



Kin detection cues and sibling relationship quality in adulthood: The role of childhood co-residence duration and maternal perinatal association

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ABSTRACT

Cues facilitating kin detection among children have been suggested to have a profound impact on adult sibling relationships. Using a large and population-based data of younger and middle-aged Finns, we test how childhood co-residence duration and maternal perinatal association (MPA) correlate with contact frequency, emotional closeness and provision of help between adult siblings. Employing sibling fixed-effect regression models we show that duration of co-residence in childhood and MPA are indeed associated with better relationship quality in all three measures. Provided MPA, sibling relationship quality is high independently of co-residence length, but in the absence of MPA, increased co-residence duration is associated with better relationship quality. Co-residence duration is more strongly associated with provision of help between opposite-gender than same-gender sibling dyads. Full siblings report better relationship quality than half siblings do, although the co-residence duration mediates the effect of genetic relatedness in emotional closeness between full and maternal half siblings and in provision of help between full and paternal half siblings. Moreover, MPA serves as a mediator in the case of emotional closeness between full and maternal half siblings. Our results provide solid support for the importance of childhood kin detection cues for sibling relationship quality in adulthood, and how such cues interact with genetic relatedness and gender.

1. Introduction

Genetic relatedness is associated with several key aspects of social behavior. Across societies individuals are more likely to invest time, help, and other resources towards close kin than distant kin or non-kin (Abbot, Abe, Alcock, Alizon, et al., 2011; Salmon & Shackelford, 2011). Inclusive fitness theory stipulates that altruistic behavior between individuals (i.e., behavior with a cost to the individual and a benefit to the receiver) should be stronger with higher genetic relatedness (Hamilton, 1964), hence the existence of kin altruism. A second evolved behavioural trait with relevance for kin detection is inbreeding avoidance (Bressan & Kramer, 2015). Inbreeding depression is well documented in many species (Charlesworth & Willis, 2009) and natural selection can be expected to have favored psychological cues which help individuals avoid mating with close relatives (Antfolk & Wolf, 2016).

In order to regulate social behavior according to the degree of genetic relatedness, individuals need to be able to assess to whom they are related. Several species including humans appear to rely on various cues for kin recognition, which help to determine whether a person is a

relative or not (Hepper, 2011). Such cues need not always reflect actual genetic relatedness, but should have done so sufficiently in ancestral environments to be favored by natural selection. Kin detection cues can be either direct (between the individuals concerned) or indirect (deduced from third parties or the environment). Direct kin recognition may include, for instance, facial resemblance (e.g. Bressan, Colarelli, & Cavalieri, 2009; Bressan & Zucchi, 2009), or smell (Brown & Eklund, 1994). However, for the most part, humans have to rely on indirect kin detection cues available in our social environment. One indirect cue is linguistic assignment: all languages have some terminology to denote immediate family members and more distant kin (Hepper, 2011), and kin terminology is appropriated to signal altruistic solidarity between two unrelated individuals or in social groups (Rotkirch, 2018). Another highly relevant indirect cue for kinship is social association and physical proximity (Lieberman, 2009). Those who we grow up with are easily coded as “family”, fostering both altruism and inbreeding avoidance (Lieberman & Billingsley, 2016).

Westermarck (1891) was the first to suggest that close association in childhood serves as a cue for kin detection. In his book *History of Human*

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Marriage, Westermarck proposed that growing up together was a cue for incest avoidance. The “home is kept pure from incestuous defilement neither by laws, nor by customs, nor by education, but by an instinct which under normal circumstances makes sexual love between the nearest kin a psychical impossibility” (ibid., 319), he wrote, and suggested that the “instinctive aversion to marriage between persons living closely together” (ibid., 334) had evolved in humans and other species in order to avoid inbreeding.

In their influential research, [Lieberman, Tooby, and Cosmides \(2007\)](#) extended Westermarck’s original hypothesis by including another possible kin detection cue alongside co-residence, namely, maternal perinatal association (MPA). Among our ancestors, a woman who reliably took care of and breast-fed a newborn baby was most likely the biological mother of this infant, meaning that MPA strongly correlated with assumed genetic relatedness. Because MPA provides a reliable cue to detect a mother and offspring, individuals can use it also as a cue for sibling detection: if my mother takes care of a newborn child, this child most likely is my sibling. Obviously, the MPA cue can only be used by older siblings because younger siblings are not present during the perinatal period of their older siblings. Younger siblings can instead fall back on childhood co-residence duration, which taps into both the time spent with siblings and the crucial developmental period when children tend to receive most child care and other forms of parental investment ([Lieberman & Billingsley, 2016](#); see [Trivers, 1972, 1974](#) on parental investment). Also paternal half siblings are not able to use MPA but can only rely on the childhood co-residence cue.

Here we study the association between kin detection cues and adult sibling relationship quality. We utilize two cues, namely childhood co-residence duration and MPA, arguably two of the most important indirect kin detection mechanisms among human siblings ([Lieberman et al., 2007](#)). Sibling relationship quality is indicated by three factors measuring the quality of social ties: contact frequency, kin support, and emotional closeness.

Emotional closeness is known to be important for both kin-directed and non-kin-directed altruism ([Korchmaros & Kenny, 2001](#)). People are generally more likely to help people to whom they feel emotionally close, but the associations between emotional closeness and altruism may vary with gender and genetic relatedness. For instance, compared to same-gender siblings, same-gender close friends may be emotionally closer but also depend more on reciprocity to maintain relationships ([Rotkirch et al., 2014](#)). But [Curry, Roberts, and Dunbar \(2012\)](#) argue for a kinship premium and show that even when controlling for emotional closeness, kin may receive more altruistic help than friends. Prior studies on sibling relationship quality have used reported emotional closeness either as a kinship estimator ([Bressan & Kramer, 2015](#)) or as a predictor and proxy for altruistic kin investment ([Pollet & Hoben, 2011](#)). Here we adopt the latter perspective, and are interested in variations among sibling’s emotional closeness and how that varies with gender and cues to genetic relatedness.

1.1. Kinship cues, sibling types and adult sibling ties

[Lieberman et al. \(2007\)](#) were the first to investigate how both childhood co-residence duration and MPA are associated with sibling relationship quality, using two outcome variables. First, they considered whether individuals are motivated to help their siblings in a life-threatening situation by asking how willing a participant was to donate a kidney if their sibling needed one. Second, they enquired about kin support by asking how many favors a participant had provided to their sibling during the last month. Using a sample of US college students, the authors detected that both childhood co-residence duration and MPA were associated with increased investments in siblings. In addition, the MPA was a stronger predictor of sibling-directed investment than childhood co-residence duration; when the MPA cue was present (i.e., in older siblings), co-residence duration was not associated with investment in siblings. However, when the MPA cue was absent (i.

e., typically in younger siblings), childhood co-residence duration was a strong predictor of kin investment. Similar findings were detected also in a replication study, which used data of college students from five populations and one sample from a general population ([Sznycer, De Smet, Billingsley, & Lieberman, 2016](#)).

Regarding genetic relatedness, inclusive fitness theory predicts notable differences in motivations to trade one’s own welfare for that of a full versus half sibling ([Hamilton, 1964](#)). Full siblings share the same mother and father, while maternal half siblings share the same mother only and paternal half siblings share the same father only. Full siblings have a 0.5 probability of sharing the same gene by virtue of recent common descent while half-siblings have only a 0.25 probability. Consequently, inclusive fitness theory predicts that individuals tend to invest more time and other resources in full than half siblings, a prediction that has received clear support from several studies from present-day Western societies (e.g., [Pollet & Hoben, 2011](#); [Steinbach & Hank, 2018](#); [Tanskanen & Danielsbacka, 2018](#)).

Although some investigations have considered the role of childhood co-residence duration shaping the ties between full and half siblings (e.g., [Gyuris et al., 2020](#)), studies have only rarely concerned both the length of childhood co-residence duration and MPA (but see [Sznycer et al., 2016](#)). Here we suggest that the difference in relationship quality between full, maternal and paternal half siblings could be related to childhood co-residence duration and MPA. Given the prevalence of polygamy and patrilocality in human history, households have often encompassed several breeding females and children have grown up together with their paternal half siblings or cousins (the latter was the case in agrarian Finland; [Pettay, Lahdenperä, Rotkirch, & Lummaa, 2018](#)). By contrast, in contemporary Western societies children typically stay with their mothers, or spend most of their time with their mother, if their parents separate. This means that full and maternal half siblings are more likely to grow up together in the same household and among them the MPA cue can be present, while paternal half siblings have rarely spent their whole childhood together and among them the MPA cue is absent. Thus, we predict that full and half siblings should be equally or almost as close to one another when they have lived their childhood together in the same household or if one of them has seen the mother take care of the other in infancy. Of course, other biological cues of higher genetic relatedness such as physical appearance may still serve to render full siblings closer than half siblings.

Finally, it has been argued that incest aversion may be stronger between opposite-gender than same-gender siblings, since the risk of genetic inbreeding evolutionarily stemmed from heterosexual intercourse ([Chapais, 2008](#)). If the cues promoting kin altruism simultaneously promote incest aversion, they can be expected to have different outcomes for kin dyads of opposite gender compared to same-gender kin dyads. With regards to sibling altruism and relationship quality, high incest aversion could hence be expected to render opposite-gender siblings more distant from one another compared to same-gender siblings ([Antfolk, 2014](#)). Prior studies have indicated that same-gender siblings do report more contact, emotional closeness and mutual support than opposite-gender siblings ([Tanskanen & Rotkirch, 2019](#); [Voorpostel, van der Lippe, Dykstra, & Flap, 2007](#)) but have rarely considered the role of childhood co-residence or MPA.

1.2. Hypotheses

Research considering the effects of both childhood co-residence and MPA on sibling altruism, sibling-directed kin investments, and relationship quality, have been scarce and used small-scale and non-representative data ([Lieberman et al., 2007](#); [Sznycer et al., 2016](#)). We know of no other prior study using large and population-based data to study the association between co-residence, MPA and sibling relationship quality. Another novelty of the present study is that we consider gender differences and childhood proximity simultaneously with regards to sibling relationship quality. We conduct the analyses using

data gathered from Finland and utilize sibling fixed-effect regressions, which concentrate on the effects within families and take into account unobserved factors shared by siblings, making the findings more robust compared to ordinary regressions (Carlin, Gurrin, Sterne, Morley, & Dwyer, 2005).

The present study considers several predictions derived from the theories of kinship and sibling relations discussed above, predicting that childhood co-residence duration and MPA regulate adult sibling ties. The following hypotheses are tested:

Hypothesis 1. The effect of childhood co-residence is expected to be moderated by MPA. If the MPA cue is absent, co-residence duration is a stronger predictor of sibling relationship quality than when the MPA is present.

Hypothesis 2. Relationship quality is expected to be lower between half siblings compared to full siblings. However, if the MPA and co-residence duration serve as cues for genetic relatedness, they should mediate this association. Hence, we hypothesize that only when MPA is absent should co-residence equalize groups.

Hypothesis 3. The strength of the association between childhood co-residence and sibling relationship quality is expected to vary with gender composition of the sibling dyads. Due to the expected incest aversion between kin of different gender, we predict that childhood co-residence duration or the MPA cue can be especially beneficial for relationship quality between sisters and between brothers (same-gender dyads), but not as much between sisters and brothers (opposite gender dyads).

2. Methods

2.1. Participants

We use population-based survey data from the Generational Transmissions in Finland (Gentrans) project. The Gentrans gathers information on two family generations: the Finnish baby boomer generation born between 1945 and 1950 and their adult children born between 1964 and 1999 (for the specifics of the baby boom in Finland demographically see Van Bavel & Reher, 2013 and Karisto, 2007 for a sociological description). Here, we used only the survey of the younger generation because it included systematic information on participants' household structure and family arrangements during childhood. This nationally representative survey was conducted by Statistics Finland in autumn 2018 and included 1945 younger and middle-aged adults who were between 19 and 56 (Mean = 42, SD = 6.09).

The present study sample was constructed in several steps. First, we included participants who had living siblings and available data concerning all variables studied here, leaving us with a final sample of 1427 adults. Next, the data was reshaped into a long format, so that observations were recorded from the perspective of the original respondent's siblings. This resulted in a total of 2639 observations from 1427 unique individuals in the data (approximately 1.9 siblings per respondent). Our sibling fixed-effect models include only participants with two or more siblings because they compared sibling relationship quality among original siblings from same family (i.e., among siblings who shared the same mother and/or father); the fixed-effect sample had 1871 observations from 735 unique individuals.

2.2. Measures

The dependent variables measure contact frequencies, emotional support, and provision of help, which have often been used as indicators for sibling relationship quality (Tanskanen & Danielsbacka, 2021). In the Gentrans survey, contact frequency was measured by asking participants in a single question to report using a 5-point scale (ranging from 0 = never to 4 = several times a week) how often they have had

contact with their siblings in the last 12 months either in person, by phone, or via the Internet. Emotional closeness was indicated by asking how emotionally close respondents consider their siblings using a 5-point scale (ranging from 0 = very distant to 4 = very close). Finally, the questionnaires asked whether respondents have provided practical or financial help to their siblings in the last 12 months (0 = no, 1 = yes). Contact frequency, emotional closeness and help variables were gathered separately for four of the respondents' oldest siblings. Bivariate correlations of the three sibling relationship quality measures show that the strongest correlation exists between contact frequency and emotional closeness ($r = 0.60$). Moderate correlations exist also between contact frequency and help ($r = 0.41$) as well as emotional closeness and help ($r = 0.33$) (all these correlations are statistically significant: $p < .05$) (Appendix Table 1).

The main independent variables are childhood co-residence duration with siblings and the maternal perinatal association (MPA). Retrospective information about childhood co-residence duration and MPA were again gathered separately for four of the respondents' oldest siblings. Childhood co-residence duration was indicated by asking the respondents to report how long they had lived with their sibling before the respondents' 18th birthday via a 5-point scale (0 = no time at all, 1 = only for a short time, 2 = less than half of the time, 3 = more than half of the time, and 4 = the entire time). In the analyses, the group that indicated "no time at all" was used as a reference category. MPA was coded as 1 (i.e., MPA is present) when all following conditions were fulfilled: (i) the participant shared a biological mother with sibling, (ii) the participant lived in the same household with his or her mother when the sibling was born, and (iii) the participant started co-residence with his or her sibling at the very beginning of sibling's birth, and MPA was coded as 0 (i.e., MPA is absent) in any other circumstance. There was a moderate correlation between childhood co-residence duration and MPA ($r = 0.49$, $p < .05$) (Appendix Table 1).

To provide more robust results we controlled for several factors that have been shown to correlate with sibling relationship quality in prior studies (e.g., Pollet & Hoben, 2011; Tanskanen & Danielsbacka, 2021). These include gender constellation of sibling pairs, age difference between siblings, parenthood status of sibling pairs (i.e., whether they have own children), genetic relatedness (full siblings, maternal or paternal half siblings; note that adoptive and step-siblings are dropped from the data because of low number of them), siblings' financial condition, and geographical distance between siblings. In sibling fixed-effect models all background characteristics related to respondents (e.g., age, education, and number of siblings) and shared by siblings (e.g., mothers' and/or fathers' age, education, and social values) are taken into account due to the design itself, whether this information exists in the data or not. Descriptive statistics are presented in Table 1.

2.3. Data analyses

We use multilevel regression models, in which sibling observations are nested within participating persons. Sibling fixed-effect regressions were used because they can provide more robust results regarding the association between childhood family arrangements and relationship quality in adulthood compared to random-effect models. In general, sibling fixed-effect regressions are used to investigate effects among participants with two or more siblings by comparing the relationship quality in siblings from same families. Sibling fixed-effect models are designed to reduce omitted variable bias, and control for any observed or unobserved confounding factors shared by siblings (Carlin et al., 2005). Since the sibling fixed-effect procedure removes problems related to unobserved heterogeneity at the family level, they may also provide more causal estimates compared to random-effect models.

Although sibling fixed-effect models have several strengths, among their limitations is that these models cannot account for unobserved characteristics not shared by siblings. Fixed-effect models may also be exacerbated by reduced sample size because there may be a small

Table 1
Descriptive statistics.

	No. of obs.	No. of person	%	Mean	SD
Gender constellation of sibling pairs					
Same gender	945	371	50.5		
Opposite gender	926	364	49.5		
Age difference between siblings (years)	1871	735		6.7	4.64
Parenthood status of sibling pairs					
Both are childless	187	74	10.0		
Parent-childless dyad	782	307	41.8		
Both have children	902	354	48.2		
Genetic relatedness					
Full siblings	1634	642	87.3		
Maternal half siblings	120	47	6.4		
Paternal half siblings	117	46	6.3		
Sibling's financial condition					
Low income	395	155	21.1		
Middle-income	800	314	42.8		
Comfortable or wealthy	676	266	36.1		
Geographical distance between siblings					
Less than 1 km	31	12	1.7		
1–5 km	133	52	7.1		
5–25 km	416	164	22.2		
25–100 km	408	160	21.8		
100–500 km	637	250	34.1		
More than 500 km	246	97	13.2		
Childhood co-residence duration					
No time at all	139		7.4		
Only for a short time	93		5.0		
Less than half of the time	148		7.9		
More than half of the time	532		28.4		
Entire time	959		51.3		
MPA					
Absent	994	391	53.1		
Present	877	344	46.9		
Contact frequency with sibling	1871	735		2.0	1.15
Emotional closeness to sibling	1871	735		2.7	1.00
Provision of help	1871	735		0.4	0.48

Notes. No. of obs. = Number of total observations; No. of person = Number of unique individuals; SD = Overall standard deviation. Contact frequency varies from 0 (never) to 4 (several times a week), emotional closeness from 0 (very distant) to 4 (very close) and provision of help from 0 (none) to 1 (has helped during the last 12 months). MPA = maternal perinatal association.

Table 2
Fixed-effect regressions of associations between childhood co-residence duration and maternal perinatal association (MPA) and sibling relationship quality.

	Contact frequency				Emotional closeness				Provision of help			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
(A) Childhood co-residence duration and sibling relationship quality												
Childhood co-residence duration												
No time at all	Ref		Ref		Ref		Ref		Ref		Ref	
Only for a short time	0.60***	0.16	0.33	0.17	0.70***	0.15	0.42*	0.18	0.19*	0.069	0.15	0.08
Less than half of the time	0.81***	0.14	0.44*	0.17	1.06***	0.13	0.74***	0.18	0.26***	0.06	0.21**	0.08
More than half of the time	0.87***	0.12	0.54**	0.18	1.06***	0.12	0.75***	0.18	0.24***	0.052	0.23**	0.08
Entire time	1.06***	0.11	0.66***	0.18	1.15***	0.11	0.84***	0.18	0.24***	0.049	0.22**	0.08
R2		0.07		0.21		0.10		0.15		0.02		0.09
(B) MPA and sibling relationship quality												
MPA												
Absent	Ref		Ref		Ref		Ref		Ref		Ref	
Present	0.45***	0.06	0.29***	0.06	0.43***	0.06	0.31***	0.06	0.13***	0.03	0.09***	0.03
R2		0.05		0.22		0.05		0.16		0.02		0.09

Notes. Unadjusted = univariate association; Adjusted = adjusted for gender constellation of sibling pairs, age difference between siblings, parenthood status of sibling pairs, genetic relatedness, siblings' financial condition, and geographical distance between siblings.

n = 1871 observations of 735 unique individuals;

*p < .05, ** p < .01, *** p < .001.

number of participants who have variance in both the outcome measure and main independent factors. Despite these limitations, sibling fixed-effect models can be considered to provide a sophisticated method to study the associations between childhood family arrangements and adult sibling relationship quality and is well-suited to study family complexities (Kalmijn et al., 2019). To help to interpret the findings we calculated predictive margins from the regression models (see Williams, 2012 for margins command in Stata).

3. Results

Results indicate that sibling relationship quality as measured by contact frequency, emotional closeness, and help between siblings increased with longer childhood co-residence. Table 2 also shows, and as we expected, that when the MPA cue was present, sibling relationship quality was better than when it was absent.

Hypothesis 1 predicted that the length of childhood co-residence would be a stronger predictor of sibling relationship quality in the absence of the MPA cue. To study this question, we included the interaction term between childhood co-residence and MPA in the models (Table 3). Provided maternal perinatal association, childhood co-residence length was a weaker predictor of kin contact, closeness, and help, compared to the absence of the MPA cue. These findings are illustrated in Figs. 1–3. The point at which the lines indicating co-residence duration and MPA crossed is “entire time,” meaning that the presence of the MPA cue corresponded to 18 years of co-residence during childhood. The effect was similar in the case of all three measures of sibling relationship quality analyzed here. Finally, we included co-residence duration and MPA in the same model, so that for co-residence duration the effect of MPA was statistically removed, and for MPA the effect of co-residence duration was removed. Also when these variables were mutually adjusted, both co-residence duration and the MPA correlated with sibling relationship quality, indicating that they affect sibling relationship quality independently of each other, as expected (Appendix Table 2).

Hypothesis 2 concerned the relationship quality between full and half siblings. For the potential mediating effect of MPA, only full and maternal half siblings were analyzed (since the MPA cue is absent in paternal half siblings, who have different mothers). In Table 4, the first models show results from unadjusted regressions and the second models show associations between genetic relatedness and sibling relationship quality when all other covariates were controlled for, with the exception of the co-residence duration or MPA. The third models also control for

Table 3
Fixed effect regressions of associations between childhood co-residence duration and sibling relationship quality in adulthood by maternal perinatal association (MPA).

	Contact frequency				Emotional closeness				Provision of help			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Co-residence duration	0.21***	0.03	0.13**	0.04	0.24***	0.03	0.15**	0.04	0.04**	0.01	0.03	0.02
MPA	1.24***	0.31	1.16***	0.29	1.41***	0.30	1.11***	0.30	0.49***	0.13	0.40**	0.14
Co-residence duration \times MPA	-0.27**	0.08	-0.25**	0.08	-0.32***	0.08	-0.24**	0.08	-0.10**	0.04	-0.09*	0.04
R2		0.09		0.25		0.10		0.19		0.04		0.10

Notes. Unadjusted = univariate association; Adjusted = adjusted for gender constellation of sibling pairs, age difference between siblings, parenthood status of sibling pairs, genetic relatedness, siblings' financial condition, and geographical distance between siblings.

$n = 1871$ observations of 735 unique individuals.

* $p < .05$, ** $p < .01$, *** $p < .001$.

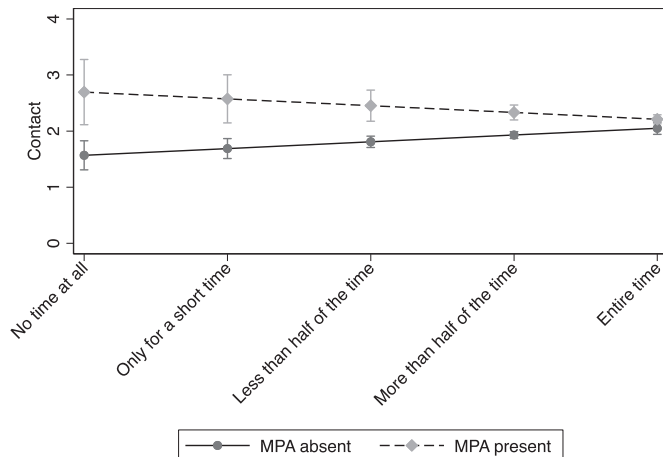


Fig. 1. Associations between childhood co-residence duration and sibling contact frequency in adulthood by maternal perinatal association (MPA) (predictive margins and 95% confidence intervals), entire time is 18 years (see Table 3 for statistical details).

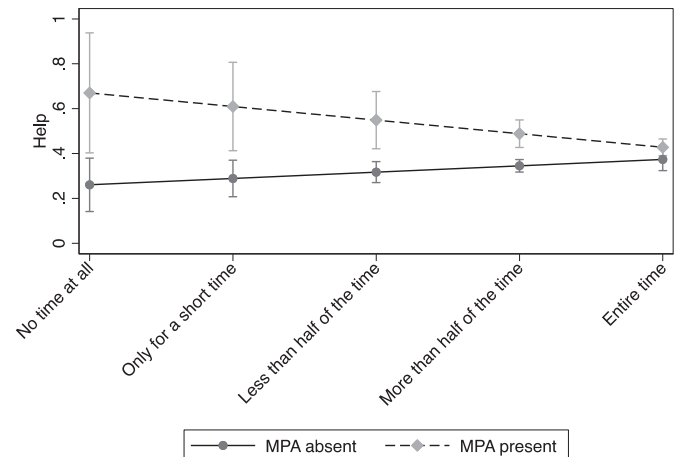


Fig. 3. Associations between childhood co-residence duration and sibling provision of help in adulthood by maternal perinatal association (predictive margins and 95% confidence intervals), entire time is 18 years (see Table 3 for statistical details).

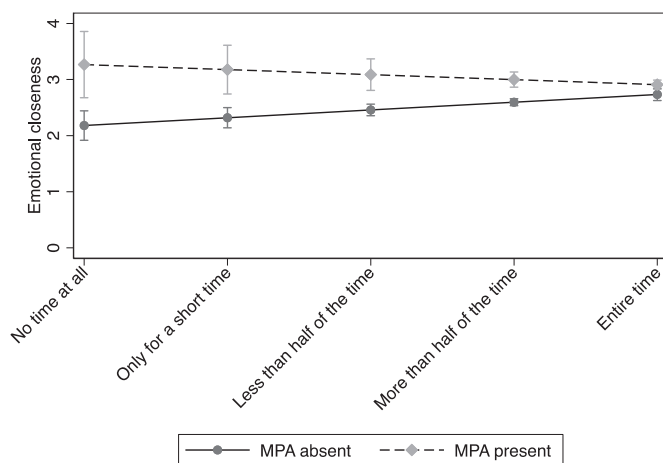


Fig. 2. Associations between childhood co-residence duration and sibling emotional closeness in adulthood by maternal perinatal association (predictive margins and 95% confidence intervals), entire time is 18 years (see Table 3 for statistical details).

the co-residence length or MPA in addition to the other variables.

Results show that when co-residence duration is not controlled for, full siblings reported more contact and emotional closeness than maternal or paternal half siblings did, and full siblings provided more help compared to paternal half siblings, as can be expected. However, once co-residence duration was taken into account, the difference in

emotional closeness between full and maternal half siblings, as well as the statistically significant differences in provision of help between full and paternal half siblings disappeared. This indicated, in support of our second hypothesis, that co-residence duration mediates the effect of genetic relatedness. A Sobel test for mediation confirmed that co-residence duration is indeed a mediator in the case of both these variables ($p < .05$). In addition, once MPA was controlled for, the difference in emotional closeness between full and maternal half siblings disappeared and based on the Sobel test, also MPA was a mediator in this respect ($p < .05$).

Hypothesis 3 predicted, based on gender constellations in sibling dyads, that childhood co-residence duration and MPA would be associated with increased sibling relationship quality more strongly in same-gender than opposite-gender dyads. We investigated this by including the interaction term between the length of childhood co-residence and gender constellation in the regression models (Table 5). Results were contrary to our hypothesis: in opposite-gender sibling dyads, provision of help increased with increased co-residence duration, while no similar effect was detected for same-gender sibling dyads (this finding is illustrated in Fig. 4). No statistically significant associations were found for contact frequency and emotional closeness. Finally, we investigated the interaction between MPA and gender constellation, finding no significant interaction effects in the case of any of the three measures of sibling relationship quality (Table 6).

4. Discussion

The present study considered how childhood family constellations

Table 4
Fixed-effect regressions of associations between genetic relatedness, childhood proximity and sibling relationship quality.

	Contact frequency						Emotional closeness						Provision of help						
	Model 1		Model 2		Model 3		Model 1		Model 2		Model 3		Model 1		Model 2		Model 3		
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	
(A) Genetic relatedness, childhood co-residence duration and sibling relationship quality																			
Genetic relatedness																			
Full siblings	Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref
Maternal half siblings	−0.40**	0.12	−0.42***	0.12	−0.30*	0.13	−0.34**	0.12	−0.36**	0.13	−0.20	0.13	0.02	0.05	−0.01	0.06	0.03	0.06	0.06
Paternal half siblings	−1.08***	0.12	−1.08***	0.12	−0.59**	0.18	−1.19***	0.11	−1.23***	0.12	−0.58**	0.19	−0.22***	0.05	−0.26***	0.06	−0.08	0.08	0.08
Co-residence duration																			
No time at all					Ref						Ref								Ref
Only for a short time					0.33	0.17					0.42*	0.18							0.15
Less than half of the time					0.44*	0.17					0.74***	0.18							0.21**
More than half of the time					0.54**	0.18					0.75***	0.18							0.23**
Entire time					0.66***	0.18					0.84***	0.18							0.21**
R2		0.07		0.20		0.21		0.09		0.14		0.15		0.02		0.08			0.09
(B) Genetic relatedness, maternal perinatal association (MPA) and sibling relationship quality																			
Genetic relatedness																			
Full siblings	Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref		Ref
Maternal half siblings	−0.22	0.14	−0.34*	0.14	−0.27*	0.14	−0.23	0.13	−0.30*	0.14	−0.21	0.13	0.03	0.06	−0.02	0.06	0.01	0.06	0.06
MPA																			
Absent					Ref						Ref								Ref
Present					0.30***	0.06					0.33***	0.06							0.10***
R2		0.01		0.15		0.17		0.01		0.06		0.06		0.002		0.08			0.09

Notes. Model 1 = unadjusted, univariate association;

Model 2 = adjusted for gender constellation of sibling pairs, age difference between siblings, parenthood status of sibling pairs, siblings' financial condition, and geographical distance between siblings.

Model 3 = adjusted for all the same variables as in model 2, including co-residence duration (A) or MPA (B).

(A) $n = 1871$ observations of 735 unique individuals;

(B) $n = 1711$ observations of 685 unique individuals;

* $p < .05$, ** $p < .01$, *** $p < .001$.

Table 5
Fixed effect regressions of associations between childhood co-residence duration and sibling relationship quality in adulthood by gender constellation of siblings.

	Contact frequency				Emotional closeness				Provision of help			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Co-residence duration	0.24***	0.03	0.13**	0.04	0.24***	0.03	0.14**	0.04	0.07***	0.01	0.06**	0.02
Gender	-0.47***	0.13	-0.48***	0.12	-0.42**	0.12	-0.48***	0.12	0.07	0.06	0.06	0.06
Co-residence duration × gender	0.01	0.04	0.01	0.04	0.04	0.04	0.05	0.04	-0.05**	0.02	-0.05**	0.02
R2		0.15		0.21		0.12		0.15		0.04		0.09

Notes. Unadjusted = univariate association; Adjusted = adjusted for age difference between siblings, parenthood status of sibling pairs, genetic relatedness, siblings' financial condition, and geographical distance between siblings.

n = 1,871 observations of 735 unique individuals.

* p < .05, ** p < .01, *** p < .001.

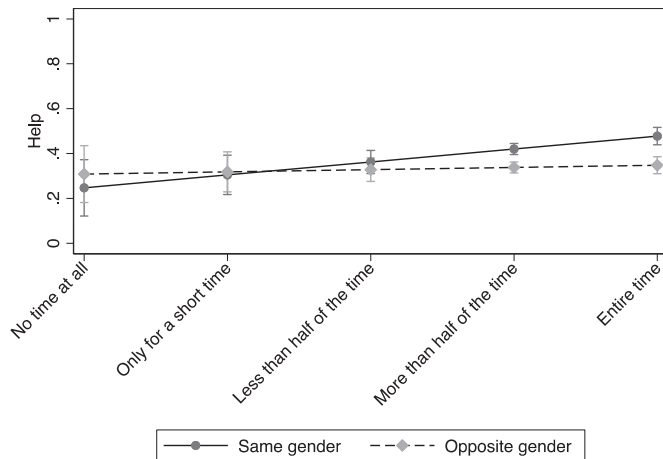


Fig. 4. Associations between childhood co-residence duration and sibling provision of help in adulthood by gender constellation of siblings (predictive margins and 95% confidence intervals), entire time is 18 years (see Table 5 for statistical details).

shape sibling relationship quality in adulthood. We investigated the role of two central environmental kin detection cues for siblings, namely childhood co-residence duration and maternal perinatal association (Lieberman et al., 2007). In line with predictions derived from kinship theories, our data from contemporary adult Finns showed that length of childhood co-residence and MPA are associated with emotional closeness and altruism among adult siblings. Siblings who had lived a longer period with one another in the same household during childhood also reported better relationship quality with each other when they had reached adulthood. Moreover, we found support for the prediction that individuals who were present when their mother was nursing a younger sibling during the infant's perinatal period (i.e., the MPA cue was present) had stronger sibling ties in adulthood compared to those who did not (i.e., the MPA cue was absent). Hence, our findings provide

Table 6
Fixed effect regressions of associations between maternal perinatal association (MPA) and sibling relationship quality in adulthood by gender constellation of siblings.

	Contact frequency				Emotional closeness				Provision of help			
	Unadjusted		Adjusted		Unadjusted		Adjusted		Unadjusted		Adjusted	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
MPA	0.50***	0.07	0.34***	0.07	0.43***	0.07	0.29***	0.07	0.17***	0.03	0.13***	0.03
Gender	-0.41***	0.06	-0.40***	0.06	-0.32***	0.06	-0.33***	0.06	-0.06*	0.03	-0.06*	0.03
MPA × gender	-0.10	0.09	-0.10	0.09	0.01	0.09	0.03	0.09	-0.07	0.04	-0.07	0.04
R2		0.13		0.22		0.08		0.16		0.04		0.10

Notes. Unadjusted = univariate association; Adjusted = adjusted for age difference between siblings, parenthood status of sibling pairs, genetic relatedness, siblings' financial condition, and geographical distance between siblings.

n = 1,871 observations of 735 unique individuals.

* p < .05, ** p < .01, *** p < .001.

robust evidence for the long-term effects of childhood family constellation on sibling ties in later life in a contemporary high-income population.

Moreover, we found that co-residence was a stronger predictor of sibling relationship quality in the absence of the maternal perinatal association cue. This was the case in all sibling relationship quality indicators analyzed here: contact frequency, emotional closeness, and provision of help. Interestingly, the effect of the presence of the MPA cue corresponded to full childhood co-residence in the same household with siblings (i.e., 18 years). This finding is in line with the study by Lieberman et al. (2007), which reported that for sibling-directed altruism, as indicated by favors provided to siblings and willingness to make costly sacrifices for them, the presence of the MPA cue coincides with 18 years of co-residence. The same authors also argued that when co-residence length and MPA cues are both available, individuals should use the MPA which is a more reliable cue for kinship. In line with this hypothesis, they detected that when co-residence duration and MPA were mutually adjusted in the same model, the effect of co-residence duration disappeared, while MPA remained a predictor of sibling directed altruism. Contrary to this prior finding, when co-residence duration and MPA were included simultaneously in the same regression model in our study, they were both significant predictors of sibling relationship quality. This suggests that childhood co-residence length and MPA are both independent and highly important kin detection cues in human siblings. While it would always be beneficial to be able to identify a shared biological mother, the need to identify paternal half siblings, or the high prevalence of maternal mortality in many societies including our study population a few centuries ago (Pettay et al., 2018), may both have contributed to the usefulness of the co-residence cue; the reasons for the possible existence of two separate pathways to sibling kin detection deserves future exploration.

The Westermarck hypothesis states that close association and physical proximity in early childhood provides an important cue for genetical kinship and thus should regulate individuals' behavior in later life. Prior studies have provided evidence for the Westermarck hypothesis in relation to his original topic, marriage and sexual aversion (e.g., Wolf,

1993; Rantala & Marcinkowska, 2011; Talmon, 1964; Walter & Buyske, 2003; see also Shor & Simchai, 2009 and Maryanski, Sanderson, & Russell, 2012 for recent turns in the prolonged debate on incest aversion in anthropology). However, the original thesis can also be extended in the way that physical proximity in early childhood fosters not only incest aversion but also altruism (Lieberman et al., 2007), and our study contributes to this dimension of the Westermarck hypothesis. We did not investigate sexual aversion here, and further studies are needed to disentangle how kin detection cues simultaneously can affect both sexual aversion, emotional closeness, and altruistic helping, and how this varies with gender, sexual orientation, and degrees of genetical relatedness.

Prior studies have indicated that genetic relatedness shapes adult sibling ties and render full siblings emotionally closer compared to half siblings (e.g., Pollet, 2007; Steinbach & Hank, 2018; Tanskanen & Danielsbacka, 2014). However, humans build their understanding of genetic relatedness not on abstract notions of genes, but on observations of their family surroundings. We showed that childhood co-residence duration mediates the effect of genetic relatedness regarding the emotional closeness between full and maternal half siblings, and the provision of help between full and paternal half siblings. Moreover, MPA mediates the effect of genetic relatedness regarding emotional closeness between full and maternal half siblings. In other words, when full and half siblings have similar kin detection cues available, the relationship quality between these groups tends to become more similar. This finding questions several earlier assertions about genetic relatedness and highlights how environmental cues are the most important at least for certain outcomes. We hope this can also serve as an example of how to integrate evolutionary and social science, and ultimate and proximate, explanations (Tanskanen & Danielsbacka, 2019).

Key theories of kin detection have claimed that the presence of cues for kinship should similarly affect both incest aversion and nepotistic efforts (Billingsley, Antfolk, Santtila, & Lieberman, 2018; Lieberman & Billingsley, 2016). Building on previous work we hypothesized that kin detection cues might regulate the relationship quality more strongly between opposite-gender than same-gender siblings (Antfolk, 2014). We were, however, unable to find support for this prediction. Contrary to our prediction, co-residence duration was more strongly associated with provision of help in opposite-gender sibling dyads than same-gender dyads. The lack of differences regarding sibling gender constellations could reflect the fact that sibling relationship quality substantially differs from incest aversion. From an inclusive fitness perspective, emphasizing the evolutionary benefits of nepotistic altruism, sibling contact, closeness, and support should not be as dependent on gender similarity as incest aversion, because investing time and support in closely related kin can enhance increased fitness in both same-gender and opposite-gender sibling dyads. Furthermore, other factors may affect female and male kin altruism more strongly: we know from other studies on the same Finnish cotemporary population that gender-role stereotypes and skills in division of work are also likely to affect behavior (Tanskanen & Rotkirch, 2019). For instance, practical help is more often solicited by sisters from brothers and childcare help by

brothers from sisters. Our results suggest that this kind of help may be more prevalent when the brothers and sisters have lived together throughout their childhood.

To best of our knowledge the present study is the first that has investigated how childhood co-residence duration and MPA are associated with adult sibling relationship quality with large-scale and population-based data. Compared to prior studies on the topic, we have been able to study more reliably not only the direct effects of childhood co-residence duration and MPA on sibling relationship quality but also interaction effects of genetic relatedness and gender. We measured sibling relationship quality with three different outcomes (contact frequency, emotional closeness, and provision of help), and in most cases all three variables led to similar conclusions, underscoring the strength of the findings. Methodologically, we have used sibling fixed-effect models where all factors shared by siblings are taken into account. Our data also allowed us to control for several factors not shared by siblings and potentially shaping sibling relationship quality. These factors increase the robustness of the findings presented in this study.

A limitation of the present investigation is the fact that although sibling fixed-effect regressions in theory control for all characteristics shared by siblings, there are aspects of family life that siblings may experience differently and we could not control for. There could also be factors influencing sibling ties that are not shared by siblings (e.g., personality), which are not available in the data and thus cannot be taken into account. Finally, correlational results should be always approached with caution. For instance, it is possible that rather than co-residence duration and MPA, some underlying factors that highly correlate with them are responsible for the results. However, to date these other potential confounding factors have not been identified and our study had a solid theoretical rationale. A final methodological limitation is that due to data limitations, childhood co-residence duration between siblings was measured by 5-point scale, although continuous variable could provide more nuanced information.

We considered long-term effects of childhood family arrangements on sibling relationship quality in adulthood, finding robust and strong support for how the indirect kin detection cues that are available in the social environment during early life can shape our sibling relations over the life course. Our findings contribute to the increasing body of research showing how both genetic relatedness and environmental experiences influence human behavior, and we hope they can further stimulate the combination of evolutionary and social science perspectives in the study of contemporary societies.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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Appendix

Appendix Table 1

Correlations of independent and dependent variables.

	1	2	3	4	5	6	7	8	9	10
1 Gender constellation of sibling pairs	—									
2 Age difference between siblings	0.001									
3 Parenthood status of sibling pairs	−0.003	−0.15								
4 Genetic relatedness	−0.02	0.39	−0.08							
5 Sibling’s financial condition	0.02	−0.06	0.09	−0.05						
6 Geographical distance between siblings	0.01	−0.02	−0.04	0.04	0.06					

(continued on next page)

Appendix Table 1 (continued)

		1	2	3	4	5	6	7	8	9	10
7	Co-residence duration	0.02	−0.58	0.09	−0.64	0.04	−0.07				
8	Maternal perinatal association	0.01	−0.16	0.02	−0.24	−0.07	−0.05	0.49			
9	Contact frequency	−0.23	−0.09	−0.02	−0.22	0.03	−0.22	0.19	0.12		
10	Emotional closeness	−0.13	−0.10	−0.001	−0.22	0.08	−0.06	0.20	0.12	0.60	
11	Help	−0.04	−0.01	−0.14	−0.11	−0.01	−0.21	0.08	0.07	0.40	0.33

Notes. Bolded numbers indicate significant associations, $p < .05$.

Appendix Table 2

Fixed-effect regressions of associations between childhood co-residence duration and MPA and sibling relationship quality.

	Contact frequency		Emotional closeness		Provision of help	
	β	SE	β	SE	β	SE
Childhood co-residence duration						
No time at all	Ref		Ref		Ref	
Only for a short time	0.29	0.17	0.38*	0.17	0.15	0.08
Less than half of the time	0.38*	0.17	0.67***	0.17	0.19*	0.08
More than half of the time	0.49**	0.17	0.70***	0.17	0.21**	0.08
Entire time	0.46*	0.18	0.61**	0.18	0.13	0.08
MPA						
Absent	Ref		Ref		Ref	
Present	0.27***	0.06	0.30***	0.07	0.11***	0.03

Notes. Co-residence duration and MPA are simultaneously included in the same models.

Adjusted for gender constellation of sibling pairs, age difference between siblings, parenthood status of sibling pairs, genetic relatedness, siblings' financial condition, and geographical distance between siblings.

$n = 1,871$ observations of 735 unique individuals;

* $p < .05$, ** $p < .01$, *** $p < .001$.

References

- Abbot, P., Abe, J., Alcock, J., Alizon, S., et al. (2011). Inclusive fitness theory and eusociality. *Nature*, 471, E1–E4. <https://doi.org/10.1038/nature09831>.
- Antfolk, J. (2014). *Incest aversion: The evolutionary roots of individual regulation*. Åbo: Åbo Akademi.
- Antfolk, J., & Wolf, A. P. (2016). Itemising Westermarck's hypothesis: The assumptions embedded in Westermarck's explanation of human incest avoidance. In O. Lagerspetz, J. Antfolk, & C. Kronqvist (Eds.), *Evolution, human behaviour and morality: The legacy of Westermarck* (pp. 72–84). London & New York: Routledge.
- Billingsley, J., Antfolk, J., Santtila, P., & Lieberman, D. (2018). Cues to paternity: Do partner fidelity and offspring resemblance predict daughter-directed sexual aversions? *Evolution and Human Behavior*, 39(3), 290–299. <https://doi.org/10.1016/j.evolhumbehav.2018.02.001>.
- Bressan, P., Colarelli, S. M., & Cavalieri, M. B. (2009). Biologically costly altruism depends on emotional closeness among step but not half or full sibling. *Evolutionary Psychology*, 7(1), 118–132. <https://doi.org/10.1177/147470490900700116>.
- Bressan, P., & Kramer, P. (2015). Human kin detection. *WIREs Cognitive Science*, 6(3), 299–311. <https://doi.org/10.1002/wcs.1347>.
- Bressan, P., & Zucchi, G. (2009). Human kin recognition is self-rather than family-referential. *Biology Letters*, 5(3), 336–338. <https://doi.org/10.1098/rsbl.2008.0789>.
- Brown, J. L., & Eklund, A. (1994). Kin recognition and the major histocompatibility complex: An integrative review. *The American Naturalist*, 143(3), 435–461. <https://doi.org/10.1086/285612>.
- Carlin, J. B., Gurrin, L. C., Sterne, J. A. C., Morley, R., & Dwyer, T. (2005). Regression models for twin studies: A critical review. *International Journal of Epidemiology*, 34(5), 1089–1099. <https://doi.org/10.1093/ije/dyi153>.
- Charlesworth, D., & Willis, J. H. (2009). The genetics of inbreeding depression. *Nature Reviews Genetics*, 10(11), 783. <https://doi.org/10.1038/nrg2664>.
- Curry, O., Roberts, S. G., & Dunbar, R. I. (2012). Altruism in social networks: Evidence for a "kinship premium". *British Journal of Psychology*, 104, 283–295. <https://doi.org/10.1111/j.2044-8295.2012.02119.x>.
- Gyuris, P., Kozma, L., Kisander, Z., Láng, A., Ferencz, T., & Kocsor, F. (2020). Sibling relations in patchwork families: Co-residence is more influential than genetic relatedness. *Frontiers in Psychology*, 11(993). <https://doi.org/10.3389/fpsyg.2020.00993>.
- Hamilton, W. D. (1964). The genetical evolution of social behaviour (I and II). *Journal of Theoretical Biology*, 7, 1–52. [https://doi.org/10.1016/0022-5193\(64\)90038-4](https://doi.org/10.1016/0022-5193(64)90038-4).
- Hepper, P. (2011). Kin recognition. In C. Salmon, & T. K. Shackelford (Eds.), *The Oxford handbook of evolutionary family psychology* (pp. 211–229). New York, NY: Oxford University Press.
- Kalmijn, M., de Leeuw, S. G., Hornstra, M., Ivanova, K., van Gaalen, R., & van Houdt, K. (2019). Family complexity into adulthood: The central role of mothers in shaping intergenerational ties. *American Sociological Review*, 84(5), 876–904. <https://doi.org/10.1177/0003122419871959>.
- Karisto, A. (2007). Finnish baby boomers and the emergence of the third age. *International Journal of Ageing and Later Life*, 2(2), 91–108. <https://doi.org/10.3384/ijal.1652-8670.072291>.
- Korchmaros, J. D., & Kenny, D. A. (2001). Emotional closeness as a mediator of the effect of genetic relatedness on altruism. *Psychological Science*, 12, 262–265. <https://doi.org/10.1111/1467-9280.00348>.
- Lieberman, D. (2009). Rethinking the Taiwanese minor marriage data: Evidence the mind uses multiple kinship cues to regulate inbreeding avoidance. *Evolution and Human Behavior*, 30(3), 153–160. <https://doi.org/10.1016/j.evolhumbehav.2008.11.003>.
- Lieberman, D., & Billingsley, J. (2016). Current issues in sibling detection. *Current Opinion in Psychology*, 7, 57–60. <https://doi.org/10.1016/j.copsyc.2015.07.014>.
- Lieberman, D., Tooby, J., & Cosmides, L. (2007). The architecture of human kin detection. *Nature*, 445, 727–731. <https://doi.org/10.1038/nature05510>.
- Maryanski, A., Sanderson, S. K., & Russell, R. (2012). The Israeli kibbutzim and the Westermarck hypothesis: Does early association dampen sexual passion? A comment on Shor and Simchai. *American Journal of Sociology*, 117(5), 1503–1508. <https://doi.org/10.1086/665578>.
- Pettay, J. E., Lahdenperä, M., Rotkirch, A., & Lummaa, V. (2018). Effects of female reproductive competition on birth rate and reproductive scheduling in a historical human population. *Behavioral Ecology*, 29(2), 333–341. <https://doi.org/10.1093/beheco/arx168>.
- Pollet, T. V. (2007). Genetic relatedness and sibling relationship characteristics in a modern society. *Evolution and Human Behavior*, 28, 176–185. <https://doi.org/10.1016/j.evolhumbehav.2006.10.001>.
- Pollet, T. V., & Hoben, A. D. (2011). An evolutionary perspective on siblings: Rivals and resources. In C. Salmon, & T. K. Shackelford (Eds.), *The Oxford handbook on evolutionary family psychology* (pp. 128–148). New York: Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780195396690.013.0009>.
- Rantala, M. J., & Marcinkowska, U. M. (2011). The role of sexual imprinting and the Westermarck effect in mate choice in humans. *Behavioral Ecology and Sociobiology*, 65(5), 859–873. <https://doi.org/10.1007/s00265-011-1145-y>.
- Rotkirch, A., Lyons, M., David-Barrett, T., & Jokela, M. (2014). Gratitude for help among adult friends and siblings. *Evolutionary Psychology*, 12(4), 147470491401200401. <https://doi.org/10.1093/oxfordhb/9780190299323.013.39>.
- Rotkirch, A. (2018). Evolutionary family sociology. In R. Hopcroft (Ed.), *Oxford handbook of evolution, biology and society* (pp. 1–33). Oxford: Oxford University Press.
- Salmon, C., & Shackelford, T. K. (2011). *The Oxford handbook of evolutionary family psychology*. Oxford University Press.
- Shor, E., & Simchai, D. (2009). Incest avoidance, the incest taboo, and social cohesion: Revisiting Westermarck and the case of the Israeli kibbutzim. *American Journal of Sociology*, 114(6), 1803–1842. <https://doi.org/10.1086/597178>.

- Steinbach, A., & Hank, K. (2018). Full-, half-, and step-sibling relations in young and middle adulthood. *Journal of Family Issues*, 39, 2639–2658. <https://doi.org/10.1177/0192513X18757829>.
- Sznycer, D., De Smet, D., Billingsley, J., & Lieberman, D. (2016). Coresidence duration and cues of maternal investment regulate sibling altruism across cultures. *Journal of Personality and Social Psychology*, 111, 159–177. <https://doi.org/10.1037/pspi0000057>.
- Talmon, Y. (1964). Mate selection in collective settlements. *American Sociological Review*, 29, 491–508. <https://doi.org/10.2307/2091199>.
- Tanskanen, A. O., & Danielsbacka, M. (2014). Genetic relatedness predicts contact frequencies with siblings, nieces and nephews: Results from the generational transmissions in Finland surveys. *Personality and Individual Differences*, 55, 5–11. <https://doi.org/10.1016/j.paid.2014.04.034>.
- Tanskanen, A. O., & Danielsbacka, M. (2018). Relationship quality among half siblings: The role of childhood co-residence. *Evolutionary Psychological Science*, 4. <https://doi.org/10.1007/s40806-018-0161-9>.
- Tanskanen, A. O., & Danielsbacka, M. (2019). *Intergenerational family relations: An evolutionary social science approach*. New York & London: Routledge.
- Tanskanen, A. O., & Danielsbacka, M. (2021). Brothers and sisters across the life course: Eleven factors shaping relationship quality in adult siblings. In A. Buchanan, & A. Rotkirch (Eds.), *Brothers and sisters: Global perspectives on the longest enduring relationship* (pp. 25–40). London: Palgrave MacMillan. https://doi.org/10.1007/978-3-030-55985-4_2.
- Tanskanen, A. O., & Rotkirch, A. (2019). Sibling similarity and relationship quality in Finland. *Acta Sociologica*, 62, 440–456. <https://doi.org/10.1177/0001699318777042>.
- Trivers, R. L. (1972). Parental investment and sexual selection. In *Sexual selection & the descent of man* (pp. 136–179). Chicago: Aldine. <https://doi.org/10.4324/9781315129266-7>.
- Trivers, R. L. (1974). Parent-offspring conflict. *Integrative and Comparative Biology*, 14(1), 249–264. <https://doi.org/10.1093/icb/14.1.249>.
- Van Bavel, J., & Reher, D. S. (2013). The baby boom and its causes: What we know and what we need to know. *Population and Development Review*, 39(2), 257–288.
- Voorpostel, M., van der Lippe, T., Dykstra, P. A., & Flap, H. (2007). Similar or different? The importance of similarities and differences for support between siblings. *Journal of Family Issues*, 28(8), 1026–1053. <https://doi.org/10.1177/0192513X07300713>.
- Walter, A., & Buyske, S. (2003). The Westermarck effect and early childhood co-socialization: Sex differences in inbreeding-avoidance. *British Journal of Developmental Psychology*, 21(3), 353–365. <https://doi.org/10.1348/026151003322277748>.
- Westermarck, E. A. (1891). *The history of human marriage*. London: Macmillan.
- Williams, R. (2012). Using the margins command to estimate and interpret adjusted predictions and marginal effects. *The Stata Journal*, 12(2), 308–331. <https://doi.org/10.1177/1536867X1201200209>.
- Wolf, A. P. (1993). Westermarck redivivus. *Annual Review of Anthropology*, 22(1), 157–175. <https://doi.org/10.1146/annurev.an.22.100193.001105>.