Wilson, 1975).

One of the proposed explanations developed in recent years is the so-called sexually antagonistic gene hypothesis (SAGH), which is based on the notion of sexually antagonistic selection (Camperio Ciani et al., 2004). Generally speaking, sexually antagonistic selection is a process where genetic variants detrimental to the biological fitness of one sex persist in the population if they confer a reproductive advantage to members of the opposite sex. For the process to operate, this advantage should be significant enough to compensate for the detrimental effects of these genetic variants in the sex that is affected negatively (Gibson et al., 2002). In relation to human homosexuality, this hypothesis states that reduced reproduction rates of homosexual men may be compensated by elevated fertility of their maternal female relatives (i.e., mothers, maternal aunts, and maternal grandmothers).

The increased female fertility anticipated by the SAGH was restricted to maternal relatives because certain evidence suggests that alleles associated with male homosexuality may be located on the X-chromosome (Hamer et al., 1993; Sanders et al., 2015; but see Ganna et al., 2019). Given this reasoning, one might conjecture that beyond the higher fertility of

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¹ Throughout the article, we treat the distinctions homosexual vs. heterosexual and gay, lesbian vs. straight as synonymous.

Published online: 12 March 2024

Springer

maternal female kin of gay men (as opposed to straight men), we should also see higher fertility in gay men's maternal aunts and grandmothers than in gay men's paternal aunts and grandmothers. This is because, usually, a male inherits a copy of his X-chromosome only from his mother, not father, and therefore, only maternal aunts and grandmothers can have the antagonistic genetic variants potentially promoting their fertility. In fact, Camperio Ciani and Pellizzari (2012) have reported a higher fertility of maternal (as opposed to paternal) aunts of gay men.

Nevertheless, research testing the X-linked version of the SAGH yielded conflicting results. While some studies reported increased fertility in gay men's (as opposed to straight men's) maternal female relatives (and not paternal or male relatives; Camperio Ciani et al., 2004, 2009; Iemmola & Camperio Ciani, 2009; Rahman et al., 2008 for white men; Semenyna et al., 2017), other researchers found increased fertility in both paternal and maternal female relatives (Gómez Jiménez et al., 2020 for transgender androphilic males) or only in paternal female relatives (King et al., 2005). Moreover, Gómez Jiménez et al. recorded higher fertility also in maternal uncles of transgender androphilic males. This indicates that balancing mechanisms other than the sexually antagonistic selection may be involved. In this context, Miller (2000) proposed the overdominance model, which suggests that the higher fertility of male (regardless of whether paternal or maternal) relatives of gay men could be explained by some sort of heterozygous advantage.

Other studies, however, found no difference in the fertility of maternal female relatives of straight and gay men (Fořt et al., 2024; Gómez Jiménez et al., 2020 for cisgender androphilic males), and some even found decreased fertility of gay men's mothers (Ablaza et al., 2022; Rahman et al., 2008 for non-white men). Most importantly, a recent meta-analysis found no association between a mother's fertility and her son's sexual orientation (Blanchard et al., 2020).

The observation that gay men generally have more older brothers than straight men do (Ablaza et al., 2022; Blanchard & Skorska, 2022) could have an impact on assessments of fertility of gay men's mothers: It could be artificially increased due to the very existence of these older brothers (Ablaza et al., 2022; Khovanova, 2020). In particular, it is possible that the association between family size and male homosexuality is due to the greater likelihood of finding gay men in larger families rather than a consequence of sexually antagonistic genes leading to homosexuality in one sex and greater fertility in the opposite sex. To address this potential bias, one possible approach would be to examine the fertility of mothers with only firstborn gay and straight sons, because these individuals have no older siblings. The results of studies that used this method are, however, mixed: One study reported, as expected, a higher fertility of gay men's mothers (Iemmola & Camperio

Ciani, 2009) but other studies did not (e.g., Camperio Ciani et al., 2004, 2009). Importantly, two recent studies by Raymond et al. (2023) and Semenyna et al. (2023) suggest that there is no difference in the fertility of mothers of gay and straight men once the birth order is taken into account. This indicates that the higher fertility observed in gay men's mothers may be the result of them having more sons. For a thorough discussion of older brothers' influence on their younger brothers' sexual orientation and a possible immunological mechanism of this influence, see, e.g., Ablaza et al. (2022), Blanchard and Klassen (1997), or Bogaert et al. (2018).

The logic of the SAGH can be in principle applied also to female homosexuality (Luoto et al., 2019). Camperio Ciani et al. (2018) found that the pedigree size and kin fertility of lesbian women were significantly higher than in straight women. If sexually antagonistic selection were responsible for maintaining female homosexuality-associated alleles, we should see increased fertility in lesbian women's *male* relatives. If some other balancing mechanism were involved (e.g., overdominance; Miller, 2000; Zietsch et al., 2008), we should see increased fertility of either female or both male and female relatives.

Zietsch et al. (2021) published interesting results that offer another insight into possible roles of sexually antagonistic genes (or other balancing factors) in human homosexuality. For heterosexual women, they found no genetic correlation ($r_g = 0.01$) between the presence of alleles linked to male same-sex sexual behavior and the number of those women's children. For those women, they did, however, find a genetic correlation between the presence of alleles linked to male same-sex sexual behavior and the number of their opposite-sex sexual partners ($r_g = 0.32$), and even a strong correlation between alleles linked to female same-sex sexual behavior and the number of opposite-sex sexual partners ($r_g = 0.73$). For heterosexual men, they found a positive genetic correlation between the number of their children and the presence of alleles linked to both male ($r_g = 0.18$) and female ($r_g = 0.30$) same-sex sexual behavior (Zietsch et al., 2021, Supplementary material). This genetic evidence supports both the SAGH and the overdominance model (Miller, 2000), i.e., a possession of alleles predisposing individuals of either sex to same-sex sexual behavior seems to be associated with fitness benefits for heterosexual individuals, of both sexes.

Based on these ambiguous findings regarding the fertility of relatives of gay men and lesbian women, we decided to test the SAGH using a large online collected dataset. Our hypotheses were preregistered (<https://osf.io/a2rbe>) and state that:

- (1) H1: Mothers of homosexual men will exhibit a higher fertility than mothers of heterosexual men.

- (2) H2: Mothers of firstborn homosexual men will exhibit a higher fertility than mothers of firstborn heterosexual men.
- (3) H3: Maternal grandmothers of homosexual men will exhibit a higher fertility than maternal grandmothers of heterosexual men.
- (4) H4: Maternal grandmothers of homosexual men will exhibit a higher fertility than paternal grandmothers of homosexual men.
- (5) H5: Homosexual men will exhibit lower fertility (have fewer children) than heterosexual men.

In our preregistration, we stated no specific predictions for women or their relatives, planning to perform the same investigations in the female sample primarily for exploratory purposes. However, it is important to note that if sexual antagonism was a mechanism responsible, or partly responsible, for maintaining female homosexuality in the population, we would expect to observe increased fertility in the fathers of lesbian women, as compared to the fathers of straight women.

Method

Participants

Between January 19, 2015, and March 28, 2020, a total of 53,538 participants started the survey session. Of these, we excluded those who were less than 30 years old ($N = 24,578$). From the remainder, some participants did not answer one or both items regarding sexual attraction ($N = 15,203$), while others were excluded as their sexual orientation was classified as other than homosexual or heterosexual ($N = 2,271$). From the remaining number, we have also filtered out one participant who took less than 10 min to fill the questionnaire (as an apparently nonserious responder) as well as participants who reported that their maternal or paternal grandparents had more than nine children (considering them outliers; $N = 85$). From the remainder, we have also excluded those who self-identified as asexual ($N = 130$). Afterward, we have also excluded transgender persons ($N = 66$). From the remainder, we have excluded participants ($N = 2$) who met more than two of the following criteria: being over 80 years old, having more than eight children, reporting more than nine mental disorders, reporting having Alzheimer's or Parkinson's disease, and being below the 1st or above the 99th percentile (whole dataset taken as a comparison) in height, weight, or body mass index.

The final sample included 7,312 straight men ($M = 42.67$ years, $SD = 10.48$), 459 gay men ($M = 40.36$ years, $SD = 8.70$), 3,352 straight women ($M = 41.94$ years, $SD = 9.67$), and 79 lesbian women ($M = 38.68$ years, $SD = 8.27$). For definitions of homosexuality and

heterosexuality, see Measures. The criterion of including in the sample only participants aged 30 or older was chosen to increase the likelihood that their relatives had already completed their reproductive period. A similar study (Camperio Ciani & Pellizzari, 2012) had for the same reason set as a criterion that the analyzed relatives must be 50 years of age or older (we did not collect data on the relatives' age). Descriptive statistics on the fertility of gay/lesbian and straight participants and their relatives are summarized in Table 1.

To ascertain asexuality, we asked participants this question: "Do you consider yourself an asexual person (you are uninterested in any form of sex)?" (range 1–6, with 1 being "certainly not" and 6 being "certainly yes"). Individuals who answered 5 or 6 were labeled as asexual. During the study (after 25,659 individual responses were collected), we have added another item to assess whether there are any transgender people in our sample, namely the question "Do you sometimes feel that you live in the body of a person of the opposite sex (that you are a transsexual)?" (range 0–100, with 0 being "certainly not" and 100 "certainly yes"). A participant was labeled transgender if their score on this item was 50 or more.

Procedure

The Qualtrics survey was initially advertised in various traditional and online media by members of the research team (television and radio interviews, etc.). Additional participants were recruited for "a study examining various evolutionary, psychological, and parasitological hypotheses, with focus on sexual life," through the Facebook page "Lab Bunnies" (www.facebook.com/pokusnikralici). This page is geared toward Czech and Slovak nationals interested in contributing to large citizen science projects, especially studies focused on various aspects of evolutionary psychology. The participant pool was expanded and diversified using a Facebook-based snowball method (Kaňková et al., 2015), where participants were prompted to invite others to join by clicking the "Like" button at both the beginning and the end of the survey. On the first page of the survey, participants were informed about the procedure as follows: "The questionnaire is anonymous and obtained data will be used exclusively for scientific purposes. Your cooperation in the project is voluntary and you can terminate it at any time by closing this web page. You can also skip any uncomfortable questions but most valuable are complete data from each participant." The survey included a total of 701 questions and the average time needed to complete it was about 89 min (the most common completion time was 72 min). It is important to note that we initially collected the data primarily for a different project. Subsequently, we registered the current project and its hypotheses in the Open Science Framework, followed by the data analysis.

Table 1 Descriptive statistics of the fertility of participants and their relatives

			Fertility				
			Participant	Mother	Father	Maternal grandmother	Paternal grandmother
Men	Straight	<i>N</i>	6741	7291	7291	6694	6674
		<i>M</i>	1.44	2.15	2.13	2.80	2.80
		<i>SD</i>	1.16	0.81	0.85	1.47	1.49
	Gay	<i>N</i>	407	459	459	426	420
		<i>M</i>	0.23	2.20	2.16	2.74	2.95
		<i>SD</i>	0.64	0.96	0.88	1.48	1.51
Firstborn men	Straight	<i>N</i>	3975	4336	4336	3923	3899
		<i>M</i>	1.41	1.95	1.93	2.75	2.72
		<i>SD</i>	1.14	0.75	0.78	1.44	1.41
	Gay	<i>N</i>	215	238	238	222	218
		<i>M</i>	0.28	1.89	1.90	2.66	2.93
		<i>SD</i>	0.70	0.76	0.74	1.39	1.44
Women	Straight	<i>N</i>	2786	3345	3345	3198	3162
		<i>M</i>	1.55	2.20	2.16	2.80	2.82
		<i>SD</i>	1.00	0.83	0.86	1.46	1.57
	Lesbian	<i>N</i>	47	79	79	74	73
		<i>M</i>	1.21	2.09	1.97	2.86	2.84
		<i>SD</i>	1.06	0.94	0.91	1.65	1.63
Christian men	Straight	<i>N</i>	912	963	963	894	890
		<i>M</i>	1.80	2.38	2.38	3.11	3.10
		<i>SD</i>	1.28	1.04	1.04	1.65	1.66
	Gay	<i>N</i>	50	55	55	51	50
		<i>M</i>	0.28	2.16	2.27	2.51	3.30
		<i>SD</i>	0.76	0.88	0.93	1.42	1.72
Atheist men	Straight	<i>N</i>	4173	4518	4518	4131	4129
		<i>M</i>	1.36	2.11	2.09	2.74	2.72
		<i>SD</i>	1.10	0.74	0.79	1.42	1.43
	Gay	<i>N</i>	240	270	270	250	245
		<i>M</i>	0.27	2.17	2.19	2.81	2.84
		<i>SD</i>	0.66	0.88	0.89	1.46	1.38

Note: *N* stands for the number of participants who provided data regarding the category of relevance (themselves or the relevant kin category); *M* denotes the mean number of children

Measures

Sociodemographic information: Participants were asked to indicate their sex, age, height, weight, the number and nature of health disorders, size of childhood place of residence (assessed by “What is the population of the town where you spent most of your childhood?”; response range 1–6 with 1 standing for “less than 1000 inhabitants,” 2 for “1,000 to 5,000 inhabitants,” 3 for “from 5,000 to 50,000 inhabitants,” 4 for “from 50,000 to 100,000 inhabitants,” 5 for “from 100,000 to 500,000 inhabitants,” and 6 for “over 500,000 inhabitants”), the strength of religious belief (assessed as an answer to “Faith in God is greatly important to me,” with answer range 0–100, where 0 stood for “certainly not” and 100 “certainly yes”), and a question regarding religious

affiliation (“Your religious belief is”: with options (1) I do not believe in God, (2) I believe in God but I am not a member of any church, (3) Roman Catholic, (4) Evangelical Church of the Czech Brethren, (5) Czechoslovak Hussite Church, (6) other). The option “other” was later (after 49,670 individual responses were collected) split in three separate options: (6) other, (7) Judaism, and (8) Buddhism. Participants who self-identified as belonging to categories (3), (4), or (5) were considered Christians. The number of participants in category “other” (including Judaism and Buddhism) was low ($N=2,427$).

Sexual orientation: Participants were asked two 6-point items: “Are you sexually attracted to same-sex individuals?” and “Are you sexually attracted to other-sex individuals?” (with 1 standing for “certainly not” and 6 for “certainly yes”).

Participants who stated their attraction toward same-sex individuals was 1 or 2 and their attraction toward opposite-sex individuals was 5 or 6 were labeled as heterosexual. Vice versa, those who stated their attraction toward same-sex individuals was 5 or 6 and their attraction toward opposite-sex individuals was 1 or 2 were labeled as homosexual. For exploratory analyses, we treated sexual orientation also as an ordinal degree (range 1–6) of attraction toward same-sex individuals.

Fertility of the participants and their family members: Apart from the number of their own sons and daughters, participants were asked to indicate the number of their siblings, including their sex, year of birth, and whether they are full siblings, maternal half-siblings, paternal half-siblings, or stepsiblings. Mother's fertility was then calculated as the sum of full siblings and maternal half-siblings, including those whose sex or year of birth was not stated, plus the participant. Father's fertility was calculated analogously. The participant's fertility was calculated as a sum of the participant's biological daughters and sons. Cases where a participant stated neither the number of daughters nor the number of sons were considered missing values but if the participant indicated only the number of daughters/sons, the number of the participant's sons/daughters was considered to be zero. Maternal grandmother's fertility was calculated as the sum of the mother's older and younger brothers and sisters (plus the mother herself). Cases where the participant did not provide any data on these four categories of mother's siblings were considered missing values. If the participant provided data on at least one of these four categories, the rest (for which the participant provided no data) were considered to be zero. Fertility of the paternal grandmother was calculated analogously. We considered firstborn all participants who reported no older full or maternal half-siblings (excluding those whose birth order could not be estimated, i.e., siblings with the same year of birth as the participant).

The Qualtrics questionnaire also included a set of psychological, health-related, and sexuality-related measures and separate items (most of which are not relevant to the current paper).

Data Preparation and Analyses

Data were prepared in Excel and analyzed in Jamovi (The Jamovi Project, 2022) and R (using RStudio; Posit Team, 2023). In analyses that worked with binary sexual orientation, missing data for the covariate "strength of religious belief" were substituted with arithmetic means separately for gay men, lesbian women, straight men, and straight women. In analyses that used the ordinal degree of homosexual attraction, observations with missing data for covariates "strength of religious belief" and "degree of heterosexual attraction" were omitted.

Associations between the participant's sexual orientation and fertility of relatives (target variables: sexual orientation, mother's fertility, father's fertility, paternal grandmother's fertility, maternal grandmother's fertility, and participant's fertility) were tested using partial Kendall's τ correlation, controlling for age, size of childhood place of residence, and strength of religious belief. This test measures the strength and significance of associations between binary, ordinal, and continuous data irrespective of their distribution shapes and offers the advantage of dispensing with the need for variable transformation: It can be applied uniformly across diverse data types. Specifically, Kendall's τ quantifies the likelihood of the value of a dependent variable for subject A exceeding that for subject B in case the value of an independent variable for subject A is greater than for subject B. This method not only allows for precise control over confounding variables but also addresses the challenge of varying subject numbers across subsets. Differences in the fertility of paternal versus maternal relatives were assessed using the Wilcoxon signed-rank test. For analyses that worked with the ordinal measure of sexual orientation (degree of homosexual attraction), we again employed partial Kendall's correlation, controlling for age, size of the childhood place of residence, strength of religious belief, and the degree of heterosexual attraction.

Higher religiosity is generally linked to higher fertility rates (Peri-Rotem, 2016), and it has been suggested that "a decision to produce fewer children could (...) prevent the female relatives of androphilic males from exhibiting the elevated reproduction that the SAGH predicts" (Gómez Jiménez et al., 2020, p. 583). Czech and Slovak populations, similar to other Euro-American populations, typically have low fertility rates. As a part of exploration and to circumvent the possible limitation of a low fertility rate in our sample, we have therefore decided to analyze the fertility of relatives of Christian male participants separately, expecting to see higher fertility. We have taken advantage of the fact that Czechia is one of the most atheist countries (Zuckerman, 2006) and conducted the main analyses separately also for atheist men.

For confirmatory testing of hypotheses concerning the male sample (Hypotheses 1–5 stated in the Introduction), we used one-tailed tests. If the result of a one-tailed test pointed in a direction opposite to what we had expected, we performed the one-tailed test in the originally hypothesized direction. (The relevant p s were thus over 0.5.) p values ($\alpha = 0.05$) were corrected for multiple hypotheses (together for hypotheses 1, 3, 4) by applying the Benjamini–Hochberg (Benjamini & Hochberg, 1995) correction with false discovery rate set to 0.2 which falls within the recommended range of 0.1–0.25 (McDonald, 2014). We preferred this type of correction over others, such as the Bonferroni's method, which would lead to an unacceptably high probability of Type II error (for a discussion of this topic, see Nakagawa, 2004). For exploratory analyses, we performed

two-tailed tests with standard alpha (0.05) and no correction for multiple tests.

Departures from Preregistration

The main departure from preregistration concerns the choice of item used to calculate the binary variable of sexual orientation. For this purpose, we originally intended to use the following item: “Do you consider your sexual orientation to be rather homosexual than heterosexual?” (range 1–7, with 1 being “certainly not” and 7 “certainly yes”). We would consider those participants providing answers 1 or 2 as heterosexual and those with answers 6 or 7 as homosexual. Nonetheless, this turned out to be rather suboptimal. There was some proportion of participants who, albeit considering their sexual orientation homosexual/heterosexual (i.e., choosing one or the other extreme of the continuum), indicated sexual attractions that clearly contradicted their self-identified sexual orientation. For example, a participant who considered their sexual orientation homosexual also indicated a minimal possible attraction toward same-sex individuals and a maximal possible attraction toward opposite-sex individuals. We believe this could be due to an insufficient comprehensibility of the item we originally intended to use. Some participants might have simply mistaken one pole of the scale for the other. To eliminate this potential issue, we instead decided to use the two items regarding sexual attraction to determine the binary variable of sexual orientation (see above)—unlike the original item, both these items were formulated in a plain and clear manner, thereby precluding possible confusion.

In the confirmatory part, we did not state how exactly the missing values for the variable “strength of religious belief” are to be substituted. In the study, we substituted them separately for men and women according to their sexual orientation. Due to a low number of lesbian women, we refrained from performing specific analyses separately for Christian and atheist female subsamples and performed those only for men. For the sake of brevity and clarity, we chose not to conduct certain preregistered analyses in the exploratory part of the study. These include, for instance, analyses of the fertility of trans- and bisexual participants, or the sex ratio of firstborn children of mothers of homosexual men.

Results

Comparisons of Fertility of Gay/Lesbian and Straight Participants and Their Relatives

In line with our prediction, we found a significant negative association between male participants’ fertility and their sexual orientation—gay men showed lower fertility than straight men (H5: $M_{\text{gay}} = 0.23$, $SD_{\text{gay}} = 0.64$, $M_{\text{straight}} = 1.44$,

$SD_{\text{straight}} = 1.16$, $\tau = -0.23$, $p_{(\text{one-tailed})} < 0.001$). Contrary to predictions of the SAGH (and the corresponding preregistered hypothesis), we found no significant positive association between either a mother’s fertility and her son’s sexual orientation (H1: $M_{\text{gay}} = 2.20$, $SD_{\text{gay}} = 0.96$, $M_{\text{straight}} = 2.15$, $SD_{\text{straight}} = 0.81$, $\tau = 0.00$, corrected $p_{(\text{one-tailed})} = 0.966$) or between maternal grandmother’s fertility and the participant’s sexual orientation (H3: $M_{\text{gay}} = 2.74$, $SD_{\text{gay}} = 1.48$, $M_{\text{straight}} = 2.80$, $SD_{\text{straight}} = 1.47$, $\tau = -0.01$, corrected $p_{(\text{one-tailed})} = 0.966$). On the other hand, we found a positive association between the participant’s sexual orientation and paternal grandmother’s fertility ($M_{\text{gay}} = 2.95$, $SD_{\text{gay}} = 1.51$, $M_{\text{straight}} = 2.80$, $SD_{\text{straight}} = 1.49$, $\tau = 0.03$, $p < 0.001$), i.e., gay men’s grandmothers had higher fertility than straight men’s grandmothers. No other significant associations were observed. For more details, see Table 2.

Contrary to predictions of the SAGH, we observed no significant association between mother’s fertility and her son’s sexual orientation in the subsample of firstborn men (H2: $M_{\text{gay}} = 1.89$, $SD_{\text{gay}} = 0.76$, $M_{\text{straight}} = 1.95$, $SD_{\text{straight}} = 0.75$, $\tau = -0.02$, $p_{(\text{one-tailed})} = 0.963$). In this subsample, we found two associations that were also observed in the full male sample: a negative association between the fertility of firstborn men and their sexual orientation, with gay men once again exhibiting lower fertility compared to straight men ($M_{\text{gay}} = 0.28$, $SD_{\text{gay}} = 0.70$, $M_{\text{straight}} = 1.41$, $SD_{\text{straight}} = 1.14$, $\tau = -0.21$, $p < 0.001$). Firstborn gay men’s paternal grandmothers had higher fertility than firstborn straight men’s paternal grandmothers ($M_{\text{gay}} = 2.93$, $SD_{\text{gay}} = 1.44$, $M_{\text{straight}} = 2.72$, $SD_{\text{straight}} = 1.41$, $\tau = 0.04$, $p < 0.001$), see Table 2.

For women, we found a negative association between their fertility and sexual orientation, lesbian women showing lower fertility than straight women ($M_{\text{lesbian}} = 1.21$, $SD_{\text{lesbian}} = 1.06$, $M_{\text{straight}} = 1.55$, $SD_{\text{straight}} = 1.00$, $\tau = -0.03$, $p = 0.012$). Moreover, we observed two other negative associations concerning lower fertility of lesbian women’s mothers ($M_{\text{lesbian}} = 2.09$, $SD_{\text{lesbian}} = 0.94$, $M_{\text{straight}} = 2.20$, $SD_{\text{straight}} = 0.83$, $\tau = -0.03$, $p = 0.016$), and lower fertility of lesbian women’s fathers ($M_{\text{lesbian}} = 1.97$, $SD_{\text{lesbian}} = 0.91$, $M_{\text{straight}} = 2.16$, $SD_{\text{straight}} = 0.86$, $\tau = -0.04$, $p < 0.001$), as compared to parents of straight women, see Table 2.

Comparisons of Fertility of Gay and Straight Participants and Their Relatives Separately for Christians and Atheists

We observed no significant differences in the proportions of homosexual and heterosexual men between atheists ($N = 270$ [5.6%] homosexuals, $N = 4,527$ [94.4%] heterosexuals) and Christians ($N = 55$ [5.4%] homosexuals, $N = 965$ [94.6%] heterosexuals; $\chi^2 = 0.08$, $p = 0.765$). Descriptive statistics

Table 2 Correlation between homosexuality and fertility of participants and their relatives

		Fertility				
		Participant	Mother	Father	Maternal grandmother	Paternal grandmother
Men	Partial Kendall τ^a	-.23	.00	.00	-.01	.03
	<i>p</i>	< .001 ^b	.966 ^{b, c}	.570	.966 ^{b, c}	< .001
	<i>N</i>	7,148	7,750	7,750	7,120	7,094
Firstborn men	Partial Kendall τ^a	-.21	-.02	-.01	-.01	.04
	<i>p</i>	< .001	.963 ^b	.401	.433	< .001
	<i>N</i>	4,190	4,574	4,574	4,145	4,117
Women	Partial Kendall τ^a	-.03	-.03	-.04	.00	.00
	<i>p</i>	.012	.016	< .001	.795	.883
	<i>N</i>	2,833	3,424	3,424	3,272	3,235
Christian men	Partial Kendall τ^a	-.26	-.03	.00	-.08	.04
	<i>p</i>	< .001	.154	.828	< .001	.102
	<i>N</i>	962	1,018	1,018	945	940
Atheist men	Partial Kendall τ^a	-.21	.00	.02	.02	.03
	<i>p</i>	< .001	.633	.085	.090	.006
	<i>N</i>	4,413	4,788	4,788	4,381	4,374

Note: All analyses were controlled for participant's age, size of childhood place of residence, and strength of religious belief

^a Heterosexual participants were assigned 0, and homosexual participants were assigned 1. A positive correlation thus indicates a higher fertility of homosexual participants or their relatives

^b These relationships were preregistered for one-tailed test

^c *p* values adjusted via Benjamini-Hochberg correction (see [Data Preparation and Analyses](#) in the [Method](#) section). The original one-tailed *p* values (before correction) are .344 for men's mothers' fertility and .785 for men's maternal grandmothers' fertility

regarding fertility in the atheist and Christian subsample are presented in Table 1.

In Christian men, we only observed a significant negative association between their maternal grandmother's fertility and the participant's sexual orientation, gay men's maternal grandmothers having fewer children than straight men's maternal grandmothers ($M_{\text{gay}} = 2.51$, $SD_{\text{gay}} = 1.42$, $M_{\text{straight}} = 3.11$, $SD_{\text{straight}} = 1.65$, $\tau = -0.08$, $p < 0.001$), and between the participants' fertility and their sexual orientation, gay men having lower fertility than straight men ($M_{\text{gay}} = 0.28$, $SD_{\text{gay}} = 0.76$, $M_{\text{straight}} = 1.80$, $SD_{\text{straight}} = 1.28$, $\tau = -0.26$, $p < 0.001$).

For atheist men, we found a positive association between paternal grandmother's fertility and the participant's sexual orientation ($M_{\text{gay}} = 2.84$, $SD_{\text{gay}} = 1.38$, $M_{\text{straight}} = 2.72$, $SD_{\text{straight}} = 1.43$, $\tau = 0.03$, $p = 0.006$), gay men's paternal grandmothers showing higher fertility than those of straight men. We also observed a negative association between the participants' fertility and their sexual orientation, gay men producing fewer children than straight men ($M_{\text{gay}} = 0.27$, $SD_{\text{gay}} = 0.66$, $M_{\text{straight}} = 1.36$, $SD_{\text{straight}} = 1.10$, $\tau = -0.21$, $p < 0.001$). No other significant association was detected in this subsample. For further details, see Table 2.

Pairwise Comparisons of Fertility of Maternal and Paternal Kin

Results of Wilcoxon signed-rank paired *t* tests of fertility differences in the paternal and maternal kin in the male sample are summarized in Table 3. Most importantly, prediction of the X-linked version of the SAGH according to which the maternal grandmothers ($M = 2.71$, $SD = 1.47$) of gay men should be more fertile than the paternal grandmothers ($M = 2.95$, $SD = 1.53$) of gay men was not confirmed (H_4 : $W = 17,220.5$, $p_{\text{(one-tailed)}} = 0.996$). This effect, which contradicts the SAGH, was significant for the subsample of Christian gay men, where paternal grandmothers ($M = 3.30$, $SD = 1.72$) were more fertile than their maternal grandmothers ($M = 2.52$, $SD = 1.43$; $W = 205$, $p = 0.015$). In these pairwise comparisons, there were two other significant relationships: We found the mothers ($M = 2.15$, $SD = 0.81$) of straight men to be more fertile than the fathers ($M = 2.13$, $SD = 0.85$) of straight men ($W = 214,652.5$, $p = 0.034$). This also held for the subsample of atheist straight men whose mothers ($M = 2.11$, $SD = 0.74$) were more fertile than their fathers ($M = 2.09$, $SD = 0.79$; $W = 92,169$, $p = 0.033$). There were no other significant associations.

Table 3 Comparisons of fertility of the paternal and maternal kin of participants with paired *t*-tests

	<i>N</i>	<i>M</i>	<i>SD</i>	Wilcoxon <i>W</i>	<i>df</i>	<i>p</i>	Rank biserial correlation	Cohen's <i>d</i>
Gay men's mother	459	2.20	0.96	1,810.5	458	.604	.06	.05
Gay men's father		2.16	0.88					
Straight men's mother	7,291	2.15	0.81	214,652.5	7,290	.034	.08	.02
Straight men's father		2.13	0.85					
Christian gay men's mother	55	2.16	0.88	0	54	.095	−1.00	.26
Christian gay men's father		2.27	0.93					
Christian straight men's mother	963	2.38	1.04	1,470	962	.802	.03	.01
Christian straight men's father		2.38	1.04					
Atheist gay men's mother	270	2.17	0.88	562	269	.453	−.12	.02
Atheist gay men's father		2.19	0.89					
Atheist straight men's mother	4,518	2.11	0.74	92,169	4,517	.033	.10	.03
Atheist straight men's father		2.09	0.79					
Gay men's maternal grandmother	412	2.71	1.47	17,220.5	411	.996 ^a	−0.18	.12
Gay men's paternal grandmother		2.95	1.53					
Straight men's maternal grandmother	6,494	2.79	1.46	5,236,305	6,493	.717	−.01	.00
Straight men's paternal grandmother		2.80	1.49					
Christian gay men's maternal grandmother	50	2.52	1.43	205	49	.015	−.45	.37
Christian gay men's paternal grandmother		3.30	1.72					
Christian straight men's maternal grandmother	871	3.10	1.64	110,350.5	870	.843	.01	.00
Christian straight men's paternal grandmother		3.10	1.66					
Atheist gay men's maternal grandmother	239	2.77	1.43	6,339.5	238	.398	−.07	.04
Atheist gay men's paternal grandmother		2.85	1.40					
Atheist straight men's maternal grandmother	4,003	2.74	1.42	1,923,840	4,002	.747	.01	.01
Atheist straight men's paternal grandmother		2.72	1.44					

^a This relationship was preregistered for a one-tailed test. *p* value after Benjamini–Hochberg correction also equals .996

Relationship Between the Degree of Homosexual Attraction and Fertility of Participants and Their Relatives

In many analyses, homosexuality is treated as a binary variable. But one can also consider and measure the degree of homosexual attraction on an ordinal scale. We hypothesized that the ordinal measure would deliver more information and tests that use it should be therefore more sensitive than tests that rely on the binary measure. Results concerning the ordinal measure of sexual orientation (degree of homosexual attraction) are summarized in Table 4. For men, we found a significant negative correlation between the degree of homosexual attraction and both the father's fertility ($r = -0.02$, $p = 0.039$) and participant's fertility ($r = -0.06$, $p < 0.001$), where fertility decreased with an increasing degree of participant's homosexual attraction. For women, we found significant negative correlations between the degree of homosexual attraction and mother's fertility ($r = -0.02$, $p = 0.025$), father's fertility ($r = -0.03$, $p = 0.006$), and participant's fertility ($r = -0.03$, $p = 0.008$), where the last-named fertility again decreased with an increasing degree of participant's

homosexual attraction. There were no other significant associations. Description of fertility differences in participants according to the degree of their homosexual attraction is depicted in Fig. 1a, b.

Discussion

Based on an online collected sample of homosexual and heterosexual men and women, we tested differences in the fertility of participants with various sexual orientations and investigated differences between the fertility of their relatives. We also examined possible differences between the fertility of participants' maternal and paternal kin. Our results did not support the SAGH: We found no evidence of the fertility of gay men's mothers and maternal grandmothers being any higher than the fertility of straight men's mothers and maternal grandmothers. We did, however, observe a slightly higher fertility among gay men's paternal grandmothers as compared to straight men's paternal grandmothers, although the effect size was very weak ($r = 0.03$). Furthermore, we observed lower fertility in mothers and fathers of lesbian

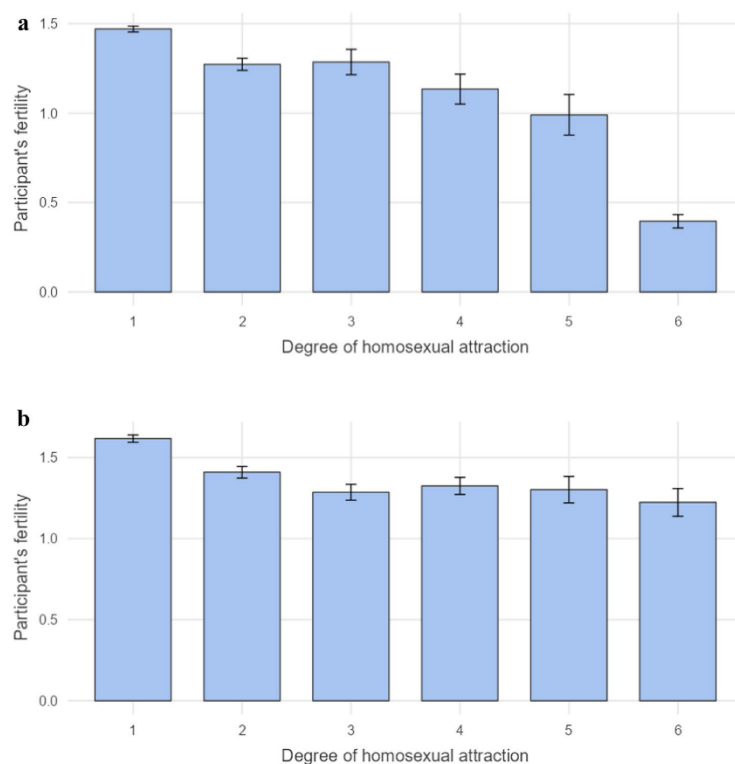
Table 4 Correlation results utilizing the ordinal definition of sexual orientation

		Fertility				
		Participant	Mother	Father	Maternal grand-mother	Paternal grandmother
Men	Partial Kendall τ^a	-.06	-.01	-.02	.00	-.01
	p	<.001	.063	.039	.672	.542
	N	6,378	6,908	6,908	6,368	6,319
Women	Partial Kendall τ^a	-.03	-.02	-.03	.00	-.01
	p	.008	.025	.006	.705	.464
	N	3,172	3,897	3,897	3,735	3,705

Note: All analyses were controlled for participant's age, size of childhood place of residence, strength of religious belief, and the degree of heterosexual attraction

^a A positive correlation denotes a positive relationship between fertility and participant's homosexual attraction (see [Measures](#) in the [Method](#) section)

Fig. 1 **a** The mean number of children in men with various degrees of homosexual attraction. Error bars represent standard error of the mean. **b** The mean number of children in women with various degrees of homosexual attraction. Error bars represent standard error of the mean



women as compared to the parents of straight women. We have also found that homosexual individuals themselves, both gay men and lesbian women, have fewer offspring than heterosexual men and women, whereby the degree of

homosexual attraction correlates negatively with fertility in both women and men.

Lower Fertility of Gay Men and Lesbian Women in Comparison with Their Straight Counterparts

We found that gay men and lesbian women have lower fertility than their straight counterparts; this finding is in line with numerous other studies (Apostolou, 2022; Camperio Ciani et al., 2009, 2018; Coome et al., 2020; Iemmola & Camperio Ciani, 2009; King et al., 2005; Schwartz et al., 2010). We have also found that the difference in fertility of lesbian vs. straight women was smaller ($r = -0.03$) than the difference in fertility of gay vs. straight men ($r = -0.23$). This was also reported in Study 1 (but not Study 2) of Apostolou (2022). This association, with a similar magnitude, also held in the subsamples of atheist and Christian men.

No Differences in the Fertility of Mothers and Maternal Grandmothers between Gay and Straight Men

Our results, which showed that the mothers and maternal grandmothers of gay men were not more fertile than the same classes of relatives of straight men, contrast with the findings of studies that did find support for the SAGH by observing a higher fertility in gay men's mothers, maternal grandmothers, or both. Such results were reported by Camperio Ciani et al. (2004), Iemmola and Camperio Ciani (2009), Camperio Ciani et al. (2009), Camperio Ciani and Pellizzari (2012), Semenyna et al. (2017), and, for transgender androphilic males, Gómez Jiménez et al. (2020). Other studies, on the other hand, found no support for the SAGH (e.g., Gómez Jiménez et al., 2020 for cisgender androphilic males, Rahman et al., 2008 for white men, Blanchard et al., 2020), or even reported the opposite of what the SAGH predicts, that is, a lower fertility of homosexuals' female relatives (for instance, Ablaza et al., 2022 or Rahman et al., 2008 for non-white men).

It is possible that contemporary modern societies with low reproduction rates are not good sample populations to test the SAGH and some indigenous, high-fertility populations would deliver different findings—although it should be noted that even in such populations, the results are mixed (Gómez Jiménez et al., 2020; Semenyna et al., 2017). That is why we decided to test our assumptions separately on Christians, where we expected to find a generally higher fertility than in the subsample of atheists. In the Christian subsample, though, the tested relationships opposed the predictions of the SAGH even more: We found that maternal grandmothers of Christian gay men were less fertile than maternal grandmothers of straight Christians. Our assumption that higher fertility in the subsample of Christians and their relatives would be more appropriate for testing the SAGH thus found no support in the empirical data.

Higher Fertility of Gay Men's Paternal Grandmothers

In the sample as a whole, we found the paternal grandmothers of gay men to be more fertile than the paternal grandmothers of straight men. This effect was also significant in the subsample of atheists but not in the subsample of Christians. This very weak effect is in line with some other studies (King et al., 2005; Schwartz et al., 2010) and could actually be in line with the SAGH. As Fry (2010) argued, sexually antagonistic selection could in fact work not only for X-based loci but also for autosomal loci. If that is the case, it could be expressed as a higher fertility of gay men's paternal grandmothers. However, we prefer not to attribute greater significance to such a subtle effect.

The (preregistered) one-tailed test did not find higher fertility in gay men's maternal grandmothers compared to their paternal grandmothers. It should be noted that had we used a two-tailed test instead, it would have returned a significant result ($p = 0.007$), reflecting a higher fertility of gay men's paternal grandmothers. A higher fertility of gay men's paternal grandmothers (as compared to gay men's maternal grandmothers) was observed in the subsample of Christian gay men. These findings contrast with at least one other study (Camperio Ciani & Pellizzari, 2012) and with what the X-linked version of the SAGH would predict, but they could be explained by sexual antagonism working for autosomal loci (Fry, 2010; see above).

Correlation Between the Degree of Homosexual Attraction and the Fertility of Participants and Their Relatives

For the female sample, aside from the negative correlation between women's fertility and the degree of their homosexual attraction, we also found two other significant correlations, namely negative correlations with both the mother's and father's fertility and the degree of participant's homosexual attraction. For the male sample, we found a negative correlation between the father's fertility and the degree of participant's homosexual attraction and between the participant's fertility and the degree of the participant's homosexual attraction. This effect, however, was weaker than the association between participant's fertility with binary sexual orientation in the male sample.

Differences in the Fertility of Relatives between Lesbian and Straight Women

In comparison with straight women's parents, we observed lower fertility of lesbian women's mothers and fathers. These results (together with correlations that used the ordinal definition of homosexuality, see above) contrast with those of Camperio Ciani et al. (2018), who found that lesbian women have a significantly larger pedigree size and higher kin fertility. Our results do not support the SAGH or any other balancing

mechanism accounting for the reduced reproduction levels of lesbian women. It is possible that female homosexuality was not ancestrally associated with any direct fitness decrease. If this is the case, no evolutionary mechanism to counter the decreased fitness would have needed to emerge. Even in our sample, the fertility of lesbian women was not as decreased as the fertility of gay men (compared to straight individuals of the corresponding sex).

Summary

Our data did not support the SAGH (at least its commonest, X-linked version) as a solution to the evolutionary conundrum of homosexuality but there are some alternative explanations worth considering. One such is the kin selection model, which posits that homosexual individuals increase inclusive fitness by helping their family members with raising their children (Wilson, 1975, 1978), but studies which tested this hypothesis yielded mixed results (Bobrow & Bailey, 2001; Gómez Jiménez & Vasey, 2022; Vasey et al., 2007).

A related theory proposes that in men, homosexuality could result from unintentional manipulation by some of the homosexual man's relatives, such as parents or older brothers. This idea is indirectly supported by the finding that gay men have more older brothers than straight men (Blanchard, 2018). The relatives might benefit from enhanced fitness if the sexual orientation of younger brothers is more likely to be shifted toward homosexuality, thereby reducing competition in multi-son families and redirecting parental investment in a way that benefits the fitness of the relevant individuals, i.e., either the parents (Trivers, 1974) or the older brothers (Apostolou, 2013; Flegr, 2022). From the parent's perspective, having a homosexual son who helps to raise siblings could be advantageous given that parents share a greater portion of alleles with their children (one half) than with their grandchildren (one fourth, Trivers, 1974). For older brothers, the theory is more relevant to originally agricultural societies where inheritance was paramount and brothers competed for a substantial share to increase their attractiveness as potential husbands. If there were too many straight brothers in a family, the probability of each acquiring enough parental wealth decreased. In such environmental conditions, any biological mechanism that increases the probability of homosexuality among later-born male siblings (e.g., increasing exposure to anti-Y antibodies from mothers, see Blanchard & Klassen, 1997 and Bogaert et al., 2018) is more likely to persist despite its reproductive costs. This is because having a later-born homosexual rather than heterosexual male in such contexts might: (1) reduce competition for inheritance among the brothers (see Apostolou, 2013) and potentially (2) increase the survival of the older brothers' offspring via elevated kin-directed altruism among the younger homosexual brother (see Gómez Jiménez & Vasey, 2022). Altogether, this would

increase the direct fitness of the older brothers and the inclusive fitness of the homosexual male. While these hypotheses are intriguing, there is at present insufficient empirical evidence to confirm or refute them.

Another perspective is rooted in the same-sex affiliations hypothesis. This suggests that non-exclusive homosexual behavior, which does not preclude direct reproduction, has certain adaptive benefits. It posits that individuals who engage in homosexual behavior are more inclined to support one another in competition and resource acquisition (Kirkpatrick, 2000; Muscarella, 2000). While supporting evidence in humans remains limited (Fleischman et al., 2015), observations in nonhuman primates provide some validation. For instance, female bonobo dyads which frequently engage in sexual activities are more likely to support each other in intra-sexual coalitions (Moscovice et al., 2019). A recent study reinforces this viewpoint, suggesting that in mammals same-sex sexual behavior has evolved to cement social bonds and alliances within groups (Gómez et al., 2023).

We are not aware of any reason why the role of sexually antagonistic selection as a general force promoting *exclusive* homosexuality should be restricted to humans. There is plenty of evidence of non-exclusive homosexual behavior in other animal species (e.g., Gómez et al., 2023; Monk et al., 2019; Vasey, 1995), while exclusive homosexual orientation seems to be almost nonexistent (except for rams, see Roselli, 2020). But why would sexually antagonistic selection promote higher fertility in one sex and sporadic exclusive homosexuality in the other sex only in one of the many possible species? Perhaps the mechanism compensating for the lower reproduction of exclusively homosexual humans depends on another factor that is specific to humankind. Apostolou (2013) proposed that it might hinge upon the human ability to accumulate material possessions and allocate them to one's heirs, while Barthes et al. (2013, 2015) speculated it may also be related to the social stratification of many human societies.

Another possible explanation for our null results is the hypothesized existence of different biodevelopmental subgroups of male homosexuality (Swift-Gallant et al., 2019; VanderLaan et al., 2022). If this is the case, it would be conceivable that various subgroups of gay men (differing with respect to the biodevelopment of their homosexuality) evolved different ultimate mechanisms to compensate for the lowered reproduction rates (Raymond & Crochet, 2023). This especially intriguing possibility could result in null findings in a study that includes participants with different biodevelopmental trajectories in a single research sample. The SAGH relies on an X-chromosome-related genetic mechanism. If we wanted to restrict our sample only to gay men with a possible genetic etiology of homosexuality (Swift-Gallant et al., 2019), we would have to work with a sample of gay men who have a homosexual relative. Having a homosexual relative is considered one

of the biological correlates of homosexuality, or rather a proxy marker for having homosexual alleles. This is also why it could be a good criterion for enriching the study with gay men who have homosexual alleles: They would form a better study sample to test the SAGH. Unfortunately, we did not have information on the sexual orientation of our participants' relatives. Nevertheless, we suggest that future studies should test the SAGH using a sample of gay men who have at least one homosexual male relative.

Yet another possibility is that the SAGH, as a theoretical construct, is simply not correct, or at least is not demonstrable in modern-day low-fertility populations with their extensive use of contraceptives and family planning, i.e., features which were absent for most of human evolutionary history. We also acknowledge the potential role of gene–environment interactions. Certain genes, while neutral or beneficial for fertility, may interact with specific environmental factors and subsequently influence the likelihood of homosexual orientation and/or fertility, thus adding a layer of complexity to this issue.

We note that our study is one of several recent works that failed to bring evidence in support of the SAGH, that is, the hypothesis of higher fertility of female relatives of homosexual men (Ablaza et al., 2022; Blanchard et al., 2020; Fort et al., 2024; Raymond et al., 2023; Semenyna et al., 2023; Zietsch et al., 2021). These studies sampled participants from geographically variable populations and used differing methodologies.

Perhaps it is that the number of offspring itself need not be a good indicator of biological fitness in modern times. In this context, the study of Zietsch et al. (2021) is particularly relevant: While they found no genetic correlation between female fertility and the possession of alleles predisposing men to homosexual behavior, they did find such correlation between the number of opposite-sex sexual partners of women and the possession of alleles predisposing men to homosexual behavior (see Introduction). Perhaps the number of opposite-sex sexual partners is thus a better proxy for fitness in societies that use family planning strategies and where the use of contraceptives is widespread. To conduct such study would be rather difficult, but we would like to encourage other researchers to investigate not only the number of offspring but also the number of sexual partners in the relatives (possibly siblings or parents) of gay and straight men and women by inquiring them directly.

Strengths and Limitations

Our study had several strengths but also some limitations. The main strength is that our questionnaire was completely anonymous and since our participants were not in any way reimbursed for participation, we attracted no semi-professional responders who might be attracted by financial profit.

Moreover, our large initial sample size enabled us to narrow down the pool of analyzed individuals to 7,771 men and 3,431 women who were 30 years or older to ensure that participants' parents and grandparents had already finished their reproduction. Another strength is that we examined fertility associations using both a binary definition of sexual orientation (gay/lesbian and straight individuals) and an ordinal definition of sexual orientation (the degree of homosexual attraction controlled for the degree of heterosexual attraction).

Limitations of our study include the self-selection of participants, i.e., the non-randomness of the sample. Due to the nature of our method, an anonymous internet survey, we were unable to cross-check the self-reported fertility data against reports from other family members. While we recognize the lack of cross-checked self-reports as a shortcoming, this is something that probably applies to most, if not all, studies in this field (e.g., Camperio Ciani et al., 2004, 2009; Gómez Jiménez et al., 2020; Iemmola & Camperio Ciani, 2009; Schwartz et al., 2010; Semenyna et al., 2017).

In our investigation, we employed measures that primarily reflect direct fitness (the counts of offspring and relatives). While this approach is widely used and favored for its clarity and technical feasibility, it need not fully capture the web of relatedness involved in the concept of inclusive fitness. Inclusive fitness becomes especially pertinent when exploring the complexities of gene propagation within pedigrees. Future studies should develop and use a methodology that focuses more on issues of inclusive fitness and relatedness proportions rather than on direct fitness.

It is also possible that our data were enriched with participants from smaller families: It may perhaps be more difficult for individuals from large families to recall all their aunts and uncles (which equals to paternal or maternal grandmother's fertility), including those they are not in touch with, which is why they left blank the relevant items on the number of their family members. If, for example, some effect connected with sexual antagonism manifested itself only if an individual produced at least a certain liminal number of children, this would hamper our efforts to record such an effect, especially given that we may have selectively lost data on grandmothers' fertility from participants from larger families. We believe, however, that this limitation is unlikely to have affected the data on mother's and father's fertility, because one can quite safely suppose that participants recall the number of their own siblings more easily and accurately than the number of their aunts and uncles.

Another important limitation is that we completely lacked data on the number of participants' cousins and could not therefore test for differences in the fertility of aunts and uncles of gay vs. straight individuals, as other researchers did (e.g., Camperio Ciani et al., 2004; Gómez Jiménez et al., 2020; Iemmola & Camperio Ciani, 2009). We monitored and controlled for a wider range of potentially confounding variables

than is usual in similar studies. Still, some unknown factors may also affect fertility or homosexuality, and this could obscure the relation between our focal variables, increasing the risk of false negative results of statistical tests.

Conclusions

In a large online collected sample of homosexual and heterosexual men and women, we confirmed that gay men and lesbian women have significantly fewer offspring than their straight counterparts. In line with recent studies, our results do not support the sexually antagonistic gene hypothesis, that is, the notion that maternal female relatives of gay men should be more fertile than the same relatives of straight men. The effect sizes of other observed significant associations in our study were small or very small. It is possible that the number of children is not a good indicator of biological fitness in Western societies and the number of opposite-sex sexual partners should be used instead. The absence of significant effects might be possibly attributed to the hypothesized existence of distinct biodevelopmental subgroups of homosexuality, each with possibly different ultimate explanations.

Acknowledgements We would like to thank Lenka Příplatová for her help with the preparation of the survey and Jan Toman, Daniela Dlouhá, and Jana Hlaváčová for their valuable comments and improvements of the manuscript. We also wish to thank Anna Pilátová for final revisions of the manuscript.

Author Contributions JFo, JFI, RK, and ŠK designed the study, JFI, RK, and ŠK collected the data, and JFo, JFI, and ŠK analyzed the data. All authors wrote the manuscript, approved its final version, and agree to be accountable for its content.

Funding Open access publishing supported by the National Technical Library in Prague. This research was supported by the Charles University Grant Agency (grant No. 282422; JFo) and by the Charles University Research Centres (No. 204056; ŠK, JFI).

Declarations

Competing Interests The authors have no competing interests to declare.

Ethical Approval All procedures performed in this study are in accordance with the 1964 Helsinki Declaration. The study was approved by the Institutional Review Board of Charles University, Faculty of Science (No. 2015/01).

Consent to Participate All subjects gave consent to participate in this study.

Data Transparency Data associated with this research and the preregistration are available publicly at Open Science Framework: <https://osf.io/2umzt/>

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13 Přílohy

13.1 Prohlášení o spoluautorství publikací



Přírodovědecká fakulta
Univerzita Karlova

Prohlášení o spoluautorství publikací

Tímto potvrzujeme, že doktorand Radim Kuba se podílel na vzniku následující publikace:

- Kuba, R., & Flegr, J. (2024). *Birth Order*. In *Encyclopedia of Sexual Psychology and Behavior* (pp. 1-17). Cham: Springer International Publishing.

Svým přínosem se podílel na návrhu studie, sběru dat, statistických analýzách, psaní rukopisů a jejich následných revizích.

Níže podepsaní spoluautoři souhlasí s tím, aby tento článek byl součástí jeho disertační práce.

prof. RNDr. Jaroslav Flegr, CSc.
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Přírodovědecká fakulta
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Prohlášení o spoluautorství publikací

Tímto potvrzujeme, že doktorand Radim Kuba se podílel na vzniku následující publikace:

- Kuba, R., Flegr, J., & Havlíček, J. (2018). *The effect of birth order on the probability of university enrolment. Intelligence*, 70, 61-72.

Svým přínosem se podílel na návrhu studie, sběru dat, statistických analýzách, psaní rukopisů a jejich následných revizích.

Níže podepsaní spoluautoři souhlasí s tím, aby tento článek byl součástí jeho disertační práce.

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- Kuba, R., & Flegr, J. (2025). *The Evolutionary Roots of Familial Altruism: Paternity Uncertainty Shapes Patterns of Kindness. Evolutionary Psychology. (submitováno)*

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- Daňková, H., **Kuba, R.**, & Flegr, J. (2025). Born to lead or submit? How birth order shapes sexual preferences and behavior. *The Journal of Sex Research*. (submitováno)

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- Fořt, J., Flegr, J., **Kuba, R.**, & Kaňková, Š. (2024). Fertility of Czech Gay and Straight Men, Women, and Their Relatives: Testing the Sexually Antagonistic Gene Hypothesis. *Archives of Sexual Behavior*, 53(5), 1747-1761.

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