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EMPIRICAL ARTICLE

CHILD DEVELOPMENT

Sibling effects on problem and prosocial behavior in childhood: Patterns of intrafamilial "contagion" by birth order

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Abstract

We investigated longitudinal relations between siblings' problem and prosocial behavior, measured by the Strengths and Difficulties Questionnaire, among different sibship sizes in the UK's Millennium Cohort Study. We identified 3436 families with two children and 1188 families with three children. All children (cohort members and their older sibling [OS]) had valid data on behavior at two time points (in 2004 and 2006). Using structural equation model, we found that for internalizing and externalizing problems, OSs (M_{OS1} = 6.3 years, M_{OS2} = 9.1 years at T1) exerted a dominant effect on younger siblings (M_{age} = 3.12 years at T1; 49.7% boys) across sibship sizes. For prosocial behavior, there was OS dominance in two-child families and youngest sibling dominance in three-child families.

INTRODUCTION

Mental health problems have become an increasingly significant concern worldwide (Olesen et al., 2012). In childhood and adolescence, when most of them begin (Bayer et al., 2011; Brauner & Stephens, 2006), they are typically divided into internalizing problems, such as anxiety and depressive symptoms (more prevalent in girls), and externalizing problems (more prevalent in boys), manifested through disruptive and aggressive behaviors (Midouhas, 2017; Regier et al., 2013). Internalizing and externalizing problems tend to persist over time and show some stability, which usually increases from childhood to early adolescence (e.g., Flouri et al., 2019; Neville et al., 2021; Oh et al., 2020). However, there is change too, with externalizing problems generally declining from age 4 to 18, while internalizing problems show a quadratic increase, where they steadily increase until about age 14 and then stabilize or decrease until age 18 (Bongers et al., 2003). A wealth of evidence suggests that within-family factors can also play a major role in their development. Maternal mental health, for example, is strongly linked to child problem behavior via genetic and environmental influences (Elgar et al., 2004; O'Connor et al., 2018). Low socioeconomic status (Fitzsimons et al., 2017) and ethnic minority status (Midouhas, 2017) appear to be risk factors, whereas positive and cognitively enriching parenting activities (Kwok et al., 2005) and high parental education (Sonego et al., 2013) can serve as protective factors.

A relatively less well-explored within-family source of influence is siblings. Siblings can influence one another across the life course, and on various aspects such as emotion regulation, psychopathology, delinquency, prosociality, and educational attainment (Buist et al., 2013; Her et al., 2021; Karbownik & Özek, 2019; Kramer, 2014; Prime et al., 2017; Slomkowski et al., 2001). Intervention programs for adolescents with a focus on siblings have also shown high efficacy (Feinberg et al., 2013; Kothari et al., 2014; Waid et al., 2021). Recently, Waid et al. (2020) reviewed the role of siblings in externalizing symptom development in childhood and adolescence and found a significant influence across several domains including

Abbreviations: CFI, comparative fit index; CM, cohort member; MCS, Millennium Cohort Study; NVQ, National Vocational Qualification; OS, older sibling; RMSEA, root mean square error of approximation; SDQ, Strengths and Difficulties Questionnaire; SEM, structural equation model; SRMR, standard root mean squared residual.

conduct problems and substance use. Yet, the mechanisms underlying sibling effects and their interaction with various structural factors (e.g., birth order, gender) are still unclear. Meanwhile, it remains unknown how prosocial behavior (i.e., actions intended to benefit others), a key dimension of well-being and an important correlate of problem behavior (Carlo & Padilla-Walker, 2020; Padilla-Walker et al., 2015), develops and interacts within the complex family system (Hughes et al., 2018). To add to this literature, we investigated in this study cross-sibling effects, within and across behavior domains (internalizing, externalizing, and prosocial), among two-child and three-child families over a developmental period of 2 years in childhood.

Sibling similarities and sibling effects

Siblings share considerable similarities in emotional and behavioral development, which can be attributed to their sharing of both genes and environments. Evidence from twin studies and molecular genetic studies, for example, has strongly suggested the importance of genetic effects on mental health problems, which have a higher likelihood to be shared by biological siblings, compared with unrelated individuals (Her et al., 2021; Wesseldijk et al., 2017). Within families, siblings' shared exposures to environmental influences, such as peer deviance, psychosocial deprivation, inadequate parenting, and family stressors, also contribute to their similarities. Siblings themselves however can also be an environmental influence as they actively provide a crucial social environment for each other, thus likely influencing each other's behavior (Feinberg et al., 2012). The much-cited sibling contagion phenomenon, for example, refers to the dynamic processes whereby behaviors get transmitted between siblings, facilitating the similarities between them (Her et al., 2021; Kotte & Ludwig, 2011). Typically seen through the lens of social learning theory (Bandura, 1977), sibling contagion is also expected to be stronger when siblings are close (Samek & Rueter, 2011). For example, in a group of adolescents in Grades 7 through 12, older siblings' (OS) substance use was more likely to be modeled by their younger siblings when they had more contact and mutual friendships (Rende et al., 2005). Earlier research has shown that sibling contagion is also found for prosocial behavior, from early to mid-childhood (Abramovitch et al., 1986; Dunn, 1983). It remains unknown, however, whether such sibling contagion interacts with the sibship's structural features, arguably predictors of problem and prosocial behavior.

The role of sibship's structural features

The structural features of the sibship that have probably received the most attention as predictors of internalizing and externalizing problems are size, birth order, birth spacing and gender. The role of sibship size, for example, is typically examined by research testing the resource dilution hypothesis, which views the birth of each child as a new demand on parental resources (Ruggiero et al., 2021). Although studies generally suggest weak or nonsignificant correlations between sibship size and childhood problem behavior (Yucel & Yuan, 2015), there are also findings that, in the preschool and early primary school years, children in two-child families have the lowest odds of behavioral problems and those in three-child families exhibit the greatest prosociality, compared to those with no or more siblings (de La Rochebrochard, 2013). More consistent is the evidence for the positive role of childhood sibship size in some long-term social outcomes, such as marriage and friendship in adulthood (e.g., Merry et al., 2020). This is frequently seen as evidence supporting the argument that the skills learned in early childhood through interacting with siblings may provide the foundation for lifelong skills needed for developing and sustaining intimate relationships.

Much more nuanced is the sibling research that adds a clear focus on birth order when modeling effects across the childhood years. This has uncovered some intriguing patterns and broadly supported two conclusions. First, the arrival of a new sibling can lead to maladjustment and behavior problems in early childhood (Volling, 2017), with increases, particularly, in physical aggression (Tremblay et al., 2004). There is also some domain specificity when birth order effects are modeled further in time (i.e., removed from the shock of the birth of a new sibling) with evidence, for example, suggesting that while the presence of OSs is influential for hyperactive behaviors, the number of younger siblings influences emotional problems and conduct problems (Lawson & Mace, 2010). Second, for sibling contagion, there is typically stronger transmission from older to younger than from younger to OSs, particularly for externalizing problems, across the preschool period (Olson et al., 2020), primary school years (Pike & Oliver, 2017; Shortt et al., 2010) and adolescence (Defoe et al., 2013), and across different externalizing domains, including conduct problems, delinquency, smoking, and substance use (for a review, see Waid et al., 2020). Importantly, such contagion effects can be seen very early, with a study for example showing that OSs' emotional and behavioral problems at the birth of a younger sibling strongly predicted that child's same problems at 4.5 years old (Rodrigues et al., 2017). A recent study, however, has shown broad (emotional and behavioral) problems of younger siblings (at age 5) to be predictive of OSs' (age 5–15) broad problems, peer problems, conduct problems, and emotional symptoms (Hayden et al., 2019). Adding further complexity to the picture, there has been some evidence of bidirectional sibling effects on risky behaviors during adolescence

(Whiteman et al., 2017). With prosocial behavior the findings are even more mixed (Abramovitch et al., 1986; Dunn, 1983; Prime et al., 2017).

Sibling contagion: Moderation by the sibship's structural features

An explanation for this mixed picture may be that sibling contagion effects are moderated not only by birth order but by other important features of the sibship as well, such as size, gender, and birth spacing. With respect to the latter, for example, if siblings' age range is wide, then children would be at widely different points in development and therefore sibling effects may arguably vary substantially in both direction and magnitude. Sibship size, on the other hand, may moderate sibling effects not only because it is related to the dilution of parental resources, as discussed (Her et al., 2021), but also because, it approximates, by definition, the number of sources of sibling input (Tippett & Wolke, 2015). In many two-child families, for example, the younger sibling grows up with the same source of sibling influence during key developmental periods (Prime et al., 2017). In three-child families, comparatively, children have more sources of influence but also more, and potentially different, social relationships to navigate, and more complex dynamics to negotiate.

On the other hand, the gender composition of the sibship and the age difference between siblings can influence sibling contagion directly but also moderate the effect of birth order on it. Brother–brother pairs, for example, are where the strongest sibling contagion effects in delinquency and antisocial behavior are usually found (Ensor et al., 2010; Fagan & Najman, 2003). Birth spacing, in comparison, has yielded mixed results. When age gaps are smaller, siblings are more likely to act as role models but also show both comparison and deidentification. However, there has been little evidence to date that explores all these influences simultaneously.

In summary, while many studies have established the effect of sibling contagion and that of various sibship constellation factors on children's problem and prosocial behavior, it is unknown whether these effects are independent or interact with each other. Sibling contagion for example might vary by sibship size, birth order, birth spacing, and gender. We carried out this study to address this issue.

The current study

Our review of the extant literature showed a research gap in the direction of "transmission" by birth order of problem and prosocial behavior between siblings in childhood after taking into account the complex influences of the sibship's size, birth spacing, and gender. Using longitudinal data of two time points from a national cohort of families with young children in the UK, this study attempted to bridge this gap in a relatively confirmatory way. We explored patterns of transmission of child behavior by birth order across different sibship sizes and explored its within-family development across a period of 2 years in early and middle childhood, i.e., when sibling effects are strong, before starting to decrease during adolescence (Steinberg & Monahan, 2007). We explored effects for sibling dyads and sibling triads only, due to data constraints (see Sample). We included gender composition and age differences between siblings as two extra confounding variables in a supplementary analysis. Child behaviors were treated in two ways, with scores summed either into three subscales (i.e., internalizing, externalizing, and prosocial), or into five (i.e., emotional, conduct, peer, hyperactive, and prosocial). We show in Figure 1 the possible direction and magnitude of effects between the "cohort member" (CM), who is our target child (aged about 3 years at Time 1 and about 5 years at Time 2), and always the youngest child, and their OSs (OS1 and OS2).

We hypothesize that: (1) siblings' behavioral domains are concurrently correlated at both time points ("c" indicating concurrent correlations), (2) the autoregressive pathways, or homotypic continuity within-person, from Time 1 to Time 2 are stronger for the OSs than for the younger ("a" indicating autoregressive pathways), (3) there is OS dominance for the problem and prosocial behavior in two-child families while the youngest sibling may also be influential in three-child families ("d" indicating dominance). Doing so we expand previous research in two ways. First, we consider simultaneously sibship size and birth order but also their interaction. To the best of our knowledge, this is the first study to use a large, birth-cohort dataset to test such phenomena in sibling pairs and sibling triads in childhood. Second, we explore the cross-sibling, cross-domain longitudinal development of problem and prosocial behavior, which allows for the possibility of testing, for example, protective effects of earlier prosocial behavior on own or sibling's problem behavior.

METHODS

Sample

We used data from the Millennium Cohort Study (MCS), a longitudinal birth-cohort study tracing the lives of UK children born in the new millennium. The study began in 2000–2001 and has followed 18,552 children in England, Scotland, Wales, and Northern Ireland from 9 months to 18 years (Connelly & Platt, 2014). In the present study, we used data from

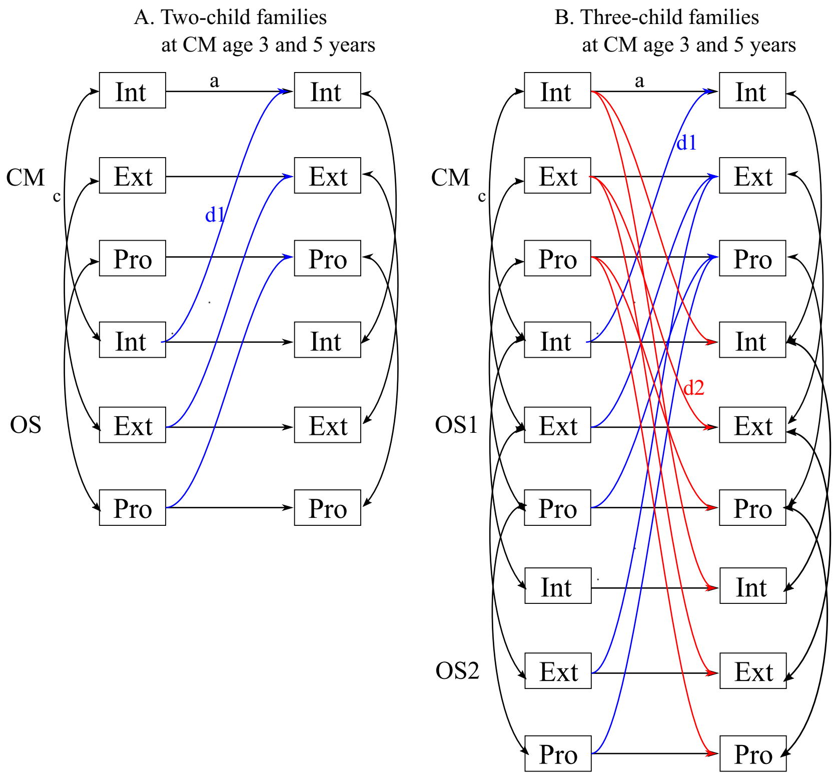

FIGURE 1 Theoretical model. (a) Two-child families at CM age 3 and 5 years. (b) Three-child families at CM age 3 and 5 years. a, autoregressive (homotypic) effect; c, concurrent association; d1, older sibling (OS) dominance effect; d2, cohort member (CM; i.e., the youngest sibling) dominance effect; Ext, externalizing symptoms; Int, internalizing symptoms; Pro, prosocial behavior. For simplicity, only some paths are shown.

sweeps 2 and 3 (MCS2, 2004; and MCS3, 2006), when CMs were, respectively, around age three (n = 15,808) and five (n = 15,460), and when information about their OSs and their behavior was also collected at MCS. We linked these with covariates (see Table 1) from the first sweep (MCS 1, n = 18,552) when CMs were about 9 months old.

While CMs in the MCS have up to 12 OSs in the household, most MCS households are two- and three-child families, adding up to 70.2% of the whole sample. To control for the effect of sibship size and subsequent births in the family, we selected two groups of families where the CM is the youngest child in their family at sweeps 2 and 3 and has either one OS (Sample 1; n_1 = 3436, M = 3.12 years, SD = 0.18 and 50.1% boys) or two OS (Sample 2; n_2 = 1188, M = 3.12 years, SD = 0.18 and 48.2% boys) in the household. (Families where problem and prosocial behavior data of any sibling [CM, OS1, and OS2] in any of the two sweeps was missing were excluded.) The average ages of OS1 and OS2 at Time 1 (MCS2) are 6.30 years (SD = 2.02) and 9.12 years (SD = 2.11), respectively. OS were almost gender balanced (Sample 1: 51.3% were boys, Sample 2: 53.2% OS1 were boys and 52.1% OS2 were boys). Most OS were biological siblings (86.8%), some were half siblings (13.2%), and a few were step, adopted, and other kinds of siblings (under 0.1%).

Measures

Problem and prosocial behavior

Problem and prosocial behavior of both CMs and their OSs were measured by the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) at MCS2 and MCS3. The SDQ (www.sdqinfo.com) is a well-validated screening tool of problem and prosocial behavior in childhood and adolescence (Goodman et al., 2010). It consists of 25 questions (reported on a 3-point Likert scale [0 = not true, 1 = somewhat true, 2 = certainly true]), divided into five subscales: emotional problems, peer problems, hyperactivity, conduct problems, and prosocial behavior. In general population and low-risk samples, it is suggested to alternatively use a three-subscale division into prosocial behavior, internalizing problems (consisting of emotional and peer problems), and externalizing problems (consisting of hyperactivity and conduct problems) (Goodman et al., 2010). In the present study, we tested our models using both ways of division. However, we present results from our analysis using the three rather than the five subscales, due to the general population base of the MCS.

In the two MCS sweeps, we used the SDQ was filled out by the main respondent (overwhelmingly, e.g., for 93% of cases, the mother). We tested the structural

TABLE 1 Descriptive analyses of the study samples.

Demographic variable	MCS full sample (*N*=13,034) %	Sub-sample 1 Two-child families (*N*=3436) %	Sub-sample 2 Three-child families (*N*=1188) %
Mother's education T1 (%)			
NVQ LEVEL 1	8.9	8.2	10.3
NVQ LEVEL 2	33.2	32.8	38.2
NVQ LEVEL 3	17.6	17.3	14.0
NVQ LEVEL 4	35.4	37.0	33.3
NVQ LEVEL 5	4.9	4.6	4.2
Mother's education T2			
NVQ LEVEL 1	8.5	7.7	9.4
NVQ LEVEL 2	31.7	31.0	36.8
NVQ LEVEL 3	17.5	17.1	13.9
NVQ LEVEL 4	35.9	37.5	33.7
NVQ LEVEL 5	6.5	6.7	6.1
Family structure T1			
Lives with both natural parents	81.1	85.2	85.5
Does not live with both natural parents	18.9	14.8	14.5
Family structure T2			
Lives with both natural parents	76.7	81.1	81.8
Does not live with both natural parents	23.3	18.9	18.2
Stratum			
England—advantaged	33.4	36.7	31.6
England—disadvantaged	22.7	22.6	21.3
England—ethnic	7.0	4.9	9.1
Wales—advantaged	5.8	6.8	5.1
Wales—disadvantaged	9.3	8.6	9.8
Scotland—advantaged	6.9	7.7	7.3
Scotland—disadvantaged	5.3	5.4	4.5
Northern Ireland—advantaged	4.3	3.6	4.5
Northern Ireland—disadvantaged	5.4	3.8	6.8
CM gender			
Male	51.1	50.1	48.2
Female	48.9	49.9	51.8
OS1 gender			
Male	52.1	51.3	53.2
Female	47.9	48.7	46.8
OS2 gender			
Male	50.7	\	52.1
Female	49.3	\	47.9
Mother's Kessler T1	3.2	3.1	3.3
Mother's Kessler T2	3.1	2.9	3.4
Harsh parenting T1	9.5	9.6	9.3
Harsh parenting T2	8.4	8.5	8.3
OS1 age T1	6.6	6.3	6.3
OS2 age T1	9.4	\	9.1

Note: For categorical variables, the percentage of each value is shown. For continuous variables, the mean value is displayed. As the mother was overwhelmingly (in 93% of cases) the main respondent for SDQ, we excluded the few cases where she was not. The full MCS sample was generated by merging data for the three sweeps (MCS1, MCS2 and MCS3) and listwise deleting cases without SDQ data for the CM at either MCS2 or MCS3.

Abbreviations: CM, cohort member; MCS, Millennium Cohort Study; NVQ, National Vocational Qualification; OS, older sibling; SDQ, Strengths and Difficulties Questionnaire.

validity of the SDQ by specifying a Confirmatory Factor Analysis for the scale. There was an appropriate fit of all subscales for both CM and OS (root mean square error of approximation [RMSEA] = .02–.11; comparative fit index [CFI] = .92–1.00). Fit of the three-factor model was also confirmed by an exploratory structural equation model (SEM) with target rotation (CFI = .93, TLI = .91, RMSEA = .047; Chiorri et al., 2016). Reliability of the SDQ was tested by the Ordinal Cronbach's alpha (Gadermann et al., 2012), with α values ranging from .61 to .89 (Table S1). For our path models, we used scale-scores (see Figure 2).

Covariates

We included both time-varying covariates (i.e., maternal psychological distress, maternal education, harsh parenting, family structure) and time-invariant covariates known to be associated with problem and prosocial behavior in childhood. Child-related covariates include gender and age. As all CMs in the MCS are within the same age-band (M = 3.12, SD = 0.18 at Time 1; M = 5.21, SD = 0.25 at Time 2), age in years was only controlled for the OSs. Maternal education was measured by the UK's National Vocational Qualification (NVQ) levels (Bøe et al., 2012; Flouri et al., 2019), where Level 1 refers to entry-level knowledge and skills, and Level 5 refers to higher degrees or postgraduate qualifications. Considering associations between poor maternal mental health and children's problem behavior (Malmberg & Flouri, 2011), we also adjusted for maternal psychological distress. This was assessed by the Kessler K6 scale (Kessler et al., 2003), a 6-item 4-point Likert scale focusing on mental illness in the general population (e.g., "how often during the past 30 days did you feel nervous"). We also considered maternal harsh parenting, which was measured by three items rated from 1 to 6, selected from the Conflict Tactics Scales (ordinal α = .69; Straus & Hamby, 1997; i.e., how often do you tell off/shout at/smack the CM when he/she is naughty).

The family-level covariates were family structure and sampling stratum. Family structure information was collected by a question asking whether children live with both natural parents or not. Sampling stratum describes the nine sub-groups of MCS families, as sampled from advantaged and disadvantaged areas from all four UK countries (England, Wales, Scotland, and Northern Ireland), and areas of higher ethnic minority density in England. These were included as eight dummy-coded variables, using the "England-advantaged" stratum as baseline.

We also explored the roles of the gender composition of the sibship and the age difference between siblings in a supplementary analysis (see Data S1). The former was a binary variable (1 = same gender, 0 = different gender). The latter was the age difference between the youngest sibling (i.e., the CM) and his/her OSs (ΔCM and OS1: M = 3.48, SD = 2.32; ΔCM and OS2: M = 6.32, SD = 2.25).

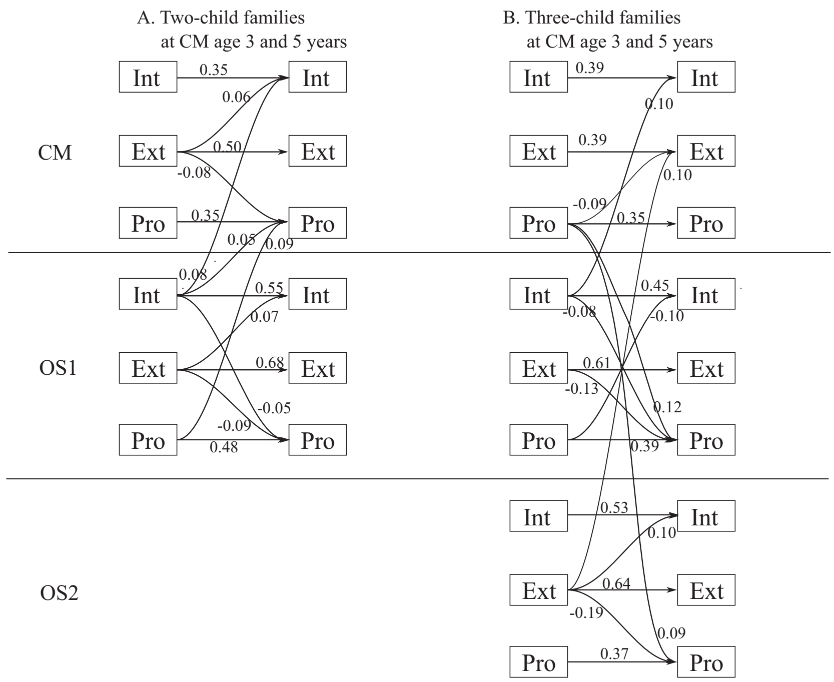

FIGURE 2 Sibling effects model in two-child and three-child families. (a) Two-child families at CM age 3 and 5 years. (b) Three-child families at CM age 3 and 5 years. Ext, externalizing symptoms; Int, internalizing symptoms; Pro, prosocial behavior. Parameter estimates are standardized regression-weights from Mplus 8.1 (Muthén & Muthen, 2017). Only significant (p < .01) effects are shown. CM, cohort member; OS, older sibling.

Statistical analysis

Prior to the main analyses we inspected the intraclass correlations in three-level models (as time points nested in children nested in families), indicating that there was substantive variance within children (i.e., across time: internalizing: r_{ICC}=.42, externalizing: r_{ICC}=.36, prosocial: r_{ICC}=.55), between children (i.e., between CMs and their siblings; internalizing: r_{ICC}=.31, externalizing: r_{ICC}=.45, prosocial: r_{ICC}=.31), and between families (internalizing: r_{ICC}=.27, externalizing: r_{ICC}=.19, prosocial: r_{ICC}=.14).

Following Figure 1 we specified path models using scale scores for our SEMs in Mplus (Muthén & Muthen, 2017). Goodness-of-fit indices, including the CFI and the RMSEA, and the standard root mean squared residual (SRMR), were calculated to measure the extent to which a specified model fitted the data. The thresholds we used for good fit are below .06 for RMSEA, below .08 for SRMR, and above .95 for CFI (Hu & Bentler, 1999). Two extra models that included the sibship's gender and the sibship's age difference were separately tested.

RESULTS

Descriptive results

The descriptive features of the two study samples (two-child and three-child families) and the wider MCS sample from which they were drawn are summarized in Table 1. As with the full MCS, England families comprised the largest proportion of families in both study samples (64.2% and 62%), with the remaining families coming from Wales, Scotland, and Northern Ireland. Most mothers in two-child families had an education qualification of NVQ4, while the largest proportion of mothers in three-child families held an NVQ2 qualification.

The correlations between CM's and OS's behavioral domains and covariates at Time 1 and Time 2 are shown in Table 2. Most covariates were associated with children's problem and prosocial behavior and thus were included in the SEMs. As expected, the age of CM had no effect as all CMs in the study sample were born in 2000–2001, as explained. The age of OS2 was also not predictive of problem behavior.

Main results

The cross-lagged models tested are shown in Figure 2. Models fitted data well (RMSEA=.03–.04; CFI=.95–.97; TLI=.90–.92; details in Table S2).

Concurrent associations

Our first research question was whether domain-specific (homotypic) behaviors of siblings are associated.

TABLE 2 Correlations between outcome variables and covariates at Time 1 (when CM was 3 years old) and Time 2 (when CM was 5 years old).

		Cohort member (n_1+n_2=4624)			Older sibling 1 (n_1+n_2=4624)			Older sibling 2 (n_2=1188)		
		Internalizing	Externalizing	Prosocial	Internalizing	Externalizing	Prosocial	Internalizing	Externalizing	Prosocial
Time 1	Family structure	**−.11**	**−.18**	.00	**−.14**	**−.16**	**.09**	**−.16**	−.09	.05
	Mother's education	**−.17**	**−.20**	.02	**−.11**	**−.16**	.03	**−.15**	**−.21**	.08
	Mother's Kessler	**.25**	**.32**	**−.09**	**.33**	**.26**	**−.14**	**.30**	**.23**	**−.11**
	Harsh parenting	**.07**	**.36**	**−.19**	**.11**	**.10**	**−.09**	.07	.10	−.06
	Age	.00	.00	.05	.05	.03	.02	−.02	.01	−.04
	Gender	**−.06**	**−.11**	**.12**	−.03	**−.19**	**.17**	−.01	**−.19**	**.14**
Time 2	Family structure	**−.11**	**−.18**	**.04**	**−.15**	**−.15**	**.09**	**−.20**	**−.18**	**.12**
	Mother's education	**−.11**	**−.16**	.03	**−.09**	**−.17**	**.07**	**−.14**	**−.18**	.06
	Mother's Kessler	**.30**	**.27**	**−.14**	**.31**	**.25**	**−.14**	**.32**	**.24**	**−.11**
	Harsh parenting	**.11**	**.36**	**−.20**	**.12**	**.13**	**−.07**	.08	**.12**	−.08
	Age	−.02	−.03	.05	.01	.05	**−.08**	−.03	.02	**−.12**
	Gender	−.02	**−.17**	**.18**	.04	**.06**	**−.05**	−.04	**.00**	**.00**

Note: Significance at $p<.001$ is indicated in bold font. Age and gender are within-person.

In two-child families (Sample 1) we found, consistent with our first hypothesis, that siblings' behavioral domains were concurrently correlated at both time points. CM's internalizing problems significantly correlated with those of OS1 at CM's age 3 years ($\rho_{T1}=.20$, $p<.001$) and 5 years ($\rho_{T2}=.08$, $p<.001$). Significant links were also found for their externalizing problems ($\rho_{T1}=.10$, $p<.001$, $\rho_{T2}=.05$, $p=.007$) and their prosocial behavior ($\rho_{T1}=.17$, $\rho_{T2}=.16$, $p<.001$), and across different domains (see Table S3).

Similar results were found for three-child families (Sample 2). At Time 1, internalizing, externalizing, and prosocial behaviors of CMs and their OS1 and OS2 were positively correlated ($\rho=.11$–$.26$, $p<.001$). At Time 2, comparatively, significant associations were found between CM and both OSs. However, no associations were found between OS1 and OS2 for internalizing problems. For externalizing problems, there were no correlations between CM and either sibling but there was a significant correlation between OS1 and OS2 ($\rho=.09$, $p=.003$). All three children's prosocial behaviors were positively associated ($\rho=.16$–$.21$, $p<.001$). Significant cross-domain concurrent correlations were found for certain domains (see Table S3).

Autoregressive pathways

The second research question was to investigate the autoregressive pathways of behaviors of both CM and OS, as well as whether they are more stable for OS than for CM. We observed, as expected, significant autoregressive pathways of all SDQ subscales for all children, with βs ranging from .35 (Sample 1, CM internalizing problems; $p<.001$) to .68 (Sample 1, OS externalizing problems; $p<.001$). Using additional parameter comparison commands in Mplus, we compared differences in the magnitudes of autoregressive path coefficients between CM and OS in both samples (shown in Table S4). In two-child families, consistent with our second hypothesis (the autoregressive pathways, or homotypic continuity within-person, from Time 1 to Time 2 would be stronger for the OSs than for the youngest) the stability of all three subscales ($\Delta\beta=.19$–$.22$, $p<.001$) was stronger among OS than among CM, as expected. In three-child families, CM's internalizing problems were significantly less stable than those of OS2 ($\Delta\beta=.16$, $p<.001$). CM's externalizing problems were also less stable than those of OS1 ($\Delta\beta=.25$, $p<.001$) and OS2 ($\Delta\beta=.23$, $p<.001$). No difference was found for prosocial behavior between CM and OSs.

Birth order effects in sibling contagion

To test our last hypothesis, we fitted cross-lagged models of problem and prosocial behavior within and across siblings. The results partially supported our hypothesis about OS dominance. Within-domain effects from OS to CM were indeed found for problem behavior. In two-child families, OS1's internalizing problems predicted CM's internalizing problems ($\beta=.07$, $p<.001$). Similarly, in three-child families, OS1's internalizing problems predicted CM's internalizing problems ($\beta=.10$, $p<.001$), and OS2's externalizing problems predicted CM's externalizing problems ($\beta=.11$, $p<.001$). Cross-domain effects were also found, but only in two-child families: OS's externalizing problems at T1 predicted CM's internalizing problem at T2 ($\beta=.06$, $p=.005$). These effects were unidirectional and provide support for OS dominance for problem behavior. Additionally, internalizing problems of OS at T1 were predictive of CM's prosocial behavior at T2 ($\beta=.05$, $p=.006$). For prosocial behavior effects, however, there seems to be OS dominance in two-child families, but youngest sibling dominates in three-child families. Specifically, when there is only one OS, CM's prosocial behavior is predicted by OS1's prosocial behavior ($\beta=.08$, $p<.001$). When there are two OSs in the family, the CM's prosocial behavior has a unidirectional effect on the prosocial behavior of both OS1 ($\beta=.13$, $p<.001$) and OS2 ($\beta=.10$, $p<.001$).

Covariate effects

We summarize the results for the covariate effects in Table 3. Within families with two children (Sample 1), mother's education predicted both internalizing and externalizing problems, and maternal psychological distress predicted internalizing, externalizing, and prosocial behavior at both time points. Harsh parenting had a significant effect on externalizing problems. In three-child families, similarly, mother's education predicted all three children's internalizing and externalizing problems. Maternal psychological distress, comparatively, predicted problem behavior but not prosocial behavior. The effect of stratum, not included in the table, showed that children living in disadvantaged areas in England, Scotland, and Wales had more problem behavior and less prosocial behavior.

Sensitivity analyses

We conducted the same analysis by scaling the SDQ into five subscales. Results were broadly similar, in the sense that while there was OS dominance for emotional (OS1 → CM; $\beta=.08$, $p<.001$) and conduct problems ($\beta=.06$, $p=.005$) within two-child families, there was some evidence for youngest sibling dominance within three-child families for prosocial behavior (CM → OS1; $\beta=.12$, $p<.001$).

Two models were also specified to include information about the gender composition of the sibship and

TABLE 3 Covariate effects on siblings' problem and prosocial behavior at Time 1 and Time 2.

	CM			OS1		
Sample 1	**Int**	**Ext**	**Pro**	**Int**	**Ext**	**Pro**
T1						
Family structure	−.04	−.11	−.02	−.04	**−.08**	.04
Mother's education	**−.13**	**−.12**	.01	**−.05**	**−.11**	−.01
Mother's Kessler	**.21**	**.19**	**−.06**	**.32**	**.21**	**−.1**
Harsh parenting	.04	**.37**	**−.22**	**.09**	**.08**	**−.08**
Age	NA			.03	.03	.02
Gender	**−.07**	**−.08**	**.1**	−.01	**−.17**	**.16**
T2						
Family structure	−.02	**−.07**	.02	−.05	**−.03**	.03
Mother's education	−.01	−.03	−.01	−.004	**−.04**	.01
Mother's Kessler	**.18**	**.11**	**−.1**	**.14**	**.09**	**−.04**
Harsh parenting	.002	**.18**	**−.07**	.03	**.04**	−.01
Age	NA			−.02	.02	**−.1**
Gender	.02	**−.08**	.12	<.001	**−.07**	**.06**

	CM			OS1			OS2		
Sample 2	**Int**	**Ext**	**Pro**	**Int**	**Ext**	**Pro**	**Int**	**Ext**	**Pro**
T1									
Family structure	−.01	**−.09**	.002	.01	−.02	.01	**−.07**	−.06	.06
Mother's education	**−.17**	**−.14**	.02	−.08	**−.11**	.03	**−.11**	**−.17**	.07
Mother's Kessler	**.24**	**.22**	−.02	**.26**	**.16**	−.06	**.27**	**.2**	−.08
Harsh parenting	.02	**.35**	**−.2**	.06	**.13**	**−.13**	.02	**.09**	−.09
Age	NA			−.01	.05	−.04	**−.02**	.01	**−.12**
Gender	−.02	**−.12**	**.12**	.001	**−.08**	**.08**	**.03**	**−.06**	.04
T2									
Family structure	−.04	**−.09**	.02	**−.12**	**−.13**	**.13**	**−.11**	−.05	**.03**
Mother's education	−.04	−.06	−.02	−.02	−.07	.02	−.04	−.02	−.02
Mother's Kessler	**.16**	**.11**	−.06	**.13**	**.08**	−.02	**.12**	**.12**	−.05
Harsh parenting	.07	**.24**	**−.17**	.02	**.09**	−.002	.04	.03	−.03
Age	NA			.04	−.004	.06	−.02	.01	−.05
Gender	**−.08**	**−.1**	**.14**	**−.07**	**−.22**	**.19**	−.05	**−.2**	**.16**

Note: Significance at $p<.001$ is indicated in bold font. Age and gender are within-person.

Abbreviations: CM, cohort member; Ext, externalizing problems; Int, internalizing problems; OS1 and OS2, older siblings 1 and 2; Pro, prosocial behavior.

the age difference between siblings. The pattern of findings did not change substantially after including this information, and detailed results are shown in Data S1.

DISCUSSION

Our analysis of the longitudinal relationship between siblings' problem and prosocial behavior in early to middle childhood among two-child and three-child families found full support for the first two hypotheses and partial support for the third. We found an association between siblings' problem and prosocial behavior at Time 1, which remains significant after 2 years, at Time 2 (Hyp 1), an autoregressive pathway of problem behavior and prosocial behavior from Time 1 to Time 2, which is stronger for OSs (Hyp 2), and an OS dominance effect for problem behavior (Hyp 3). What was unexpected was that for prosocial behavior there was OS dominance within two-child families but youngest sibling dominance within three-child families. We discuss the findings in order of the hypotheses.

Associations between siblings' behavior are weaker in larger families

Concurrent relationships between siblings' problem and prosocial behavior were found at Time 1 in both samples.

This finding extends previous results (Hayden et al., 2019; Pike & Oliver, 2017) by considering links across externalizing problems, internalizing problems and prosocial behavior, thus better reflecting patterns of sibling effects across the full range of socio-emotional development in the general child population. In our study, concurrent relationships remained significant after 2 years (at Time 2) among all siblings in two-child families, while in three-child families only the concurrent relationship for prosocial behavior remained significant for all siblings. This might indicate that within larger families, with children's ages ranging from middle childhood to pre-adolescence (the age range of our sample at Time 2), socio-emotional development is also dependent on extra-familial influences, including school, society, and culture (Bronfenbrenner, 1994).

Problem and prosocial behavior is more stable over time for OSs

In keeping with previous studies (Flouri et al., 2019; Pike & Oliver, 2017), we found within-child associations in behavior over time. There were also however age differences in this stability. In two-child families, the OS showed greater within-person stability, as expected. This means that child behavior might be less amendable to intervention later in development. In three-child families, comparatively, there were differences between siblings in the stability of problem but not prosocial behavior. These results might indicate that a larger sibship size leads to more "equality" among siblings, in the sense that OSs' prosocial behavior is not more stable than that of the youngest child.

OS dominance for problem behavior

With regard to our longitudinal cross-sibling effects, our results replicated and extended the OS dominance effect reported by Pike and Oliver (2017). In both two-child and three-child families, we found a unidirectional prediction from an OS's internalizing problems and externalizing problems to the same type of problems in the youngest child. Although our finding about externalizing behavior is consistent with previous research (Shortt et al., 2010; Van Berkel et al., 2014), our finding about internalizing problems is novel. This general pattern of results aligns well with social learning theory and adds its own implications to it. People tend to learn from the behavior of role models around them (Bandura, 1977). For young children, older sisters and brothers are important individuals to observe and imitate (Samek & Rueter, 2011). For the youngest child, their OSs may be the only peers that they observe and imitate, but also interact with, in the early years of life, which means they are very likely to model their behavior. By contrast, the oldest sibling may have been used to a life without siblings, especially if the age gap between siblings is large. They may be less likely to switch from learning from adults and peers around them to imitating their new brother or sister. In this way, an OS with challenging behaviors may directly or indirectly cause similar behaviors in their younger sibling, but a younger sibling is only a newcomer in the OS's life and in most cases is not seen as important enough to cause negative behaviors if he or she is poorly behaved. Another possible explanation can be derived from the "spillover" hypothesis. According to this, relationships between some family members can affect other family members (Erel & Burman, 1995; Pike et al., 2005). Problem behavior in the OS might shape interactions with parents and affect parenting activities and well-being, which can influence younger children particularly strongly.

Youngest sibling dominance for prosocial behavior in three-child families

We found evidence for OS dominance for all domains of behavior in two-child families and youngest sibling dominance for prosocial behavior in three-child families. In other words, for prosocial behavior there seems to be an interaction between sibship size and dominance-by birth order. Existing literature has consistently reported a later-born advantage in prosocial skills, showing that younger siblings have on average greater prosocial tendencies than their OSs (Prime et al., 2017; Salmon et al., 2016). It is possible that differences in both quality and quantity of family interactions by family size explain this differentiated dominance. With fewer children in the household, an OS would possibly spend time socializing with peers outside the family, thus limiting any influences from their younger sibling. When there are more siblings in the family, however, OSs may be more likely to find peers within the household and thus may be more likely to be influenced by their youngest siblings. In this situation, the youngest child would have more opportunities to spread their good spirit, show cooperative or sharing behavior, and affect their OSs.

Covariate effects

We included important individual and family factors in the model as covariates, and found, for example, significant effects of gender, mother's education, maternal psychological distress, harsh parenting, family structure, and socioeconomic status (Elgar et al., 2004; Erath et al., 2009; Fitzsimons et al., 2017; Sonego et al., 2013). Interestingly, these effects also seem to differ between two-child and three-child families, as well as between older and younger siblings, indicating an interaction between sibship features and the environment. For example, maternal Kessler scores predicted children's prosocial behavior at both time points in families with two children, but not in families with three children. This could be explained by the effect of family socioeconomic status, in the sense that family economic pressure, typically greater in larger families, could lead to parental depression and negative parenting (e.g., Newland et al., 2013; Roubinov & Boyce, 2017) but also child behavior. Future studies are therefore needed to explore how environmental risk factors affect children's development across sibship sizes.

Limitations

There are some important study limitations. First, as the study is longitudinal and the attrition rate due to dropout was higher for families of low socioeconomic status or from ethnic minority areas (Joshi & Fitzsimons, 2016). Second, the exclusive use of maternal reports is a limitation. Relying on one parent's report of children's behavior has been related to potential rater bias (Wesseldijk et al., 2017), which could further explain the intra and inter-child associations between and across behavioral domains we found. As there was limited information provided by fathers in the MCS, future studies should consider including them to reduce same-reporter bias. Third, there was no available measure of the quality of the interaction between siblings. Fourth, we can generalize findings across two- and three-child families only. Fifth, the findings on sibling similarities could reflect the influences of shared genes between siblings, not measured in the study. Sixth, and perhaps more important, we were constrained by the study design and study measures that we had available, and we were thus unable to separate selection from influence effects.

CONCLUSIONS

The findings of this study have implications both for parents seeking to improve children's mental health and social skills and for practitioners supporting child development. For parents, we suggest that they are reminded of the importance of OSs as role models for younger children. OSs' negative behavior can cascade down to younger children. Interventions targeting older children with problem behavior can therefore have chain effects, protecting younger siblings. In larger families, the youngest child could play a crucial role "spreading" prosocial behavior among their siblings. Extra support and effort in guiding the youngest child to be helpful, cooperative and sharing may have an indirect effect on the OSs' prosocial tendencies too, which could potentially improve the whole family atmosphere.

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CONFLICT OF INTEREST STATEMENT

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

DATA AVAILABILITY STATEMENT

The data can be acquired from the UK Data Service, and the code and materials necessary to reproduce the analyses presented in this paper are available from the first author. The analyses presented here were not preregistered.

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