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Cooperation and Conflict
Sibling Relations in Contemporary Societies

Finnish Yearbook of Population Research LI 2016 Supplement
The Population Research Institute, Helsinki, Finland

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ABSTRACT

This study investigates sibling and "extended sibling" relations. Extended sibling relations refer to relations between nieces or nephews and aunts or uncles. Both cooperation and conflict between kin are investigated. We use an evolutionary family sociological framework for analysing kin relations in present day Finland and the UK. Cooperation is measured by kin support, emotional closeness, and contact frequency, while the outcome of sibling conflict is measured by toddlers' unintended injuries, young adolescents' reports of how much siblings picked and hurt each other, and adults' self-reported disagreements with siblings. The study includes seven original articles and an introductory chapter.

Article I shows that 3-year-old British children who live in the same household with their full siblings have a lower risk of unintended home injuries than do children who live with their full and half siblings or only with their half siblings. Article II finds that 11-year-old British children living with their full siblings only were more likely to report hurting or picking between siblings compared with children who live with their half siblings only. Article III describes two generations of adult Finns and shows that both younger (mean age 36 years old) and older (mean age 65 years) generations have more contacts with full than half siblings and more contacts with the children of full siblings than with children of half siblings. Based on article IV, older and younger Finns have more contact with their sisters' children compared to their brothers' children. Article V finds that childless younger women in Finland provide more childcare to their siblings' children than do younger mothers. However, mothers and childless women provide equal amounts of support to their aunts and uncles. According to article VI, younger Finnish adults who have half siblings are more likely to have encountered unequal maternal treatment than younger adults who have full siblings only. Article VII shows that younger and older Finns are more likely to have conflicts with their full siblings than with their half siblings.

Combined, these results show that kin relations tend to differ both between maternal and paternal kin and between full and half siblings. Moreover, kin support is more likely to flow from older individuals to younger ones than vice versa. Finally, parental unequal treatment seems to shape relations between siblings. At the end of the introduction chapter, policy and practical implications of the results are discussed.

LIST OF ORIGINAL PUBLICATIONS

I Tanskanen, A.O., Danielsbacka, M. & Rotkirch, A. (2015). More Injuries in Half Sibling than Full Sibling Households in the UK. Journal of Individual Differences, 36, 177–182, doi: 10.1027/1614-0001/a000171.

II Tanskanen, A.O., Danielsbacka, M., Jokela, M. & Rotkirch, A. (2016). Sibling Conflicts in Full and Half Sibling Households in the UK. Journal of Biosocial Science, 48, in press, doi:10.1017/S0021932016000043.

III Tanskanen, A.O. (2015). Childlessness and Investment in Nieces, Nephews, Aunts, and Uncles in Finland. Journal of Biosocial Science, 47, 402–406, doi: 10.1017/S0021932014000339.

IV Tanskanen, A.O. & Danielsbacka, M. (2016). Contact Frequencies with Nieces and Nephews in Finland: Evidence for the Preferential Investment in More Certain Kin Theory. Journal of Social and Personal Relationships, 33, in press, doi: 10.1177/0265407515619556.

V 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, doi: 10.1016/j.paid.2014.04.034.

VI Danielsbacka, M. & Tanskanen, A.O. (2015). The Association between Unequal Parental Treatment and the Sibling Relationship in Finland: The Difference between Full and Half Siblings. Evolutionary Psychology, 13, 492–510.

VII Tanskanen A.O., Danielsbacka, M., Jokela, M., Rotkirch, A. & David-Barrett, T. (2016). Diluted Competition? Conflicts between Full and Half Siblings in Two Adult Generations. Frontiers in Sociology, 1, 1–11, doi: 10.3389/fsoc.2016.00006.

1. INTRODUCTION

Sibling relations are the most long lasting social ties across the human life span (Cicirelli, 1995). Although fertility rates have declined in many modern Western countries during recent decades, individuals who have no siblings at all are still a minority (Buchanan & Rotkirch, 2013). Furthermore, due to increased divorce rates and remarriages, people more commonly live in the same household with their maternal or paternal half siblings. Siblings can be very close to each other, in particular, if they are of the same sex and the age difference is moderate (Brody 1996; Dunn & Kendrick 1982), or they may be each other's worst rivals when they compete intensely over parental resources (Salmon & Hehman, 2014). Thus, relationships between siblings contain not only emotional closeness, helping and cooperation but also competition and conflict (Pollet & Hoben, 2011).

Sibling competition and conflicts tend to be most common during childhood and adolescence, while in adulthood sibling relations are more characterized by altruism and cooperation (White, 2001). In the present study, we measure cooperation through kin support, emotional closeness, and contact frequency, while the outcome of sibling conflicts are measured by toddler's unintended injuries, young adolescents' reports of how much siblings picked and hurt each other, and adults' self-reported disagreements with siblings. We investigate sibling relations using an evolutionary family sociology framework.

In family studies, the reason for kin support is often explained by receivers' need for help and helpers' (potential) possibility to provide support (e.g., Szydlik, 2008). However, helping close kin reflects not only need and opportunity structures but also the helpers' motivation to provide help. These motivating factors are, as some argue, related to evolutionary beneficial behaviour (Salmon & Shackelford, 2011). According to inclusive fitness theory (Hamilton, 1964), individuals can increase their fitness by investing time and other resources in their close

relatives with whom they share common alleles. Based on this theory, all else being equal, individuals are predicted to provide more altruistic help and assistance to their more closely related relatives compared to more distantly related relatives or non-relatives. For instance, because individuals share on average 50% of their alleles with full siblings and 25% with half siblings, they should invest more time and resources to their full rather than half siblings.

Sibling competition and conflicts may also have evolutionary roots. Sibling competition stems from parent-offspring conflict theory (Trivers, 1974). This theory emphasizes the conflicting interests between parents' capability to provide resources to particular offspring and offspring's desire to receive those investments. Although parents are "prepared" to invest enormously in their children, their resources are limited, and at the same time, children are "programmed" to present almost endless demands to their parents. Children also monitor very closely for parents' possible preference towards other siblings (Salmon & Hehman, 2014). Sibling conflict theory. which is an extension of parent-offspring conflict theory (Trivers, 1974), argues that sibling conflicts reflect competition over limited parental resources. Sibling competition tends to be most severe in childhood and adolescence because this is when parental investment matters the most. However, this notwithstanding, competition may also extend into adulthood (Salmon & Hehman, 2015). Adult siblings may compete, for instance, over parental financial support, attention, and inheritances.

In addition to relations between sisters and brothers, we investigate "extended sibling" relations. By extended sibling relations we mean the relations between an individual and his/her parents' siblings (i.e., aunts and uncles) and between an individual and his/her siblings' children (i.e., nieces and nephews). Due to evolutionary sex-specific reproductive strategies and paternity uncertainty, sex and lineage are (in addition to genetic relatedness) important factors to consider in these intergenerational relations (Euler, 2011; Pollet & Hoben, 2011).

2. MATERIALS AND METHODS

Finland and the UK differ from each other in several ways, for instance, in public spending rates on families, education, and social services (OECD, 2012), they still present modern welfare states. The UK data consist of children born at the beginning of the new millennium, from which we use data gathered when the children were 3-year-old and 11-year-old. The Finnish data consist of two different aged adult generations: a younger generation (average age 36 years) and an older generation (average age 65 years). These data allows us to study kin relations from different perspectives, and in childhood and adulthood.

The Millennium Cohort Study (MCS) is a representative longitudinal survey carried out in England, Wales, Scotland, and Northern Ireland. The aim of the MCS is to collect information on children born at the beginning of the new millennium. Here, we analysed the data from the third and fifth waves of the MCS. The third wave data were gathered in 2003–2005, when the children were approximately 3 years old. The fifth wave data were collected in 2012–2013, when the children were approximately 11 years old. The third wave data included 15,590 and the fifth wave data 13,287 responding families. In the MCS surveys, children's parents or parental figures answered questions concerning their children, themselves, and the family. In the fifth wave, the children themselves also answered the questions concerning sibling relations. The MCS data are described in detail elsewhere (Hansen, 2014).

The Generational Transmissions in Finland (Gentrans) project collects information on two generations regarding social relations: the Finnish baby boomer generation born between 1945 and 1950 (M = 1947, SD = 1.67) (i.e., the older generation) and their adult children born between 1962 and 1993 (M = 1976, SD = 5.6) (i.e., the younger generation). In the empirical articles, we used the second wave of representative surveys, which were gathered in 2012. The surveys of the older and younger generations were gathered separately. During the data collection

in 2012, the older generations' respondents were approximately 65-years-old (between 62 and 67) and the younger generations' respondents were approximately 36-years-old (between 19 and 50). The older generation's survey included 2,278 respondents altogether, and the younger generation's survey reached 1,753 respondents. The Gentrans data are described more precisely elsewhere (Danielsbacka et al., 2013).

When studying sibling and "extended sibling" relations, it is important to take into account several other factors in addition to genetic relatedness, sex, and lineage, as mentioned above. These variables include, for instance, the age difference between siblings, number of siblings, and birth order, which previous studies have often shown to be associated with sibling relations (e.g., Pollet & Hoben, 2011; Salmon & Hehman, 2014). We control for these and several other potential confounding variables in all of the empirical articles.

As methods, we have used linear regression analysis (articles III and IV), multilevel linear regression analysis (article VI), binary logistic regression analysis (articles I and V), ordered logistic regression analysis (article II), multinomial logistic regression analysis (article VI), and multilevel logistic regression analysis (article VII). In addition to quantitative materials and analyses, in article VI we have analysed qualitative text materials using qualitative content analysis as a method.

3. RESEARCH FINDINGS

As outlined above, based on inclusive fitness theory, sibling competition should be harsher between half siblings than full siblings because full siblings share on average more alleles than half siblings and should not as easily harm each other in any serious way (Salmon & Hehman, 2014). In article I, we used the second wave of the MCS data and analysed whether 3-year-old children living in households where there are only full siblings had more or less unintended injuries than children living in households where there are full and maternal half siblings or only maternal half

siblings. The results showed that, after controlling for several potential confounding factors, young children who lived in the same household with their full siblings had a significantly lower risk of injuries (predicted probability 25.3%) than did children who lived with both their full and half siblings (29.6%) or only with their half siblings (29.1%).

Using fifth wave MCS data, in article II we analysed whether the 11-year-old children had more conflicts with their siblings if they lived only with their full siblings, full and maternal half siblings or only with their maternal half siblings. Conflicts were measured using children's self-report on how much siblings picked and hurt each other. Contrary to the results in article I, we found that the 11-year-old children living with their full siblings only had *more* conflicts with their siblings than children living with their maternal half siblings only. Thus, it seems that genetically closer relationship also creates more conflict if conflicts are measured with "milder" rather than more severe indicators. As one explanation for this result, we offered lower levels of competition over parental resources between half siblings, which could be due to half siblings having another biological parent outside the household who could also invest in him or her. This may reduce sibling competition over shared parent's resources.

In article III, we turned towards sibling relations in adulthood and studied contact frequencies between full and half siblings and between nieces and nephews via full and half siblings using two-generational data from Finland. Based on inclusive fitness theory (Hamilton, 1964), we predicted that the amount of contacts should increase with the increasing degree of relatedness. In accordance with this assumption, we found that members of both older and younger generations had more contacts with full than half siblings and more with full than half siblings' children. In addition, we found that individuals had more contacts with sisters than brothers and more with sisters' children compared to brothers' children.

In article IV, we investigated the relationship between adult sisters and brothers more closely using the Finnish two-generational data. We tested preferential investment using the more certain kin hypothesis (Laham et al., 2005), which predicts that kin relations are dependent on

the different investment options. The hypothesis emphasizes that because maternity is certain and paternity is uncertain, individuals should prefer their sisters' children over their brothers' children. We found that when older and younger adults had an option to invest in either their sisters' or brothers' children, they had more contact with sisters' compared to brothers' children. The results were in line with the preferential investment hypothesis.

In article V, we tested the reproductive value hypothesis (Hughes, 1988), which emphasizes that individuals will invest more resources in their relatives in descending rather than ascending order. We found that childless younger women invest more in their siblings' children than do younger mothers. However, childless women did not invest more or less in their aunts and uncles compared to mothers. The results were in accordance with the prediction based on reproductive value.

In article VI, we studied some potential mechanisms explaining why sibling relations between maternal half siblings are poorer than between full siblings, even though maternal half siblings have most probably co-resided during childhood. We used data of younger generation Finns to investigate first, whether those who have half siblings perceived more unequal parental treatment than those who have full siblings only. Second, we studied how the perceived unequal parental treatment is associated with sibling relationship between full, maternal, and paternal half siblings. Our results show that those who have maternal and/or paternal half-siblings are more likely to have encountered unequal maternal treatment than individuals who have full siblings only. We also found that the perception of unequal parental treatment impairs full as well as maternal and paternal half sibling relations in adulthood. However, we found support for the prediction that unequal parental treatment is a mediating factor between the effect of genetic relatedness on sibling relations in the case of maternal half siblings but not in the case of paternal half siblings. Thus, maternal half sibling relations do not differ from full sibling relations if siblings do not feel that they have been treated unequally by their parents. Additionally, when we analysed the qualitative text data of

the same population, we found that in many cases the perceived unequal treatment was related to perception of unequal distribution of parental resources.

In article VII, we analysed conflicts between adult full and half siblings with Finnish two-generational data. In contrast to the prediction based on inclusive fitness theory (Salmon & Hehman, 2014), we found that younger and older Finns were more likely to have conflicts with their full rather than half siblings. The results hold even after several potential confounding variables, including contact frequencies and emotional closeness between siblings, were controlled for. The results were similar to the results in article II, which investigated sibling conflicts in 11-year-old British children but contrary to the predictions derived from inclusive fitness theory.

4. DISCUSSION

In this series of studies, we have analysed sibling relations in childhood and adulthood using data from the UK and Finland. The great advantage in using different datasets was that we could capture the nature of sibling relations in children, younger adults, and older adults. Moreover, we were able to study kin relations from different perspectives concentrating on both the cooperative and conflicting aspects of these relations. Finally, with these data we were able to control for several potential confounding variables that have been shown to be associated with kin relations in previous studies.

We found that sibling relations differ based on genetic relatedness, sex, and lineage. Adult Finns tended to have more contacts with full rather than half siblings and more with full rather than half siblings' children. Moreover, we found that maternal kin relations tended to be closer than paternal kin relations. These results are in accordance with the previous findings showing matrilineal, and genetically related kin preference in social relations (see Euler, 2011; Pollet & Hoben, 2011 for reviews). In

addition, Finnish younger adults who had half siblings reported more unequal parental treatment than individuals who had full siblings only. We also found that individuals tended to invest more in their nieces and nephews than in their aunts and uncles. This finding is in line with several previous investigations showing that people usually invest more time and resources in their kin in descending rather than ascending order (e.g., Danielsbacka et al., 2013).

In the case of 3-year-old British children, we found that living with half siblings increased the risk for unintended home injuries, reflecting more sibling competition between half rather than full siblings. In contrast, in the case of 11-year-old British children as well as adult Finns, full siblings more likely had conflicts compared to half siblings. There are two potential explanations for these seemingly contradicting results. The explanation may be related to the "mild" conflict variable used in the cases of 11-year-old British children and adult Finns. These variables may actually measure the closeness of the relationship rather than pure conflicts. Moreover, half siblings could compete over the attention, time, and resources of one shared parent, while full siblings have two shared parents. Half siblings also tended to have another parent outside the childhood family from whom to receive investment. At least in some cases (e.g., when both parents continue to invest in children after parental separation), this differential access to parental resources of biological and step-parents may explain why full siblings have more conflicts than half siblings.

The policy and practical implications of the results of the present study are multiple. In contemporary Western societies, blended families have become increasingly common. We have shown that in addition to several socioeconomic and family related factors, the presence of half rather than full siblings is associated with an increased risk of toddler injuries in the UK. As unintended injuries are the most common cause of mortality in early childhood in contemporary Western societies, family composition is worth taking into account when planning preventive measures for children at risk.

With the Finnish data, we found that younger adults who had half siblings reported unequal treatment from their parents more often compared to those who had full siblings only. Sibling relations are also affected by perceived parental treatment: younger adults who reported that their parents had not treated all siblings equally reported lower emotional closeness with their siblings compared to those who reported equal parental treatment. A third general result is that perception of unequal parental treatment was associated with a higher probability of sibling conflict in adult Finns. Thus, unequal parental treatment may negatively affect sibling relations not only in the short-term but also in the long-term, as the unequal treatment experienced in childhood tends to remain in one's mind until adulthood. It is well-known that adult siblings provide important support to each other (Pollet & Hoben, 2011), and those with poor sibling relations are likely to miss this support. Thus, it is important that parents make sure that children feel they are treated equally. This is especially important in blended families, where the perception of unequal parental treatment tends to be most common.

The finding that younger women in Finland provide more support to their nieces and nephews than their aunts and uncles shows that older kin members in particular are at risk of lacking kin support. During recent years, there has been a wide ranging debate in Finland concerning whether it is the responsibility of younger adults or the state to ensure the well-being of older kin members. If the state does not provide support for older persons, a large portion of this population could lack any support at all. Thus, if the goal is for all citizens to have a decent quality of life quality, it is important that the well-being of older individuals be publicly guaranteed.

Furthermore, our results show that sibling and extended kin relations are an important part of adult individuals' life in contemporary societies. Adult siblings, for instance, often provide emotional and practical help to each other that may in turn significantly ease everyday quality of life. Therefore, living arrangements where kin members can live closer to each other may be worth considering in social and urban planning policies.

Our findings highlight the importance of future research. For instance, it is important to study sibling relations with longitudinal data to see how they change during the individual life course. In addition, cross-national studies are needed to show how sibling relations vary between different social and family policy regimes and cultural areas. It is also essential to investigate the outcome of sibling relations. Are individuals with better sibling relations happier and healthier than others? Do children who receive support from their aunts and uncles have a higher level of well-being compared to others? In all cases it is important to take into account the degree of genetic relatedness, sex, and lineage, as these factors may remarkably influence kin relations in modern societies.

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I

Original Article

More Unintended Injuries in Half Sibling Than Full Sibling Households in the UK

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Abstract. Sibling relationships can be a source of both support and conflict. Due to more severe sibling competition, childhood injuries are predicted to increase as genetic relatedness decreases. Here we use the British Millennium Cohort Study (n = 7,143 children) to analyze the risk of accidents for small children in different types of households. Results show that, after controlling for several potential confounding factors, 3-year-old children who lived in same household with their full siblings had a significantly lower risk of injuries (predicted probability 25.3%) than did children who lived with both their full and half siblings (29.6%) or only with their half siblings (29.1%). We conclude that efforts to prevent child maltreatment should pay attention to sibling relations and family composition.

Keywords: full siblings, half siblings, injuries, Millennium Cohort Study, sibling competition

Introduction

In contemporary Western societies unintended injuries are the most common cause of death in early childhood (NCIPC, 2006; UN, 2001) and in recent years much attention has therefore been directed toward preventing childhood injuries. A growing body of research shows that several socioeconomic and cultural factors correlate with accidents in early childhood (e.g., Reading et al., 2008). In addition, family composition is known to influence the likelihood of injuries, for example, so that children with single parents are more likely to have accidents (e.g., Kendrick, Mulvaney, Burton, & Watson, 2005; Myhre, Thoresen, Grøgaard, & Dyb, 2012).

Previous studies have found that the presence of siblings significantly increases the risk of injuries (e.g., Myhre et al., 2012). Thus, in addition to parental maltreatment or negligence, early year injuries may also result from the behavior of siblings. According to evolutionary theory, sibling competition is predicted to increase as the rate of genetic relatedness between siblings decreases (Salmon & Hehman, 2014). One possible measure of sibling competition is childhood injuries. Here, we analyze whether young children are more likely to experience injuries in households with half siblings compared to full siblings. To our knowledge this topic has not been previously studied.

Human beings belong to the many species which typically grow up with siblings (Salmon & Hehman, 2014). Sibling relations and relationship quality are an important part of individual, social, and developmental environment (Deater-Deckard, Dunn, & Lussier, 2002; McHale, Updegraff, & Whiteman, 2012). Sibling relations have thus probably play a significant role by shaping individual phenotypes (Hudson & Trillmich, 2008). Sibling relations are characterized by both altruistic helping and competition for limited parental resources (Trivers, 1974; Salmon & Hehman, 2014). Also in contemporary wealthy societies, sibling competition exists and is particularly intense in early childhood (Lawson & Mace, 2009; Pollet & Hoben, 2011).

Sibling competition may manifest itself in several ways. Its most serious form, siblicide (i.e., the killing of one's own sibling), is relatively common in many bird species (Mock & Parker, 1997), but infrequent in mammals (Hudson & Trillmich, 2008). Among human beings, less than two percent of all homicides are siblicides (Bourget & Gagné, 2006; Daly & Wilson, 1988). Instead, sibling competition in early human childhood usually takes the form of aggressive interaction such as bickering, and pushing and shoving, which may cause accidents and injuries. Additionally, competition may manifest itself as neglect or low quality care, which may also lead to unintended injuries. Here, we suggest that injuries occurring at home may reflect sibling competition and rivalry, whether they occur due to fights or due to negligence to protect a sibling.

Previous studies have shown that individuals tend to be emotionally closer to their full siblings than half siblings, at least in adulthood (e.g., Pollet, 2007; Tanskanen & Danielsbacka, 2014). The evolutionary theory of kin altruism predicts that altruistic acts will increase as genetic relatedness increases between close relatives (Hamilton, 1964).

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Following this logic, severe competition between individuals is often also predicted to increase with decreasing genetic relatedness (Kurland & Gaulin, 2005). Individuals share on average 50% of genes with their full siblings and 25% with their half siblings. Small children may not be consciously aware if the sibling is a full or half sibling, especially if they have spent most of their childhood together and been nursed by the same mother (Lieberman, Tooby, & Cosmides, 2007). Nevertheless, some traits indicating lower genetic relatedness may exist. For instance, half siblings may not resemble each other in appearance or temperament as much as full siblings do and the adult caretakers in the family may treat children differently depending on their genetic relatedness to them. We therefore hypothesize that more unintended injuries will occur when children reside in the same household with their half siblings than with their full siblings only.

Several factors are known to be associated with childhood injuries. Boys are prone to have more injuries than girls (e.g., Reading et al., 2008) and same-sex siblings, especially brothers, may be involved in more intense competition over resources (see e.g., Buist, Deković, & Prinzie, 2013; Nitsch, Faurie, & Lummaa, 2013), possibly increasing the risk of injuries. The number of children in the household also tends to increase the risk of injuries (e.g., Myhre et al., 2012; Ramsay et al., 2003). Lower socioeconomic standing (e.g., Hong, Lee, Ha, & Park, 2009; Reading, Langford, Haynes, & Lovett, 1999) and a lower quality of the residential area (e.g., Haynes, Reading, & Gale, 2003; Kendrick & Marsh, 2001; Pearce et al., 2010) both increase the risk of childhood injuries compared to wealthier families and neighborhoods. Single motherhood, low maternal education, and low maternal age are also associated with an increased risk of childhood injuries (Bruce, Lake, Eden, & Denney, 2004; Hong et al., 2009; Kendrick et al., 2005; Pearce et al., 2010). Finally, children's temperament could be an important factor, since it may be associated with children's social behavior and thus with accidents (Soubhi, 2004).

In addition, previous results indicate that households with safety equipment (i.e., safety gates, fireguards, electric socket covers, and smoke alarms) have less childhood injuries than homes with no safety equipment (e.g., Kendrick et al., 2005; Reading et al., 2008; but see Pearce et al., 2012). Childcare type (i.e., formal or informal) may also matter, since the risk of unintentional injuries is smaller when the child is in formal care (e.g., Kopjar & Wickizer, 1996; Rivara et al., 1989; Schwebel, Brezausek, & Belsky, 2006; but see Pearce et al., 2010). Somewhat surprisingly perhaps, belonging to the ethnic majority may increase the risk of injuries, at least in the UK (Reading et al., 2008).

Data and Methods

We use the Millennium Cohort Study (MCS) from a representative longitudinal survey carried out in the UK. The aim of the MCS was to collect information on children born at the beginning of the new millennium. Respondents are parents or parental figures who answered questions concerning their cohort member children. The first wave data was collected in 2000–2001 when the target children were approximately 9 months old. In this article we use the data from the second wave of the MCS, which was gathered in 2003–2005 when the children were approximately three years old (M = 37.7 months, SD = 2.5). Since the information concerning some background variables (e.g., maternal education and children's temperament) were collected only in the first wave survey, these variables are derived from it. In total the second survey wave reached 15,590 responding families (see Hansen, 2010 for more detailed data description).

For our analytic sample we selected cases where the main respondents were the biological mothers of the target child (in the second wave 98% of all main respondents). Only cases where the mothers lived in the same household as the cohort member child were included. In cases of twins and triplets, only one child of the set was included. Only cohort member children who had at least one older sibling were selected. After these exclusions the analytic sample included 7,143 cohort member children.

The dependent variable measures the target child's unintentional injuries. In the second wave of the MCS mothers were asked whether the target child ever had an injury for which he/she has been taken to the doctor, health center, or hospital. Mothers were also asked to report where the injury had occurred. We included only those injuries that have happened in the home environment. This is because injuries at home are more likely to have involved sibling competition than injuries occurring elsewhere.

The main explanatory variable measures whether the cohort member child lived in the same household with half siblings. We classified the scale into three categories: 1 = lived with full sibling(s) only, 2 = lived with full and half sibling(s), 3 = lived with half sibling(s) only. Altogether 26.0% (n = 1,854; FS only, n = 1,508; FS and HS, n = 156; HS only, n = 190) of the children in the study sample were reported to have had an injury at home.

The method of analysis were correlations and binary logistic regression analysis conducted with the statistical software Stata 12.0. The regression control was applied for several potential confounding variables, which were predicted to increase the risk of injuries based on previous research (see the Introduction) and were also found to correlate significantly with childhood injuries in preliminary bivariate regressions in this data. These variables were maternal age, maternal socioeconomic circumstance, ethnic background, sex of target child and of sibling(s), number of safety practices (i.e., none; safety gate, fireguard, smoke alarm, electric socket cover; from 0 to 4), and neighborhood quality (see Table 1 for descriptive statistics).

In the MCS children's temperament was measured by the Carey Infant Temperament Scale (Carey, 1972; Carey & McDevitt, 1978). In the first survey wave mothers were asked to report infant temperament on three traits: Positive mood (five items), receptivity to novelty (five items), and rhythmicity (five items). Of these three traits in our preliminary analysis "receptivity to novelty"

Table 1. Descriptive statistics (%/mean) (n = 7,143)

	%/mean
Sibling constellation in household (%)	
Full siblings only	84.2
Full and half siblings	7.1
Half siblings only	8.7
Ethnic background (%)	
White	83.5
Mixed	2.6
Indian	2.3
Pakistani/Bangladeshi	7.2
Black	3.5
Other	1.0
Receptivity to novelty (mean)	9.1
Sex of child and sibling (%)	
Boy with brother	17.6
Boy with sister	17.5
Boy with brother and sister	14.5
Girl with sister	17.1
Girl with brother	18.9
Girl with sister and brother	14.3
Maternal age (mean)	33.4
Maternal socioeconomic circumstance (%)	
Semi-routine, routine, and not working	48.0
Lower supervisory and technical	5.5
Small employers and own account	4.3
Intermediate	16.4
Managerial and professional	25.8
Number of safety equipments (mean)	2.3
Neighborhood quality (%)	
Bottom decile	15.7
10–< 20%	13.1
20–< 30%	11.3
30–< 40%	9.5
40–< 50%	9.5
50–< 60%	8.5
60–< 70%	6.6
70–< 80%	7.6
80–< 90%	9.1
Highest decile	9.2

(Cronbach's α = .69) was significantly associated with children's injuries and was included in the final regression model.

Number of siblings, number of 0–3 year older siblings, parent's financial condition, maternal education, and marital status, the presence of biological father in household, type of childcare, positive mood and rhythmicity were not significantly related to child's injuries in this data (results not shown) and were therefore not included in the final regression model.

With the exception of maternal age, number of safety practices, and receptivity to novelty, all variables are categorical and were transformed into dummy variables for the logistic regression analysis. Maternal socioeconomic position, number of safety practices in household, and child's receptivity to novelty variables are derived from the first wave data. All other variables included in the analyses are from the second wave data.

Results

First, we studied the correlations between presence of half siblings and occurrence of injuries. Table 2 presents the Pearson correlations between independent variables. The highest correlations were found between maternal socioeconomic situation and neighborhood quality, between maternal age and socioeconomic situation, and between number of safety equipments and ethnic background.

We then ran the regression models. Before adjusting for the control variables, the odds ratios for "full and half siblings" were 1.33 (p = .004) and for "half siblings only" 1.31 (p < .003) compared to the reference group "full siblings only" (odds ratio = 1.00) (table not shown). When adjusting for the control variables, the odds ratios were attenuated but remained statistically significant in the same direction. For "full and half siblings" they were 1.25 (p = .037) and for "half siblings only" they were 1.22 (p = .040) compared to the reference group "full siblings only" (see Table 3).

Children living with their full and half sibling(s) or with their half sibling(s) only had a greater risk of injuries compared to those who lived with their full siblings only (Table 3). The regression-based predicted probabilities are 25.3% for "full siblings only," 29.6% for "full and half siblings," and 29.1% "for half siblings only."

As Table 3 shows, in addition to sibship relatedness several other variables remained statistically significant also after controlling for other variables. Thus lower maternal

Table 2. Correlations between independent variables (n = 7,143)

	Variable	1	2	3	4	5	6	7
1.	Sibling constellation in household	–						
2.	Ethnic background	−0.08*						
3.	Receptivity to novelty	−0.03*	0.14*					
4.	Sex of child and sibling	−0.02	0.04*	0.10*				
5.	Maternal age	−0.02	−0.05*	−0.09*	0.0003			
6.	Maternal socioeconomic circumstance	−0.11*	−0.16*	−0.08*	−0.06*	0.36*		
7.	Number of safety equipments	−0.11*	−0.31*	−0.05*	−0.04*	0.09*	0.21*	
8.	Neighborhood quality	−0.10*	−0.29*	−0.08*	−0.06*	0.29*	0.43*	0.24*

Note. *p < .05 (two-tailed).

Table 3. Predicting the risk of injuries in early childhood (odds ratios) (n = 7,143)

	OR	*SE*	*z*	*p*	95%CIs	
					Lower	Upper
Sibling constellation in household						
Full siblings only	1.00					
Full and half siblings	1.25	0.13	2.09	.037	1.01	1.53
Half siblings only	1.22	0.12	2.06	.040	1.01	1.46
Ethnic background						
White (ref)	1.00					
Mixed	0.85	0.15	−0.92	.359	0.60	1.20
Indian	0.38	0.09	−4.02	< .001	0.23	0.61
Pakistani/Bangladeshi	0.68	0.08	−3.13	.002	0.53	0.86
Black	0.58	0.10	−3.16	.002	0.41	0.81
Other	0.78	0.22	−0.85	.393	0.45	1.37
Receptivity to novelty	0.99	0.01	−1.47	.141	0.98	1.004
Sex of child and sibling						
Boy with brother (ref)	1.00					
Boy with sister	1.21	0.11	2.10	.036	1.01	1.44
Boy with brother and sister	1.03	0.10	0.35	.729	0.86	1.25
Girl with sister	0.90	0.08	−1.19	.234	0.75	1.07
Girl with brother	0.79	0.07	−2.62	.009	0.66	0.94
Girl with sister and brother	0.77	0.08	−2.53	.011	0.64	0.94
Maternal age	0.98	0.01	−3.95	< .001	0.97	0.99
Maternal socioeconomic circumstance						
Semi-routine, routine, and not working	1.00					
Lower supervisory and technical	1.04	0.12	0.30	.766	0.82	1.31
Small employers and own account	0.77	0.11	−1.78	.075	0.57	1.03
Intermediate	0.88	0.07	−1.50	.134	0.75	1.04
Managerial and professional	0.88	0.07	−1.67	.094	0.75	1.02
Number of safety equipments	1.03	0.03	1.32	.186	0.98	1.09
Neighborhood quality						
Bottom decile (ref)	1.00					
10–< 20%	1.04	0.10	0.34	.733	0.85	1.26
20–< 30%	0.80	0.09	−2.02	.043	0.65	0.99
30–< 40%	1.11	0.12	0.91	.364	0.89	1.38
40–< 50%	0.81	0.10	−1.77	.077	0.65	1.02
50–< 60%	0.90	0.11	−0.84	.398	0.71	1.14
60–< 70%	0.96	0.13	−0.31	.756	0.74	1.24
70–< 80%	0.93	0.12	−0.54	.587	0.73	1.20
80–< 90%	0.83	0.10	−1.47	.141	0.65	1.06
Highest decile	0.70	0.10	−2.73	.006	0.55	0.91

age remained significantly associated with higher risk of injuries. The sex of the child also mattered, so that boys tended to have greater risk of injuries compared to girls. However, when looking at specific sibship combinations, the picture is more complex. Boys with sisters had greater likelihood of injuries than boys with brothers, who in turn had higher risk of injuries compared to girls with brothers and girls with sisters and brothers. Children with mothers who were in semi-routine work, routine work, or did not wage work at all had marginally significantly greater odds to experience an injury than did children whose mothers were small employers or in managerial and professional position. Based on ethnic background, whites being the reference category, other ethnic groups had lower likelihood of unintended injuries, albeit the difference was not statistically significant for the groups "mixed" and "other." Based on the neighborhood quality, children who live in the bottom decile area were more likely to experience injuries compared to children who live in the third decile or highest decile area. Finally, there were no significant associations between the number of safety equipments or receptivity to novelty and unintended injuries.

Conclusions

Sibling relations are characterized by both high levels of helping and solidarity and high levels of competition and potential conflict. Compared to other kin, sibling relations appear to exhibit lower kin altruism (e.g., Xue, 2013), although altruistic behavior still appears to be higher between siblings than among non-kin close friends (Rotkirch, Lyons, David-Barrett, & Jokela, 2014). In relation to the ubiquity, intensity, and importance of sibling relations they remain surprisingly little studied (McHale

et al., 2012) and this relative neglect includes harmful effects.

This article compared differences between half and full siblings in relation to childhood injuries. Evolutionary theory predicts that there should be more competition between half than full siblings, since altruistic behavior is predicted to be higher among genetically closely related kin. In line with this prediction we found that children who co-resided with their full siblings only had a lower risk of injuries compared to children who lived with their half siblings. A negative effect of co-residing half siblings has been previously found in relation to child outcomes, measured as educational level with Swedish data (Sundström, 2013). Our results suggest that early childhood conditions including injuries may contribute to the penalty on educational achievement caused by living in a family which includes target children's half siblings.

Also maternal age and ethnic background were associated with higher risks of injuries in early childhood after controlling for other confounding factors. Highest neighborhood quality areas children also had a lower risk of reported injuries compared to lowest quality neighborhood areas. These results are in line with several previous studies (e.g., Bruce et al., 2004; Hong et al., 2009; Kendrick et al., 2005; Pearce et al., 2010; Reading et al., 2008). Boys with brothers were more likely to have injuries than girls with brothers or girls with sisters and brothers. In contrast to the assumption that same-sex siblings (brothers in particular) have more intense competition, which may increase the risk of injuries, we found that boys with sisters had greater likelihood for injuries than did boys with brothers. In addition, the risk of injuries among boys with brothers did not differ from girls with sisters.

The proximate mechanism beyond the different associations detected between half and full siblings is not clear. Children may recognize their closer related kin from more distantly related kin, and thus be less emotionally close, trustful, and protective toward half siblings compared to full siblings. Full siblings may also be closer to each other because of a greater number of shared traits and preferences. This could, as we have here assumed, create more severe competition between half than full siblings and raise the risk of injuries. Another possibility is that parents may treat their biological and nonbiological children differentially, which may increase competition between siblings. Also other factors, such as parental personality traits, which are known to affect risk of divorce and remarriage and thus household structure, could have a bearing on our results but were not possible to include in this study.

Among the limitations of our study is that we measured only the reported occurrence of severe injuries, that is injuries for which children have been taken to the doctor, health center, or hospital. It would be valuable to measure also milder injuries, which are probably more common. Neither can we tell what or who caused the injuries. We merely assume it is at least partly the result of sibling conflict (e.g., fights) or neglect (e.g., failing to protect a toddler). The differences may also stem from for example, differential parental treatment. However, we detected no significant association of the presence of the biological father in families, but a strong associations between child sex and injuries, indicating that parental behavior is not largely influential for the differences detected here. Further studies are needed to compare parental behavior and sibling behavior in relation to toddler injuries. In addition, there is a need for longitudinal studies on how sibling competition develops as the children grow.

The presence of half siblings increases the risk of toddler injuries regardless of several other factors raising the risk of injuries. Family and sibship composition should be taken into account when planning preventive measures and providing support for children at risk.

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SIBLING CONFLICTS IN FULL- AND HALF-SIBLING HOUSEHOLDS IN THE UK

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Summary. Sibling relations are by nature ambivalent with high levels of both altruistic helping and competition. Higher relatedness is often assumed to reduce the occurrence of conflicts between siblings, but evidence of this has been scarce and mixed. Siblings typically compete over resources and parental attention, and parental constellations vary with sibship types. Since full-siblings compete over the same two biological parents, while half-siblings have only one shared biological parent and often a higher number of parents overall, it is hypothesized that conflicts are more common between full- than half-siblings. This study tested this assumption using the British Millennium Cohort Study ($n = 7527$ children at age 11). Conflicts were measured as children's reports of how much siblings picked on and hurt each other. Households with full-siblings only, maternal half-siblings only, and both full- and maternal half-siblings were compared. The results show that children who were living with only their full-siblings were more likely to experience sibling conflicts compared with children living with their maternal half-siblings only. This was the case also after controlling for several potentially confounding variables. The results suggest that differential access to parental resources of available biological and step-parents may explain the higher amount of sibling conflict between full- compared with maternal half-siblings.

Introduction

Siblings form a relationship that can last throughout their entire lives (Cicirelli, 1995). Although siblings can be very close to each other, especially if they are of the same sex and the age difference is moderate (Brody, 1996; Dunn & Kendrick, 1982), the nature of this family tie has been described as inherently ambivalent, with high degrees of both altruism and competition (Deater-Deckard *et al.*, 2002). Sibling competition over parental resources is known to be most severe in childhood and adolescence, when parental investment matters most (Salmon & Hehman, 2014). Due to the growth in rates

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of divorce and re-marriage, blended families are becoming increasingly common in Europe (Chapple, 2009; Kreyenfeld & Martin, 2011), fuelling also the interest of scholars in the dynamics of different sibship constellations. Here, the occurrence of sibling conflicts in full- and maternal half-sibling households using UK data is explored.

Kin relations are characterized by altruistic behaviour, which is ultimately explained by Hamilton's (1964) theory of inclusive fitness. It argues that an individual can enhance its inclusive fitness (the spread of its genes in future generations) by supporting the reproductive success of closely related kin. Among humans this means that, all else being equal, individuals should feel more close to, and should invest more resources (such as time, money, emotional support) in, genetically closer kin compared with more distantly related kin and to non-kin.

Altruism between close kin has been documented in many studies: parents and grandparents, for instance, tend to invest more in their genetically related (grand) children than in step- (grand)children (e.g. Anderson, 2011; Coall *et al*., 2014; Euler, 2011). People also tend to feel closer to, and have more contact with, their full-siblings, with whom they share on average half of their genes, compared with their half-siblings, with whom they share around one-quarter of their genes (e.g. Jankowiak & Diderich, 2000; Pollet, 2007; Tanskanen & Danielsbacka, 2014).

Close kin relations are also characterized by conflicts. Indeed, kin competition can be so extreme that it negates any possible influence of kin altruism (West *et al.,* 2002). However, Hamilton's (1964) rule does not take into account or make predictions about competition, which especially characterizes 'horizontal' kin relations compared with 'vertical' relations (Voorpostel & van der Lippe, 2007; Rotkirch *et al*., 2014). Sibling relations are usually horizontal, since siblings tend to belong to the same generation. Resources are often transferred from the older generation to the younger, so that members of the same generation compete for attention and resources from the elders.

Sibling conflict stems from parent–offspring conflict (Trivers 1974). From the offspring's perspective, the more parental resources s/he gets the better, since the offspring is more genetically related to her/himself than to her/his sibling (with the exception of monozygotic twins, see Segal *et al*., 2007; Segal & Marelich, 2011). From the parental perspective, by contrast, it may sometimes be more evolutionarily beneficial to invest in other existing or potential offspring. Therefore siblings are predicted to compete with each other over access to parental resources (Salmon & Malcolm, 2011).

Sibling competition ranges from small disputes to aggressive interaction including siblicide (Michalski *et al*., 2007). Siblicide is rare in humans (Daly & Wilson, 1988; Hudson & Trillmich, 2008), but milder conflicts and disagreements between siblings are frequent and may include verbal and physical aggression (Pollet & Hoben, 2011).

The occurrence of sibling conflicts is influenced by several child and family characteristics. Boys are more likely to have sibling conflicts than are girls (Brody *et al*., 1985; Salmon & Hehman, 2015). Also, the number of siblings and birth order are known to affect sibling relations (e.g. Salmon & Daly, 1998; Salmon, 1999, 2003; Lawson & Mace 2009; Damian & Roberts, 2015). The smaller the age difference, the more intensively do siblings compete over similar parental resources, while large age differences tend to lower sibling competition (Salmon & Hehman, 2014). Sibling competition may vary by ethnic group (Tanskanen *et al*., 2015). Socioeconomic status may also influence sibling competition, which has been predicted to increase with lower

status due to resource scarcity (Pollet & Hoben, 2011). On the other hand, sibling competition may be more severe when there is 'more to compete about', e.g. in parental resources or inheritance.

Sibling conflicts are important to study since they may influence child psychopathology, for instance through raised stress levels (Buist *et al.*, 2013) or unintended injuries (Tanskanen *et al.*, 2015). Sibling conflicts can also include outright bullying, which has been shown to be associated with health and emotional problems in early adulthood (Copeland *et al.*, 2014; Wolke *et al.*, 2015).

While research on step-families and sibling relations is expanding (Kreyenfeld & Martin, 2011), studies of sibling competition between full- and half-siblings remain scarce and have mixed findings. Ganong and Coleman (1993) studied 105 families and found interactions between full- and half-siblings to be more positive than between unrelated siblings. Deater-Deckard and colleagues (2002) measured sibling negativity (conflict and aggression) among 5-year-old children and found it to be higher among full- compared with half-siblings. Similarly, Salmon and Hehman (2015) reported that college students between the ages 18 and 22 had more conflicts with co-residing full-siblings compared with half-siblings.

Based on Hamilton's (1964) rule, sibling competition is usually predicted to increase with decreasing genetic relatedness (Schlomer *et al.*, 2011; Salmon & Hehman, 2014). Therefore Salmon and Hehman (2015) predicted that non-biological siblings would have the most conflict, followed by half-siblings, and then full-siblings. Their results showed that non-biological siblings did indeed have the most conflict, while – contrary to what was expected – half-siblings had fewer conflicts than full-siblings. No theoretical explanation for their findings was provided.

In contrast to predictions based on kin altruism, predictions based on parent–offspring conflict can lead us to expect more competition over parental resources between full-siblings than half-siblings. Full-siblings compete over resources from the same parents while half-siblings also have the additional option to receive support from their other biological parent. For instance, children who live in the same household with their biological mother and stepfather may also receive investment from their non-resident biological father. At least in some circumstances (e.g. when both parents continue investment after divorce) the competition for parental resources between half-siblings may thus be lower than between full-siblings.

The UK has one of the highest divorce rates in Europe today (OECD, 2014) and over a third of children have experienced parental separation by age 11 (Connelly *et al.*, 2014). Eleven per cent of children in England and Wales were living in stepfamilies in 2011 (Office of National Statistics, 2014). While children stay with their mothers most of the time following parental separation, it is increasingly common for the biological fathers to continue to keep in touch and invest in their children from previous unions (Skinner & Davidson, 2009). Many children of divorced parents regularly live with their other parent part of the time or regularly visit him or her, e.g. during weekends and holidays (Modecki *et al.*, 2015); in the UK a great majority of fathers have contact with their non-resident children at least occasionally (O'Brien & Speight, 2013).

Half-siblings may occur from either the paternal or maternal side. Paternal half-siblings typically occur in polygynous societies, when a male can have several wives simultaneously. Re-marriages following widowhood, which were common in

pre-industrial Europe, can create sibships who are either maternal or paternal half-siblings (Pettay *et al.*, 2013). By contrast, re-marriages in contemporary Western societies usually create sibships with full-siblings and maternal half-siblings, since children tend to stay with their biological mothers following divorce. Thus European co-residing half-siblings typically have the same mother and different biological fathers (Skinner & Davidson, 2009; OECD, 2014). Forms of sibling competition may vary with family structure and mating systems. Here, competition within sibships with full- or maternal half-siblings has been studied, since that is by far the most common type of half-sibships in the current study population. Assuming that sibling conflicts reflect competition over parental resources and attention, this study explored one of the implications of living in different sibship types: do children living with full-siblings have more frequent conflicts compared with children living with maternal half-siblings?

When investigating sibling conflicts, several sibship characteristics such as gender, age, age difference between siblings and birth order were controlled for, because these are known to be associated with sibling competition as described above. Measures of the quality of the relationship between adult carers in the household were also included, assuming that when the relationship between parents is conflict-prone there are also more conflicts between siblings, and vice versa (McHale *et al.*, 1995). Changes in household composition may also influence the family environment, since previous studies have shown that the relationship between the biological mother and father is often strained after the separation but changes for the better over time (Modecki *et al.*, 2015). Maternal involvement with children is also associated with sibling dynamics (Jenkins *et al.*, 2012) and is included as a variable. In order to measure the effects of socioeconomic status on sibling competition, both maternal education and family income are included in the analyses.

Methods

The data in this study come from the Millennium Cohort Study (MCS), a representative longitudinal survey carried out in the UK. The aim of the MCS is to collect information on children born at the beginning of the new millennium. Data from the fifth wave of the MCS were analysed. The fifth wave data were gathered in 2012–2013 when the cohort member children were approximately 11 years old (mean age = 134 months, SD = 3.90). In the survey, cohort member children answered questions concerning their sibling relationships. In addition, their parents or parental figures (i.e. main respondents) answered questions concerning themselves and the family. In total the fifth survey wave reached 13,287 responding families and the response rate was 69%. The data have been described in detail by Hansen (2014).

For the analytic sample, cases where the main respondents were the biological mothers of the respondent child (in the fifth wave over 95% of all main respondents) were selected. Analyses were restricted to households where respondent children were living with biological mothers and biological fathers or stepfathers (i.e. dual-carer households). Single-mother households were excluded since in these families siblings compete with each other only for the investment and attention of one parent on a daily basis. However, sensitivity analyses including also single-mother households produced results similar to the main analyses presented in this article (results not shown). In addition, only cases where the mothers lived in the same household as the cohort

Table 1 . Distribution of sibling conflict variables, $n = 7527$

Conflict variable	%
Sibling hurt/picked on respondent	
Never	22.4
Every few months or less often	27.2
Monthly or weekly	29.4
Most days	21.0
Respondent hurt/picked on sibling	
Never	25.3
Every few months or less often	33.6
Monthly or weekly	29.8
Most days	11.4

member child were included. Children typically reside mainly with the mother after a divorce in the UK (Connelly *et al*., 2014). Cases where children resided with their biological fathers but not their biological mothers were too few to be included in the analyses, which is why the focus is on maternal siblings. In the case of twins and triplets, only one child of the twin or triplet set was included. Finally, only cohort member children who had at least one full- or maternal half-sibling (who was not a twin or triplet) living in the same household were included. After these exclusions the analytic sample included 7527 cohort member children.

In all analyses the dependent variables measure sibling conflicts, defined as self-reported frequencies of hurting or picking on siblings. In the fifth wave of the MCS children were asked two questions: 'How often do your brothers or sisters hurt you or pick on you on purpose?' and 'How often do you hurt or pick on your brothers or sisters on purpose?' The responses were classified in four categories (0 = never, 1 = less often than monthly, 2 = monthly or weekly, 4 = most days). The distributions of the dependent variables are presented in Table 1.

The main explanatory variable measures whether the cohort member child lived in the same household with full- or half-siblings. Due to the data structure all half-siblings were maternal siblings, as explained above. The scale was classified into three categories: 1 = lived with full-sibling(s) only, 2 = lived with full- and maternal half-sibling(s), 3 = lived with maternal half-sibling(s) only. In the study sample 86% of children were living with full-sibling(s) only, 8% with full- and maternal half-sibling(s) and 6% with maternal half-sibling(s) only. Siblings living only with maternal half-siblings had bigger age differences (i.e. age difference between respondent child and sibling closest in age): in 57% of households with full-siblings only, 66% of households with full- and maternal half-siblings but 8% of households with only maternal half-siblings did the siblings have an age difference of less than 3 years. For the average sibling age difference of 3–5 years the respective proportions were 29, 24 and 19%, and for sibling age differences of more than 5 years respective proportions were 14, 10 and 73%. Thus age differences between respondents living with full-siblings only and living with both full- and maternal half-siblings were quite similar, while a higher proportion of respondents living only with maternal half-siblings had larger age differences compared with the first two groups.

Given that the outcome variables had four ordered categories without equal spacing between the categories (i.e. 0 = never, 1 = less than monthly, 2 = monthly or weekly, 3 = most days), the regression models were fitted with ordered logistic regression ('ologit' command in Stata 13.1; see Liu, 2009). The analyses included several potential confounding variables. These were country (England, Wales, Scotland, Northern Ireland), respondent child's age (in months), ethnic background, number of siblings, whether respondent child had younger or older siblings in household, sex of respondent child and of sibling(s), age difference between respondent child and the sibling closest in age, maternal education, family income, parental relationship quality and changes in household composition between child's age 7 and 11. Maternal education was measured by the National Vocational Qualification (NVQ), where a higher level of NVQ means higher qualification (ranging from 0 = none to 5 = NVQ level 5). Family income was measured by equalized income quintiles based on the UK income distribution (ranging from 1 = bottom to 5 = top). The relationship quality between mothers and (step)fathers was based on maternal reports of how happy she was in her current relationship (ranging from 1 = very unhappy to 7 = very happy). Compared with households with full-siblings only, mothers in households with full- and maternal half-siblings and only maternal half-sibling reported on average lower relationship quality (full-siblings = ref.; full- and maternal half-siblings $\beta = -0.21$, $p = 0.001$; maternal full-siblings only $\beta = 0.21$, $p = 0.002$). Maternal involvement was measured by how often mothers talk to the cohort member child about things that were important to the child (ranging from 1 = less than monthly to 5 = every day). There were no significant differences in maternal involvement in different sibling constellations. Finally, using longitudinal information from MCS rounds four and five, a variable measuring changes in household composition was constructed. Descriptive distributions of these variables are presented in Table 2.

The bivariate correlations of independent variables are provided in Table 3. The highest correlations were found between maternal education and family income and between family income and number of siblings. Maternal education correlates with increased family incomes, while family incomes correlate with decreased number of siblings.

In the Results section it was first investigated whether there are more conflicts in full- than maternal half-sibling households. For sensitivity purposes, the analyses were also run using analysis weights calculated by the MCS team. Since the results were similar whether the weights were used or not, only unweighted results are shown. In the second phase, interaction terms were included in the models investigating the interactions between socioeconomic characteristics (maternal education and family income) and sibling constellation (full-siblings only, full- and maternal half-siblings or maternal half-siblings only).

Results

Associations between a sibling picking on or hurting the respondent, and the respondent picking on or hurting siblings, were studied in two separate multivariate regressions. The results are presented in Tables 4 and 5, respectively. In the first regression model (Table 4), only the age of child was included in addition to the main sibling constellation variable. In this model, full-siblings have a greater probability of reporting conflicts compared with the groups 'full- and maternal half-siblings' and 'maternal half-siblings only'.

Table 2. Descriptive statistics of respondent children (%/mean), $n = 7527$

	%/mean	SD
Age (mean, months)	133.9	3.90
Number of siblings (mean)	1.7	0.93
Younger or older siblings (%)		
Younger siblings only	37.7	
Younger and older siblings	22.0	
Older siblings only	40.4	
Sex of respondent child and sibling(s) (%)		
Boys only	17.3	
Boys and girls	66.4	
Girls only	16.3	
Age difference between respondent child and sibling closest in age (%)		
<3 years	54.5	
3 − 5 years	28.2	
>5 years	17.3	
Ethnic background (%)		
Ethnic majority group	86.6	
Ethnic minority group	13.4	
Maternal education (mean)	3.1	1.35
Family income (mean)	3.2	1.33
Maternal involvement (mean)	4.5	0.81
Relationship quality between mother and (step)father (mean)	5.7	1.41
Changes in household composition between child's age 7 and 11 (%)		
Intact → intact	90.9	
Single-mother → Intact	0.8	
Stepfather → stepfather	4.0	
Intact → stepfather	0.9	
Single mother → stepfather	3.3	

In the second regression model, variables measuring sibling characteristics were added to the model (Table 4). These variables were number of siblings, whether the respondent had younger or older siblings, child and sibling gender, and the age difference between the respondent child and the sibling closest in age. Including these variables removed the difference between 'full-siblings only' and 'full- and maternal half-siblings' found in Model 1. However, the difference between 'full-siblings only' and 'maternal half-siblings only' remained statistically significant, although the magnitude of the coefficient decreased from −0.93 to −0.35.

In addition to other variables, the third model controlled for ethnicity, maternal education, family income, maternal involvement, parental relationship quality and changes in household composition. After controlling for these variables in Model 3, full-siblings still have a higher likelihood of conflicts compared with maternal half-siblings. Adding these variables influenced effect size so that the coefficient increased from −0.35 to −0.49.

Next, the likelihood that a respondent had hurt or picked on a sibling was studied (Table 5). In all three regression models, the group 'full-siblings only' had a significantly

Table 3 . Bivariate correlations between independent variables for respondent child, $n = 7527$

		1	2	3	4	5	6	7	8	9	10
1	Age in months	–									
2	Number of siblings	0.002									
3	Younger or older siblings	−0.02	**−0.05**								
4	Sex of respondent child and sibling	−0.004	−0.01	−0.01							
5	Ethnic background	−0.02	**0.20**	**−0.03**	0.01						
6	Maternal education	−0.004	**−0.16**	**−0.06**	0.01	**−0.06**					
7	Family income	−0.01	**−0.47**	**0.07**	0.01	**−0.29**	**0.57**				
8	Maternal involvement	0.03	**−0.04**	**0.03**	0.02	−0.03	**0.08**	**0.09**			
9	Relationship quality between parents	−0.03	0.004	0.004	−0.01	0.01	**0.04**	**0.05**	**0.04**		
10	Changes in household composition	0.03	0.02	**−0.09**	0.01	**−0.06**	**−0.08**	**−0.21**	−0.01	−0.003	
11	Age difference between siblings	0.01	**−0.29**	**0.13**	0.003	−0.02	**−0.09**	0.02	−0.01	**−0.04**	**0.09**

Bold numbers indicate significant associations: $p < 0.05$

Table 4. Sibling hurt/picked on respondent: stepwise ordinal regression analyses (country fixed effects), $n = 7527$

	Model 1			Model 2			Model 3		
	Coef.	SE	*p*-value	Coef.	SE	*p*-value	Coef.	SE	*p*-value
Sibling constellation in household									
Full-siblings only (Ref.)									
Full- and maternal half-siblings	0.25	0.08	0.002	0.12	0.08	0.166	0.01	0.09	0.882
Maternal half-siblings only	−0.93	0.09	<0.001	−0.35	0.10	<0.001	−0.49	0.11	<0.001
Age (months)	−0.02	0.01	0.001	−0.02	0.01	<0.001	−0.02	0.01	<0.001
Number of siblings				0.07	0.03	0.016	0.08	0.03	0.015
Younger or older siblings									
Younger siblings only (Ref.)									
Younger and older siblings				0.15	0.07	0.028	0.16	0.07	0.020
Older siblings only				−0.004	0.05	0.928	0.02	0.05	0.714
Sex of respondent child and sibling(s)									
Boys only (Ref.)									
Boys and girls				−0.24	0.06	−0.23	0.06	<0.001	−0.24
Girls only				−0.32	0.07	−0.31	0.07	<0.001	−0.32
Age difference between respondent child and sibling closest in age (%)									
<3 years (Ref.)									
3 −5 years				−0.16	0.05	0.001	−0.17	0.05	0.001
>5 years					−0.93	0.07	−0.93	0.07	<0.001
Ethnic background									
Ethnic majority group (Ref.)									
Ethnic minority group							−0.40	0.07	<0.001
Maternal education							0.02	0.02	0.221
Family income							−0.04	0.02	0.132
Maternal involvement							−0.11	0.03	<0.001
Relationship quality between mother and (step)father							−0.08	0.02	<0.001
Changes in household composition between child's age 7 and 11									
Intact → intact (Ref.)									
Single-mother → intact							−0.05	0.24	0.853
Stepfather → stepfather							0.26	0.12	0.034
Intact → stepfather							0.10	0.21	0.637
Single mother → stepfather							−0.02	0.13	0.852
−2 log likelihood	20,564.22			20,275.18			20,181.35		
AIC	20,582.22			20,307.18			20,231.35		
BIC	20,644.55			20,418.00			20,404.51		

Table 5. Respondent hurt/picked on sibling: stepwise ordinal regression analyses (country fixed effects), $n = 7527$

	Model 1			Model 2			Model 3		
	Coef.	SE	*p*-value	Coef.	SE	*p*-value	Coef.	SE	*p*-value
Sibling constellation in household									
Full-siblings only (Ref.)									
Full- and maternal half-siblings	0.05	0.08	0.568	0.04	0.09	0.643	−0.01	0.09	0.940
Maternal half-siblings only	−1.07	0.09	<0.001	−0.47	0.10	<0.001	−0.52	0.11	<0.001
Age of child in months	−0.004	0.01	0.517	−0.004	0.01	0.450	−0.004	0.01	0.435
Number of siblings				−0.01	0.03	0.688	0.05	0.03	0.135
Younger or older siblings									
Younger siblings only (Ref.)									
Younger and older siblings				−0.19	0.07	0.005	−0.18	0.07	0.007
Older siblings only				−0.57	0.05	<0.001	−0.58	0.05	<0.001
Sex of respondent child and sibling(s)									
Boys only (Ref.)									
Boys and girls				−0.11	0.06	0.061	−0.10	0.06	0.089
Girls only				−0.08	0.07	0.272	−0.07	0.07	0.332
Age difference between respondent child and sibling closest in age (%)									
<3 years (Ref.)									
3 −5 years				−0.12	0.05	0.014	−0.10	0.05	0.038
>5 years				−0.94	0.07	<0.001	−0.91	0.07	<0.001
Ethnic background									
Ethnic majority group (Ref.)									
Ethnic minority group							−0.36	0.07	<0.001
Maternal education							0.03	0.02	0.116
Family income							0.04	0.02	0.103
Maternal involvement							−0.16	0.03	<0.001
Relationship quality between moth and step(father)							−0.06	0.02	<0.001
Changes in household composition between child's age 7 and 11									
Intact → intact (Ref.)									
Single-mother → intact							−0.27	0.24	0.269
Stepfather → stepfather							0.10	0.12	0.418
Intact → stepfather							0.21	0.22	0.329
Single mother → stepfather							−0.04	0.13	0.734
−2 log likelihood	19,736.36			19,332.38			19,231.36		
AIC	19,754.36			19,364.38			19,281.36		
BIC	19,816.70			19,475.20			19,454.52		

higher probability of conflicts than the group 'maternal half-siblings only'. There were no statistically significant differences between the groups 'full-siblings only' and 'full- and maternal half-siblings' in any of these regression models.

The final regression models (Model 3) in both multivariate regressions (Tables 4 and 5) show how several other factors also correlated with sibling conflicts. In the case of both conflict measures, a lower age difference between siblings increased the probability of conflicts. Members of ethnic minority groups were less likely to report conflicts compared with respondents belonging to the ethnic majority. Higher levels of maternal involvement and a higher parental relationship quality were associated with decreased probability of conflicts. Children with both younger and older siblings more often reported that their siblings had hurt or picked on them compared with children who only had younger siblings. In addition, for a respondent having hurt or picked on a sibling (Table 5, Model 3), those who had only older siblings had a significantly lower probability of conflicts than those who had younger siblings only. Some variables were associated with statistically significant differences only in the case when the sibling had hurt or picked on a respondent (Table 4, Model 3). Sibships with only boys tended to have more sibling conflicts compared with other gender combinations. Children who had lived with their stepfather at ages 7 and 11 had higher risk of conflicts than children who had lived with both biological parents. The probability of conflicts also increased with the number of siblings.

Next, sensitivity analyses were conducted in order to compare conflicts between full- and maternal half-sibling households within different age-difference groups. Analyses show that in the largest age-difference group (5 or more years between respondent child and sibling closest in age) full-siblings had significantly more conflicts than maternal half-siblings did (sibling hurt/picked on respondent ($n = 1301$): full-siblings only (reference group), full- and half-siblings, Coef. $= -0.02$, SE $= 0.29$, $p = 0.946$, half-siblings only, Coef. $= -0.57$, SE $= 0.14$, $p < 0.001$; respondent hurt/picked on sibling ($n = 1301$), full-siblings only (reference group), full-siblings and half-siblings, Coef. $= -0.002$, SE $= 0.29$, $p = 0.994$, half-siblings only, Coef. $= -0.52$, SE $= 0.15$, $p < 0.001$).

Interestingly, measures of socioeconomic status – maternal education and family income – were not associated with conflict occurrence in Tables 4 or 5. Therefore the interactions between sibling constellation and socioeconomic factors were explored (Tables 6 and 7). Low maternal education was associated with sibling conflicts more strongly among full-siblings and maternal half-siblings compared with families with only full-siblings (Table 6, Model 1). Low family income was related to sibling conflicts more strongly in families of maternal half-siblings compared with families of full-siblings (Model 2 in both Table 6 and Table 7).

Discussion

This study analysed whether the degree of genetic relatedness is associated with frequency of sibling conflicts, as measured by survey reports of siblings picking on, or hurting, each other. Parent–offspring conflict theory (Trivers, 1974) suggests that sibling conflicts reflect competition over parental resources. Conflict occurrence is predicted to vary with different sibship constellations and family resources. The present study hypothesized that children living with their full-siblings only would have conflicts more

Table 6. Associations between socioeconomic factors and sibling conflicts by sibling constellation: ordinal regression analyses (country fixed effects), $n = 7527$

	Sibling hurt/picked on respondent		
	Coef.	SE	*p*-value
Model 1			
Sibling constellation in household			
Full-siblings only (Ref.)			
Full- and maternal half-siblings	0.32	0.17	0.060
Maternal half-siblings only	−0.46	0.22	0.038
Maternal education	0.04	0.02	0.084
Sibling constellation × maternal education			
Maternal education × FS only (Ref.)			
Maternal education × FS and Mat HS	−0.12	0.06	0.036
Maternal education × Mat HS only	−0.01	0.07	0.879
Model 2			
Sibling constellation in household			
Full-siblings only (Ref.)			
Full- and maternal half-siblings	0.17	0.19	0.365
Maternal half-siblings only	0.05	0.24	0.826
Family income	−0.02	0.03	0.382
Sibling constellation × family income			
Family income × FS only (Ref.)			
Family income × FS and Mat HS	−0.06	0.07	0.401
Family income × Mat HS only	−0.17	0.07	0.014

FS: full-siblings. Mat HS: maternal half-siblings.

often compared with children who live with maternal half-siblings only, because the former compete for resources from the same set of parents, while the latter may receive investment also from non-resident biological fathers. The results supported this prediction, and hold even after several potential confounding factors were controlled for. The picture is thus the opposite to that predicted by general kin altruism theory.

Full-siblings tend to be closer to each other (Pollet & Hoben, 2011), but based on the present study they also have more conflicts. In many species it is common for individuals to grow up with their half-siblings. This is typical for non-monogamous mating systems: for instance, among our closest relatives the chimpanzees and bonobos, the majority of siblings are half-siblings (Chapais, 2008). Studies from other species also suggest that full- and half-sibling relationships may be qualitatively different. For instance, among Belding's ground squirrels, female half-siblings were found to be less co-operative and more antagonistic towards each other than female full-siblings were (Holmes & Sherman, 1982).

The results of the present study are supported by Deater-Deckard and colleagues (2002), who found that among 5-year-old children, sibling negativity was higher among full- compared with half-siblings. Similarly, Salmon and Hehman (2015) found that college students who were living together with siblings had more conflicts with full- than half-siblings. However, compared with these previous studies, the present study has

Table 7. Associations between socioeconomic factors and sibling conflicts by sibling constellation: ordinal regression analyses (country fixed effects), $n = 7527$

	Respondent hurt/picked on sibling		
	Coef.	SE	*p*-value
Model 1			
Sibling constellation in household			
Full-siblings only (Ref.)			
Full- and maternal half-siblings	0.02	0.17	0.916
Maternal half-siblings only	−0.52	0.23	0.022
Maternal education	0.03	0.02	0.128
Sibling constellation × maternal education			
Maternal education × FS only (Ref.)			
Maternal education × FS and Mat HS	−0.01	0.06	0.868
Maternal education × Mat HS only	−0.0003	0.07	0.996
Model 2			
Sibling constellation in household			
Full-siblings only (Ref.)			
Full- and maternal half-siblings	0.04	0.19	0.830
Maternal half-siblings only	0.05	0.25	0.846
Family income	0.05	0.03	0.042
Sibling constellation × family income			
Family income × FS only (Ref.)			
Family income × FS and mat HS	−0.01	0.07	0.859
Family income × Mat HS only	−0.18	0.07	0.012

FS: full-siblings. Mat HS: maternal half-siblings.

several strengths. Deater-Deckard and colleagues' (2002) sample was much smaller ($n = 192$ families) than the large MCS data, and thus they could not restrict the analyses to dual-earner and dual-carer families. As for Salmon and Hehman (2015), they used a small-scale ($n = 345$ young adults) and non-representative sample of college students.

In addition to genetic relatedness, several other factors were found to be associated with sibling conflicts. As expected, higher levels of both maternal involvement and spousal relationship quality were associated with decreased likelihood of conflicts, while living with a stepfather between the ages 7 and 11 was associated with an increased likelihood of sibling conflicts. The probability of sibling conflicts was smaller in ethnic minority than ethnic majority groups, which is in line with a previous study that analysed unintended injuries in full- and half-sibling households in the UK (Tanskanen *et al.*, 2015). Siblings were more likely to have picked on the respondent when there were only boys in the household. This gender effect is partly similar to previous results (Brody *et al.*, 1985; Campione-Barr & Smetana, 2010) showing that boys, but also opposite-sex siblings, have more conflicts in childhood and adolescence. Also in line with previous research, the more siblings in the household, the higher the probability of conflicts between them (Lawson & Mace, 2009). In addition, the age difference between siblings was associated with conflicts as assumed: siblings with a larger age difference were less

likely to report conflicts with each other. With regards to birth order, middle children were more likely to report being picked on or hurt by a sibling, while the oldest children were most likely to report having picked on their siblings themselves.

Contrary to what has been suggested by Pollet and Hoben (2011), higher socioeconomic status (measured by maternal education and family income) was not associated with decreased likelihood of sibling conflicts. Instead, while the overall effect of status was found to be negligible, low family income was associated with sibling conflicts more strongly among children who only had maternal half-siblings compared with children with full-siblings. Moreover, lower maternal education was associated with sibling conflicts more strongly among full-siblings and maternal half-siblings compared with full-siblings only. Thus access to more family resources may decrease sibling competition in situations where half-siblings are present.

What explains the present findings about the difference between maternal half- and full-siblings? The concept of brood competition may be useful for thinking about siblings in blended families (Parker *et al.*, 2002; Schlomer *et al.*, 2011). In intra-brood competition, siblings are born at around the same time to the same parents and compete for similar investments (e.g. maternal milk). In inter-brood competition, siblings are of different ages and may have different parents. Inter-brood competition is generally less intense and may involve children competing for different resources (e.g. milk or time) from the same parent (Parker, 1985; Schlomer *et al.*, 2011). The distinction into one or several broods is not clear-cut with regards to humans, since birth intervals vary and parental investment does not stop at a certain age but typically continues well into adulthood. Nevertheless, one could say that in contemporary societies, with re-marriages and blended families following parental divorce, siblings from the same parents represent intra-brood competition, while half-sibling relations may rather resemble inter-brood competition. Differential access to parental resources of available biological and step-parents may explain the higher amount of sibling conflict between full- compared with maternal half-siblings. The present study found that higher socioeconomic status was associated with increased conflict propensity more among full-siblings than among other sibling constellations. This indicates that parental resources tend to shape human family relations differently based on the degree of relatedness.

One of the main strengths of the present study is that the results are based on a survey of 11-year-old children, representing an age of intense sibling conflict. Moreover, the MCS provided large-scale and representative data allowing the researchers to explore the effects and associations of different variables. Because of the data structure in the study population, all half-siblings were maternal ones. Even though this reduced the potential confounding impact of paternity uncertainty, it may also influence the results. Future studies should investigate whether full-siblings also have more conflicts than paternal half-siblings.

Among the study limitations is the fact that the data included information about sibling conflicts from different sibship constellations in the household, rather than conflicts between specific sibling pairs. Also, it was not possible to analyse types of sibling conflicts other than picking on and hurting. The data had no information on the sources of these sibling conflicts. In addition, the conflict measures were based on children's subjective assessments, and some children may have either under- or overstated the number of conflicts. Finally, the data were cross-sectional, although it is known that the amount as well as type of conflicts may change over time and with age. For instance, a recent study

from the UK showed that 3-year-old children who were living in the same household with their half-siblings had a higher risk of unintended home injuries compared with children who were living with their full-siblings only (Tanskanen *et al.*, 2015).

Finally, the results of the present study highlight the importance of future studies on sibling relations across the life course. It would be valuable to have more diverse measures of sibling conflicts, at which stage of life they occur and information about both milder and more severe conflicts, in order to get a fuller picture of both the co-operation and the conflicts among brothers and sisters. Several studies have shown that children in blended families score worse on socio-emotional and cognitive development compared with children from biologically intact families (see McHale *et al.*, 2012 for review), and that stepfathers tend to invest less in their acquired children compared with biological fathers (see Anderson, 2011, for review). Sibling relations can moderate and protect children from the challenges caused by parental divorce and household changes, and the present findings point to one of the positive sides of living with half-siblings.

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Short report

CHILDLESSNESS AND INVESTMENT IN NIECES, NEPHEWS, AUNTS AND UNCLES IN FINLAND

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Summary. Kin selection theory predicts that individuals may increase their inclusive fitness by investing in their genetically related kin. In addition, according to the reproductive value hypothesis, individuals may increase their fitness more by investing in their kin in descending rather than ascending order. The present study uses the Generational Transmissions in Finland data collected in 2012 ($n = 601$ women) and analyses whether childless younger women invest more in their kin than younger women with children. The study finds that childless women are more likely than mothers to invest in their nieces and nephews but not their aunts and uncles. Thus the results are in line with the reproductive value prediction.

Childlessness is common in many modern Western societies (Buchanan & Rotkirch, 2013). For instance, 20% of Finnish women over the age of 40 have not given birth (Statistics Finland, 2011). These numbers are similar to those of many other Western countries (Hakim, 2005). Since it is unusual to have a first child after the age of 40, the majority of these women remain childless.

Studies have shown that childless individuals may give more support to their ascendants than parents do (e.g. Komter & Vollebergh, 2002; Albertini & Kohli, 2009). This could be because they are trying to buffer themselves against social isolation (Wenger *et al.*, 2000). Even though childlessness has been an important topic in family sociology (e.g. Beck & Beck-Gernsheim, 2002), few studies have separated kin by the rate of genetic relatedness when researching helpers.

Kin selection theory predicts that individuals may increase their inclusive fitness by investing in their genetically related kin (Hamilton, 1964). Individuals share on average 25% of their genes with their nieces, nephews, aunts and uncles. However, not only genetic relatedness but also the recipient's reproductive value may matter (Hughes, 1988). If someone tries to maximize his or her inclusive fitness, it is more effective to support

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kin in descending rather than ascending order. Therefore women who do not have children of their own may increase their inclusive fitness by increasing their siblings' reproductive success by in turn supporting their siblings' children (i.e. nieces/nephews). Previous studies support this supposition. Pollet and colleagues (2006), for example, showed that childless women in Belgium reported more contacts with their nieces and nephews than mothers did (see also Essock-Vitale & McGuire, 1985). Using historical data from the US, Pollet & Dunbar (2008) found that childless couples were more likely to take care of their nieces and nephews than couples with children were.

Another view indicates that childless women may have more time and resources than mothers have, since childless women do not have the occasion to invest in their own children (Pollet *et al.*, 2006). Thus, childless women may invest more than mothers in members of their kin, regardless of reproductive value. In contrast to this prediction, Pollet and colleagues (2006) found no difference between childless women and mothers in their contacts with aunts and uncles.

Using data from the Generational Transmissions in Finland (Gentrans) project, the present study analyses whether childless women give more support than mothers to their nieces, nephews, aunts and uncles in contemporary Finland. In the spring of 2012 Statistics Finland conducted a representative survey of young adults via mail. The survey reached 1753 individuals born between 1962 and 1990 (mean = 1976, SD = 5.6). The present study compares childless women and mothers. Only women with at least one niece or nephew 10 years old or younger were included, since childcare is rarely provided to older children. After these exclusions the study sample included 601 women (childless women: $n = 187$; mothers: $n = 414$).

In the case of siblings' children, the survey asked whether respondents had looked after their nieces/nephews in the last 12 months. In the questionnaire investment in nieces/nephews was gathered separately for four of the respondents' oldest siblings, and the niece/nephew sets of the specific sibling. In the case of aunts/uncles, the Gentrans survey asked whether respondents had provided practical help to their aunts/uncles in the last 12 months. The respondents may have had four types of aunts/uncles (i.e. maternal aunts, maternal uncles, paternal aunts and paternal uncles) and the questions concerned whether the respondents had provided support to at least one member of a group. For example, in the case of maternal aunts the questionnaire asked whether respondents had provided practical help to any maternal aunt.

Separate analyses for nieces/nephews (phase 1) and aunts/uncles (phase 2) were conducted. For this purpose the datasets were reshaped for a long format so that the observations were those of the original respondents' niece/nephew sets (phase 1) and aunt/uncle groups (phase 2). Since the data were clustered, Stata's statistical software cluster option was used to calculate standard errors. Logistic regression was used to predict the kin investment. The results were determined by calculating the predicted probabilities of kin investment from the logistic regression models.

Since childless women and mothers may differ from each other, e.g. based on level of education and sociability (Abma & Martinez, 2006; Jokela *et al.*, 2011), and previous studies show that not all individuals invest equally in their kin (Michalski & Euler, 2008; Pollet & Hoben, 2011), the present analysis controlled for several factors: respondent's birth year, education, partnership status, number of close relatives and lineage. In the case of nieces/nephews, the geographical distance to the niece/nephew set was also

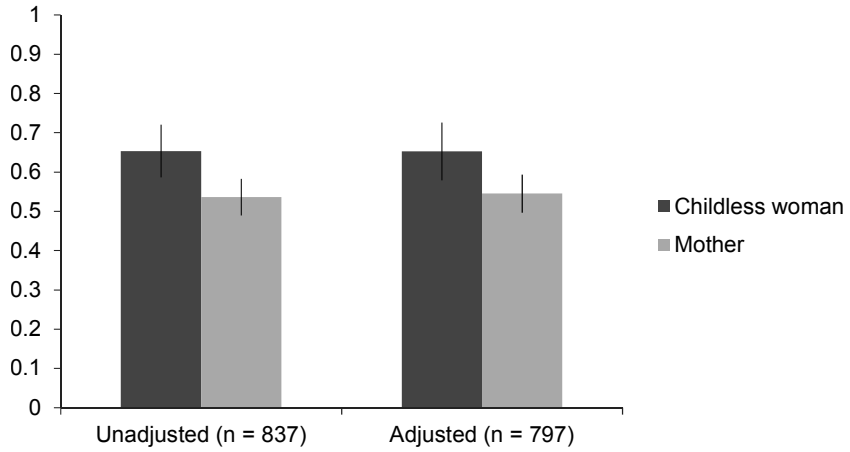

Fig. 1. Women's investment in nieces/nephews (predicted probabilities and 95% confidence intervals).

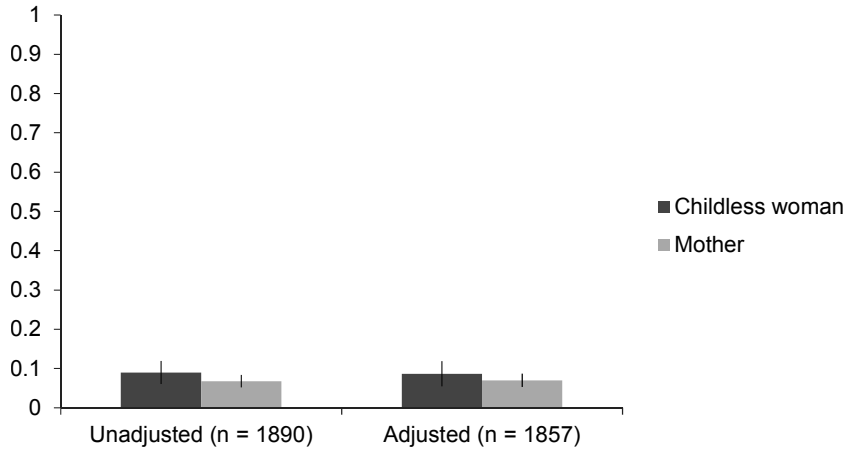

Fig. 2. Women's investment in aunts/uncles (predicted probabilities and 95% confidence intervals).

controlled for. Unfortunately, in the case of aunts/uncles the Gentrans survey did not collect information concerning this geographical distance.

Figure 1 shows that childless women have a greater probability of investing in their nieces/nephews than mothers (adjusted model: OR = 0.62, SE = 0.14, $p = 0.029$) ($-2LL = 1032.9$; $\chi^2 = 39.4$, df = 9, $p < 0.0001$; Nagelkerke's $R^2 = 0.086$). Figure 2 shows no significant difference between childless women and mothers in their probability of investing in aunts/uncles (adjusted model: OR = 0.79, SE = 0.21, $p = 0.388$) ($-2LL = 962.0$; $\chi^2 = 20.5$, df = 8, $p = 0.009$; Nagelkerke's $R^2 = 0.040$). In addition, those with more close relatives have greater odds of investing in their nieces/nephews

Table 1. Predicting investment in nieces/nephews and aunts/uncles: results from two logistic regression models (odds ratios and 95% confidence intervals), Finland 2012

	Childcare of niece/nephew		Practical help to aunt/uncle	
	OR	95% CI	OR	95% CI
Parenthood status				
Childless woman (Ref.)	1.00		1.00	
Mother	0.62*	0.41–0.95	0.79	0.47–1.34
Birth year	0.998	0.97–1.03	1.001	0.97–1.04
Educational level				
Primary or lower secondary (Ref.)	1.00		1.00	
Upper secondary	0.93	0.53–1.63	1.48	0.75–2.89
Tertiary: lower degree	1.47	0.54–2.75	1.17	0.53–2.55
Tertiary: higher degree or doctorate	1.47	0.54–4.02	1.99	0.57–6.99
Partnership status				
No spouse (Ref.)	1.00		1.00	
Have a spouse	0.71	0.46–1.11	0.72	0.43–1.21
Number of close relatives	1.11*	1.04–1.17	1.16*	1.08–1.24
Niece/nephew via sister or brother				
Via sister (Ref.)	1.00			
Via brother	0.56*	0.42–0.75		
Distance to niece/nephew	0.9996	1.00–1.00		
Maternal or paternal aunt/uncle				
Maternal (Ref.)			1.00	
Paternal			0.84	0.59–1.18
n	797		1857	

*$p < 0.05$.

and aunts/uncles. Respondents are more likely to invest in their nieces/nephews via sisters than brothers (Table 1).

To conclude, childless women tend to invest more than mothers in their nieces and nephews but not their aunts and uncles. The results are in line with the reproductive value prediction (Hughes, 1988) and a previous study by Pollet and colleagues (2006). The present study has certain limitations that highlight the importance of future research. First, due to the data limitations it was impossible to separate voluntary from involuntary childless women. However, it remains important to study whether voluntary and involuntary childless women differ from each other in the case of kin support. Second, future studies should also investigate whether those who have supported their nieces/nephews receive more support from them in their old age. Third, there is room for studies concerning the outcome of kin support.

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IV

Contact frequencies with nieces and nephews in Finland

Evidence for the preferential investment in more certain kin theory

Antti O. Tanskanen and Mirkka Danielsbacka

Abstract
Based on maternity certainty and paternity uncertainty, one can predict that individuals will channel investment in their kin according to more genetically certain investment options. According to the preferential investment in more certain kin theory, if aunts and uncles have the option to invest in either their sisters' or their brothers' children they would prefer to invest in their sisters' children. However, this question has not been previously explored in contemporary societies with nationally representative data from two generations of aunts and uncles. In our study, we have used data gathered in the Generational Transmissions in Finland project in 2012. The respondents represent older adults (born between 1945 and 1950, n = 1,604) and younger adults (born between 1962 and 1993, n = 1,159). We find that when aunts and uncles have nieces and nephews via both sisters and brothers, they have more contacts with their sisters' children than their brothers' children. Thus, the results are in accordance with the preferential investment theory.

Keywords
Aunts/uncles, contact frequencies, Finland, lineage, nieces/nephews, paternity uncertainty

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Genetic relatedness predicts contact frequencies with siblings, nieces and nephews: Results from the Generational Transmissions in Finland surveys

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Siblings

ABSTRACT

Kin selection theory predicts that people should invest more in their full than their half siblings, and more in their nieces and nephews via full siblings than via half siblings. To study these predictions we use two nationally representative surveys that were collected as a part of the Generational Transmissions in Finland project. The subjects are representative of an older generation (born in 1945–1950) and a younger generation (born in 1962–1993). We found that both generations reported more contacts with full than with half siblings, and more with nieces and nephews via full than half siblings respectively. The results of the study are in line with the kin selection theory.

1. Introduction

Humans have a predisposition to evolve positive emotions of affection toward their kin (Salmon & Shackelford, 2011). From an evolutionary point of view the function of this attachment is explained by kin selection theory (Hamilton, 1964), which predicts that the genetic relatedness in general, and the specific degree of this relatedness, have an impact on the amount of kin investment in societies of both the past and the present. In this article we study whether individuals invest more in their full than half siblings, and more in nieces and nephews via full than half siblings in contemporary Finland.

According to kin selection theory (Hamilton, 1964), help channeled toward genetically related kin enhances an individual's own inclusive fitness, because individuals share a certain amount of genes with genetically related kin. In line with kin selection theory, many studies among several populations have shown correlations between genetic relatedness and parental investment (e.g. Anderson, 2005; Gurven, Allen-Arave, Hill, & Hurtado, 2001; Ivey, 2000; Tifferet, Jorev, & Nasanovitz, 2010; see Anderson, 2011 for review). Parallel with these results, biological children also assess their relationship to their parents better than stepchildren do (Schnettler & Steinbach, 2011). Similar results were also found in the case of grandparents (e.g. Block, 2000; Christensen and Smith; 2002; Eggebeen, 1992; Sanders & Trygstad, 1989; see Euler, 2011 for review).

People share on average 50% of their genes with full siblings, 25% of their genes with half siblings as well full siblings' children, and 12.5% of their genes with half siblings' children. Hence, kin selection theory predicts that an individual's investment in full siblings (50% shared genes) should be greater than in half siblings (25% shared genes), and similarly investment in nieces and nephews via full siblings (25% shared genes) should be more substantial than that of nieces and nephews via half siblings (12.5% shared genes).

In concordance with kin selection theory (Hamilton, 1964), previous studies concerning genetic relatedness and sibling relationships indicate that the relationship between full siblings is closer than the relationship between half siblings (see Pollet & Hoben, 2011 for review). This could be the case, even though cultural values are against favoring full siblings over half siblings (Jankowiak & Diderich, 2000). For example, White and Riedmann (1992) found that adults in the US have more contact with full siblings compared to half siblings. Pollet (2007) found that Dutch adults had more face-to-face contact with their full than with their half siblings and that their relationship was stronger with full than half siblings, even though childhood proximity was controlled for. In another study Pollet and Nettle (2009) found that respondents were more likely to know whether their full siblings than their half-siblings

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were "dead or alive". In addition, two previous studies showed that aunts and uncles who are monozygotic twins of their siblings (and thus "genetic parents" of their nieces and nephews) invested more toward their nieces and nephews than did aunts and uncles who were dizygotic twins of their siblings (Segal & Marelich, 2011; Segal, Seghers, Marelich, Mechanic, & Castillo, 2007).

According to kin selection theory, "all else being equal" individuals are predicted to invest more in their closer related kin than distantly related kin (Hamilton, 1964). Obviously, in human populations there are several factors that may not be equal. In addition to genetic relatedness, the effects of genetic certainty, different reproductive interests between men and women, the reproductive value of an individual as well his or her sibling, and different life situations may also affect kin investment (Michalski & Euler, 2008; Pollet & Hoben, 2011). With this in mind, we have drawn from previous studies different variables which potentially confound individuals' relationships with siblings, nieces and nephews.

The sex of a sibling as well as the sex of the individual may be important confounders. From an evolutionary viewpoint sex matters in kin relationships for two particular reasons. First, due to women's higher obligatory invest in reproduction the reproductive interests between men and women differ (Trivers, 1972). Second, due to paternity uncertainty men can never be as sure as women that offspring really are their own, thus the certainty of genetic relatedness is higher in matrilineal than patrilineal kin (Michalski & Euler, 2008). In accordance with the predictions of the effects of genetic certainty and different reproductive interests, many studies have shown that aunts invest more in nieces and nephews than uncles, and individuals invest more in matrilineal than patrilineal kin (e.g. Gaulin, McBurney, & Brakeman-Wartell, 1997; Pashos & McBurney, 2008).

One's own age as well as the age of siblings, nieces and nephews may all matter when considering contacts with siblings and investments in siblings' children. In general, the relationship between siblings tends to change as individuals get older (Pollet & Hoben, 2011). In childhood and adolescence sibling rivalry is the prevalent factor in sibling relationships, but in adult life siblings are mostly providers of help and emotional support (Connidis, 1992; White, 2001).

The relative age of the sibling may be also important, on the one hand because support given to fertility-aged siblings and their children may substantially increase the fitness of the helpers themselves (Sear & Mace, 2008). On the other hand, if one has fertility-aged siblings he or she is probably also of fertility age, and in terms of one's own inclusive fitness it could be more beneficial to invest in one's own reproductive career instead (Pollet & Hoben, 2011). However, non-reproductive aunts may especially benefit by investing in their nieces and nephews (Lahdenperä, Gillespie, Lummaa, & Russell, 2012). In the case of investing in nieces and nephews their age may also matter, since younger children may need more support than older ones (Euler, 2011). In addition, birth order may influence sibling relationships (Salmon & Daly, 1998; Salmon, 1999, 2003). Pollet and Nettle (2007), for instance, found that firstborns had more contact with their siblings than later borns. In addition, the total number of siblings may matter, because the more siblings there are the less time there is to spend with each of them (Michalski & Euler, 2008).

Sibling relationship varies through different life stages (Pollet & Hoben, 2011). Two important life history events bearing on this relationship are the existence of a spouse and the existence of one's own children. According to preferential investment perspective, whether individuals have biological children of their own is an important factor (Pollet & Dunbar, 2008). In the case of younger adults, the existence of a spouse is important, since it increases the probability of having one's own children in the future (Waynforth, 2011). If one tries to maximize his or her own inclusive fitness it could be more beneficial to invest in one's own children and reproduction rather than siblings, nieces and nephews (Hamilton, 1964). However, previous studies have shown that while marriage decreases emotional closeness between siblings, the birth of one's own children does not have the same effect (Connidis, 1992; Cicirelli, 1995). Previous studies show that the geographical distance between siblings correlate with contact frequencies. Those who live closer also tend to have more contacts (e.g. Pollet, 2007; Pollet & Nettle, 2007). In addition, sibling relationships may vary according to socioeconomic factors. There are studies showing that less educated individuals often give less support to their siblings than their more highly educated counterparts (Pollet, 2007; White, 2001).

Finally, since sibling ties primarily develop in childhood there are two other important factors to note. First, the age difference between siblings is a factor which may influence contact between siblings (Pollet, 2007). In the case of a large age difference it is less likely that siblings have shared childhood experiences, which could result in less emotional closeness between siblings in adulthood. Hence, the larger the age difference between siblings, the less likely will be contact in adulthood. Second, childhood proximity may matter. Full siblings have normally grown up together, while it is more probable that half siblings have not. Here we follow Pollet's (2007) example and divide half sibling relationships into those between maternal half siblings and paternal half siblings. We assume that siblings who have the same mother have in most cases been raised together, due to the fact that in Finland children normally stay with their mothers if parents separate (Statistics Finland, 2012).

2. Hypotheses

Based on kin selection theory we predict that:

(H1) Individuals will have more contacts with their full than half siblings
(H2) Individuals will have more contacts with nieces and nephews via full than half siblings

3. Data, methods and measurement

In this article we use data from the Generational Transmissions in Finland (Gentrans) project. The aim of Gentrans is to gather longitudinal information on two generations: the Finnish baby boomer generation born between 1945 and 1950 ($M = 1947$, SD = 1.67) (i.e. the older generation), and their adult children born between 1962 and 1993 ($M = 1976$, SD = 5.6) (i.e. the younger generation). The first wave of the Gentrans surveys was gathered in 2007. This article uses the second wave of representative surveys, which were collected in 2012 by Statistics Finland via mail. The surveys of the older and younger generations are independent samples that were gathered separately. The older generation's survey included altogether 2278 respondents, and the younger generation's survey reached 1753 respondents.

In the Gentrans surveys, respondents were asked whether they and their sibling have the same mother and father, same mother only, or same father only. If the respondents had the same mother and father as the sibling, the relationship was coded as a full sibling relationship. In the cases where there was only the same mother or only the same father, the relationship was coded as a half sibling relationship. In addition, we separated maternal half siblings and paternal half siblings into different categories.

This study conducts two-stage analyses with two different selection criterions. In the first stage we included only those

observations where the respondent has at least one full or half sibling (older generation: $n = 2015$; younger generation: $n = 1562$). In the second stage we included only those observations where the respondent has at least one niece or nephew via a full or half sibling (older generation: $n = 1882$; younger generation = 1150).

The dependent variable measures respondents' contact frequencies with their siblings and nieces and nephews. Although contact frequencies reflect the potential for more laborious investment, it may also measure fairly well social investment between relatives (see Pollet, 2007; Pollet, Kuppens, & Dunbar, 2006). Contacts may also be a reliable measurement of overall kin support hence they tend to correlate with social and financial support (see Pollet, 2005; Pollet, Nelissen, & Nettle, 2009). In the Gentrans survey, respondents were asked to report via a 5-point scale (ranging from 0 = "never" to 4 = "several times a week") how often they have had contact with their siblings and nieces and nephews in the last 12 months either personally, by phone or by internet. Contact frequencies were gathered separately for four of the respondents' oldest siblings and the niece and nephew sets of the specific sibling. The contact frequency variables are normally distributed.

For the purposes of the analyses, the data were reshaped into a long format form, meaning that the present datasets were constructed so that observations are viewed from the perspective of the original respondent's siblings. In the case of analyses concerning contacts with siblings, this resulted in a total of 5107 observations from the older generation's data and 2803 observations from the younger generation data. In the case of analyses concerning contacts with nieces and nephews, the data include 3648 observations from the older generation's sample and 1655 observations from the younger generation's sample.

Methodologically, we use linear regression analysis and adjust the following variables: respondent's sex, marital status, birth year, existence of biological children, education, birth order, sibling's year of birth, sex, number of siblings, and age difference between respondents and siblings. In the case of the models concerning siblings, respondent's geographical distance to sibling is controlled for. Since the Gentrans data include information concerning the niece/nephew set of specific sibling we do not have information of geographical distance between respondents and a specific niece/nephew. In the case of the niece/nephew analyses, the year of birth of the youngest niece or nephew is controlled for (see Table 1 for descriptive statistics). With the exception of the respondent's birth year, number of siblings, age difference, sibling's birth year and the year of birth of the youngest niece/nephew variables all independent variables are categorical. We have transformed them into dummy variable. We illustrate the results by calculating the adjusted means (and 95% confidence intervals) of kin contacts by full sibling, maternal half sibling, and paternal half sibling relationship from the linear regression models. Since the data are clustered, we use Stata's statistical software cluster option to compute the standard errors.

4. Results

The results presented in Fig. 1 (and Table 2, Model 1) show that older generation have significantly more contacts with their full siblings than half siblings. Full siblings being the reference category, maternal and paternal half siblings have significantly less contacts.

Second, we examine the older generation's contacts with nieces and nephews, with the results presented in Fig. 2 (and Table 2, Model 2). The older generation have more contacts with their nieces and nephews via full than half siblings. These differences are significant in the case of maternal half siblings. However, margins are only marginally significant in the case of paternal half siblings. This is due to the relatively low number of paternal half siblings.

Next, in the model concerning nieces/nephews besides other factors we also controlled for sibling contacts (overall model: $R^2 = 0.19$, $n = 3297$) (results not shown in Tables or Figures). Thus, when controlling the sibling contacts the adjusted R-square rise from 4% to 19%. The model shows that there is a significant correlation between sibling contacts and niece/nephew contacts ($\beta = 0.28$, SE = 0.01, $t = 19.79$, $p < .0001$). In addition, also after controlling for sibling contacts full siblings tend to have significantly more contacts with their nieces/nephews than maternal half siblings (FS = ref; MHS's children $\beta = -0.15$, SE = 0.06, $t = -2.67$; $p = .008$; PHS's children $\beta = -0.15$, SE = 0.10, $t = -1.49$; $p = .136$).

Next, we examine the younger generation's contacts with their siblings. The results, presented in Fig. 3 (and Table 2, Model 3), show that the younger generation have significantly more contacts with their full than half siblings.

Then, we examine the younger generation's contacts with their nieces and nephews. The results are presented in Fig. 4 (and Table 2, Model 4). The younger generation have significantly more contacts with their nieces and nephews via full than half siblings.

Next, in the model concerning nieces/nephews besides other factors we also controlled for sibling contacts (overall model: $R^2 = 0.34$, $n = 1593$) (results not shown in Tables or Figures). Thus, when controlling the sibling contacts the adjusted R-square rise from 11% to 34%. The model shows that there is a significant correlation between sibling contacts and niece/nephew contacts ($\beta = 0.47$, SE = 0.03, $t = 18.17$, $p < .0001$). However, after controlling for sibling contacts full siblings tend not to have significantly more contacts with their nieces/nephews than maternal and paternal half siblings (FS = ref; MHS's children $\beta = -0.10$, SE = 0.09, $t = -1.11$; $p = .268$; PHS's children $\beta = -0.18$, SE = 0.10, $t = -1.78$; $p = .076$).

In addition to genetic relatedness other factors also correlate with the kin contacts. Table 2 (Models 1–4) shows that in the case of both generations females have more contacts with their siblings and nieces/nephews than males. Both generations also reported having more contacts with sisters and their children compared to brothers and their children. In addition, when the number of siblings increases, the contacts with siblings and nieces/nephews decrease. Models 1 and 3 in Table 2 show that the more there is geographical distance between siblings the lesser they have contacts with each other. Only in the case of younger generation the higher the age difference between siblings the less they have contacts with each other.

In the case of the older generation, existence of a biological child correlate with decreased but in the case of younger generation increased contact frequencies with siblings (Table 2, Models 1 and 3). Only in the case of older generation the highest educated respondents reported significantly more contacts to siblings than the lowest educated respondents. Older generation have also more contacts with nieces/nephews when these offspring are younger. Finally, only in the case of younger generation respondents have more contacts with younger than older siblings.

5. Conclusions

In this study we examined whether the degree of genetic relatedness plays a role in an older and younger generations' kin relationships. We found that both the older and younger generations have more contacts with their full than half siblings, and with their nieces and nephews via full than half siblings. Results are in line with the expectations of kin selection theory.

Our results are in concordance with previous studies which show that genetic relatedness and the degree of it will affect

Table 1
Descriptive statistics (n and %/mean).

	Older generation				Younger generation			
	Siblings		Nieces/nephews		Siblings		Nieces/nephews	
	n	%/mean	*n*	%/mean	*n*	%/mean	*n*	%/mean
Sibling type (%)								
FS	4751	93.0	3297	93.6	2423	86.4	1460	88.2
MHS	266	5.2	169	4.8	209	7.5	123	7.4
PHS	90	1.8	56	1.59	171	6.1	72	4.4
Respondent's sex (%)								
Female	1197	58.1	928	57.9	1,004	63.8	741	63.9
Male	862	41.9	676	42.1	569	36.2	418	36.1
Birth year (mean)	2059	1947	1604	1947	1573	1976	1159	1975
Marital status (%)								
Unmarried	140	6.8	95	5.9	306	19.5	194	16.8
Cohabitation	199	9.7	146	9.1	374	23.8	282	24.4
Married	1350	65.9	1092	68.3	822	52.4	627	54.2
Other	361	17.6	265	16.6	68	4.3	54	4.7
Existence of a biological child (%)								
No child	318	15.4	215	13.4	579	36.8	391	33.7
Has a child	1741	84.6	1389	86.6	994	63.2	768	66.3
Education (%)								
Primary or lower secondary level	647	32.1	496	31.6	53	3.4	41	3.6
Upper secondary level	1026	50.8	810	51.5	665	42.6	518	44.9
Lower degree level tertiary education	133	6.6	105	6.7	426	27.3	308	26.7
Higher degree level tertiary education or doctorate education	212	10.5	161	10.2	417	26.7	286	24.8
Number of siblings (mean)	2059	3.6	1566	3.7	1573	2.0	1150	2.1
Birth order (%)								
First born	607	30.0	449	28.6	629	40.4	401	35.1
Later born	1420	70.1	1123	71.4	927	59.6	743	65.0
Age difference (mean)	4967	5.7	3487	5.6	2755	6.2	1636	5.7
Sibling's sex (%)								
Female	2615	51.7	1866	53.3	1420	50.8	909	55.0
Male	2443	48.3	1635	46.7	1376	49.2	744	45.0
Sibling's birth year (mean)	4967	1947	3487	1947	2755	1976	1636	1974
Respondent's distance to sibling (%)								
Less than 1 km away	122	2.5			53	1.9		
Between 1 and 5 km away	433	8.8			190	6.9		
Between 5 and 25 km away	946	19.2			736	26.6		
Between 25 and 100 km away	1041	21.1			528	19.1		
Between 100 and 500 km away	1825	37.1			938	33.9		
More than 500 km away	558	11.3			321	11.6		
Year of birth of youngest niece/nephew (mean)			3522	1978			1655	2005

Note: FS = Full sibling, MHS = Maternal half sibling, PHS = Paternal half sibling. Basic data: Respondent's sex, birth year, marital status, existence of a biological child, education, number of siblings, birth order; long-format data: sibling type, age difference, sibling's sex, sibling's birth year, distance to sibling, year of birth of youngest niece/nephew.

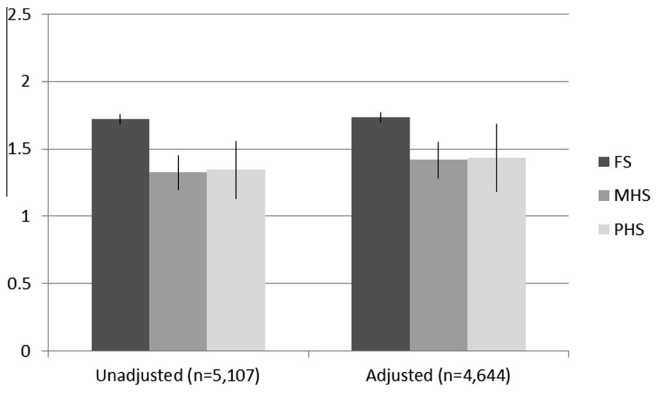

Fig. 1. Older generation's contact frequencies with siblings (adjusted means and 95% confidence intervals). *Notes.* FS = Full sibling, MHS = Maternal half sibling, PHS = Paternal half sibling.

individuals investment behavior in the case of parents (see Anderson, 2011 for review), grandparents (see Euler, 2011 for review), as well as subjective closeness in the case of several other types of relatives (Neyer & Lang, 2003). Our results replicate previous studies which have indicated that individuals have more contacts with their full than half siblings (e.g. Pollet, 2007; White & Riedmann, 1992). In addition, individuals tend to have more contacts with their nieces and nephews via full than via half siblings. We found also that people have more contacts with nieces and nephews via sisters than via brothers. This is in accordance with the prediction based on paternity uncertainty. Our findings are in line with the two studies concerning the investment behavior of twin aunts and uncles (Segal & Marelich, 2011; Segal et al., 2007).

Our study shows that genetic relatedness may play a significant role in sibling relationships for two different-aged generations. The study also points out that the generations may differ from each other in respect of contacts with maternal and paternal half siblings. The members of the older generation have overall fewer half siblings than the younger generation and the contacts with maternal and paternal half siblings in the case of older generation's respondents is almost the same. This may be due to the fact that although divorce rates did had a minor peak in Finland after the second World War, divorces were still more uncommon in 1940s and 1950s than in 1970s, 1980s or 1990s (Statistics Finland, 2012). If marriages ended in the death of a partner, the children stayed with the living spouse and both, the maternal and paternal half siblings may have spent more likely their childhood in the same family. This may explain the difference between older and younger generation in respect of maternal and paternal half siblings.

Table 2
Older and younger generation's contact frequencies with siblings and nieces/nephews.

	Older generation		Younger generation	
	Model 1 Siblings	Model 2 Nieces/nephews	Model 3 Siblings	Model 4 Nieces/nephews
Sibling type				
FS (ref)				
MHS	−0.31***	−0.24***	−0.35***	−0.28**
PHS	−0.30*	−0.22	−0.97***	−0.68***
Respondent's sex				
Female (ref)				
Male	−0.26***	−0.10**	−0.22***	−0.35***
Birth year	−0.004	0.007	0.02***	0.03**
Marital status				
Unmarried (ref)				
Cohabitation	−0.12	−0.08	0.06	−0.10
Married	−0.10	−0.10	−0.01	−0.11
Other	−0.04	−0.10	0.09	−0.18
Existence of a biological child				
No child (ref)				
Has a child	−0.16*	−0.09	0.15*	0.0005
Education				
Primary or lower secondary level (ref)				
Upper secondary level	0.07	0.03	0.16	−0.13
Lower degree level tertiary education	0.05	0.02	0.21	−0.19
Higher degree level tertiary education or doctorate education	0.20**	0.09	0.13	−0.35
Number of siblings	−0.04***	−0.02***	−0.07***	−0.07**
Birth order				
First born (ref)				
Later born	−0.003	0.03	−0.04	−0.13
Age difference	−0.01	0.005	−0.01*	−0.003
Sibling's sex				
Female (ref)				
Male	−0.34***	−0.14***	−0.40***	−0.22***
Sibling's birth year	−0.005	−0.005	0.02***	−0.00003
Respondent's distance to sibling				
Less than 1 km away (ref)				
Between 1 and 5 km away	−0.69***		−0.74***	
Between 5 and 25 km away	−1.03***		−1.04***	
Between 25 and 100 km away	−1.19***		−1.32***	
Between 100 and 500 km away	−1.38***		−1.54***	
More than 500 km away	−1.42***		−1.64***	
Year of birth of youngest niece/nephew		0.01**		0.01
Adjusted R^2	0.150	0.038	0.243	0.114
n	4510	3419	2655	1598

Notes: FS = Full sibling, MHS = Maternal half sibling, PHS = Paternal half sibling.
* p < .05.
** p < .01.
*** p < .001.

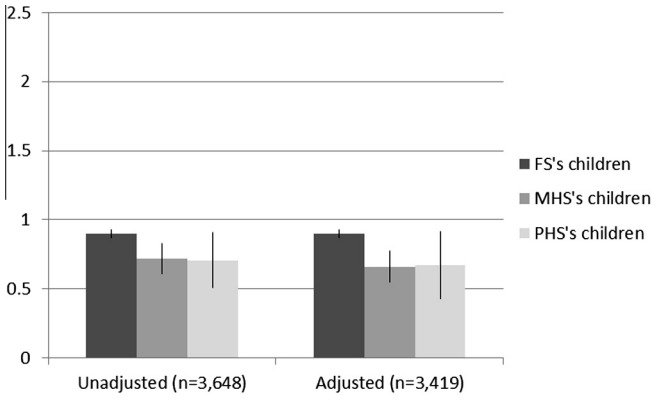

Fig. 2. Older generation's contact frequencies with nieces and nephews (adjusted means and 95% confidence intervals). *Notes.* FS = Full sibling, MHS = Maternal half sibling, PHS = Paternal half sibling.

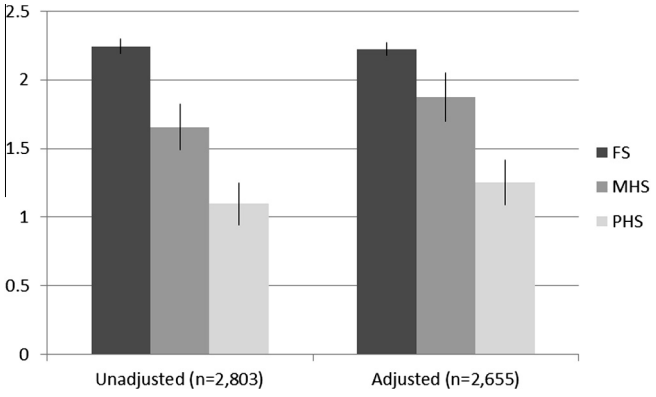

Fig. 3. Younger generation's contact frequencies with siblings (adjusted means and 95% confidence intervals). *Notes.* FS = Full sibling, MHS = Maternal half sibling, PHS = Paternal half sibling.

The other difference between older and younger generation is the association between sibling and niece/nephew contacts. In case of older generation the difference in contacts between full and maternal half siblings' children remains significant even after controlling for the contacts between the respondent and the sibling. In the case of younger generation the contact between a respondent

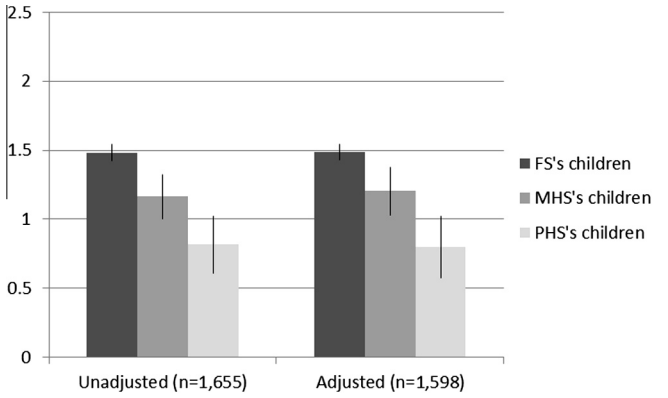

Fig. 4. Younger generation's contact frequencies with nieces and nephews (adjusted means and 95% confidence intervals). *Notes.* FS = Full sibling, MHS = Maternal half sibling, PHS = Paternal half sibling.

and sibling removes the difference between respondent's contact in full and half siblings' children. This is probably due to the fact that in the case of the younger generation the niece/nephew contacts goes via parents (i.e. respondent's siblings), since the nieces and nephews are mostly small children.

Genetic relatedness cannot be directly observed and hence there must be some cues to detect genetically related kin (Pollet & Hoben, 2011). One possible cue is physical resemblance, since those who share more genes with each other may also look alike more than those who share fewer genes with each other. Lewis (2011) found that facial resemblance predicts investment and closeness between siblings. Another cue may be that parents may favor their biological children over non-biological children, which could reflect on the relationship between siblings (Schnettler & Steinbach, 2011). Unequal treatment may cause more sibling rivalry between half than full siblings, and this may lead to less close relationships between half siblings. The other cues that predict genetic relatedness and that can act as proximate mechanisms for differences in sibling investments are co-residence during childhood and maternal perinatal association (Lieberman, Tooby, & Cosmides, 2007). The latter kin detection mechanism can be used naturally only by older siblings.

Further study is needed to understand the proximate mechanisms beyond results concerning differential relationships with full and half siblings and nieces and nephews via full and half siblings. In addition, longitudinal studies concerning the relationship between siblings as well nieces and nephews are needed. Finally, it is important to study whether the support provided by aunts and uncles have any fitness outcomes in modern societies, as it may have in pre-modern and traditional populations (Sear & Mace, 2008).

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VI

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Original Article

The Association between Unequal Parental Treatment and the Sibling Relationship in Finland: The Difference between Full and Half-Siblings

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Abstract: Studies have shown that unequal parental treatment is associated with relationship quality between siblings. However, it is unclear how it affects the relationship between full and half-siblings. Using data from the Generational Transmissions in Finland project (n = 1,537 younger adults), we study whether those who have half-siblings perceive more unequal parental treatment than those who have full siblings only. In addition, we study how unequal parental treatment is associated with sibling relationship between full, maternal, and paternal half-siblings. First, we found that individuals who have maternal and/or paternal half-siblings are more likely to have encountered unequal maternal treatment than individuals who have full siblings only. Second, we found that unequal parental treatment impairs full as well as maternal and paternal half-sibling relations in adulthood. Third, unequal parental treatment mediates the effect of genetic relatedness on sibling relations in the case of maternal half-siblings, but not in the case of paternal half-siblings. After controlling for unequal parental treatment, the quality of maternal half-sibling relationships did not differ from that of full siblings, whereas the quality of paternal half-sibling relationships still did. Fourth, the qualitative comments (n = 206) from the same population reveal that unequal parental treatment presents itself several ways, such as differential financial, emotional, or practical support.

Keywords: differential parental treatment, genetic relatedness, siblings, kin detection

Introduction

Individuals tend to be emotionally closer and have more contact with their full siblings than half-siblings, at least in adulthood (e.g., Pollet, 2007; Pollet and Hoben, 2011; Tanskanen and Danielsbacka, 2014). This difference seems to be fairly robust, even when other potentially confounding variables associated with the sibling relationship are

controlled for (e.g., the number of siblings, age difference between siblings, geographical distance to sibling, gender of a respondent and sibling, birth order).

The ultimate explanation for differential full and half-sibling relations can be derived from Hamilton's (1964) inclusive fitness theory. According to the theory, an individual can enhance his or her inclusive fitness by supporting the reproductive success of closely related kin. Thus, the inclusive fitness theory predicts that, all else being equal, individuals should invest more resources (e.g., time, money, emotional support) in more closely related kin. Full siblings have a 50% chance of inheriting the same allele, whereas half-siblings share only a 25% chance. Thus, all else equal, full siblings may benefit more than half-siblings by helping each other, in terms of inclusive fitness.

However, to form differential emotions according to the probability of shared alleles, humans must be able to assess the relatedness of a sibling. All human relatedness is more or less uncertain and must be inferred, except a mother's relatedness to her child. In order to recognize kin members, humans must use cues indicative of relatedness, and these cues can be direct or indirect (e.g., Antfolk, 2014; Bressan and Kramer, 2015). Direct cues can be physical or psychological such as facial or personal resemblance, and they may be other-referent or self-referent (Krupp, DeBruine, and, Jones, 2011). The former is based on information from already recognized kin (e.g., mother or father) against which an alleged relative (e.g., sibling) is compared, and the latter is based on information about oneself, against which an alleged relative is compared.

For the most part, humans have to rely on indirect environmental cues. Lieberman, Tooby, and Cosmides (2007) have tracked two such kin detection mechanisms in the case of human siblings: maternal perinatal association (e.g., seeing one's own mother nurse another child), a cue which can be used only by older siblings, and childhood co-residence duration. Naturally, maternal perinatal association requires mother recognition but co-residence duration before adulthood includes all family members who are co-residing, and thus it might be used to also detect other relatives apart from siblings. Co-residence during childhood acts as a proximate kin detection cue and as a precondition for incest aversion (Westermarck, 1891; see also Antfolk, Lieberman, and Santtila, 2012).

As the case of maternal perinatal association indicates, kin recognition of parents is a relevant prerequisite for sibling recognition. However, there is a lack of studies on how children actually detect their parents (but see DeBruine, 2005; Marcinkowska and Rantala, 2012). In particular, father recognition has been understudied, although most probably human children recognize their fathers as the adult male who co-resided and associated with their mother during childhood (Haig, 2011). Antfolk, Lindqvist, Albrecht, and Santtila (2014) found with a sample of Finnish undergraduate and graduate students that three childhood kinship cues associated with kin directed behavior to parents in adulthood: the reported amount of parental support, phenotypic similarity, and behavioral similarity.

Maternal and paternal half-siblings likely differ in terms of their exposure to various kinship cues, which, in turn, could cause differences in the quality of relationships in adulthood. Cues such as childhood co-residence and maternal perinatal association may be available for maternal half-siblings, but neither is usually available for paternal half-siblings. A father's contact with his offspring often attenuates if his sexual relationship with the mother ends, especially if the father has new offspring with a new partner (Haig, 2011; Jankowiak and Diderich, 2000). In addition, maternal and paternal half-siblings differ from each other because of asymmetries of patrilineal and matrilineal relatedness, and this may

affect the perceived difference in attachment among maternal and paternal half-siblings (Haig, 2009; 2011; Schlomer, del Giudice, and Ellis, 2011).

In contemporary Western welfare states (and likely ancestral hunter-gatherer groups), children usually stay with their mothers if parents separate, which means that maternal half-siblings likely co-resided longer than paternal half-siblings (OECD, 2014). Here, we study the sibling relationship in Finland, where approximately 80% of children remain with their mother in the case of parental separation (Statistics Finland, 2012). However, in a previous study that utilized the same data, a difference in contact frequencies between adult full siblings and maternal half-siblings was found to exist even though they most likely lived together in childhood (Tanskanen and Danielsbacka, 2014). This result indicates that there is an additional cue or a factor that differentiates full versus maternal half-sibling relations besides maternal perinatal association and childhood co-residence.

One factor that might deteriorate sibling relationship is parental divorce, which most likely has occurred if a person has younger half-siblings. The rates of divorce and remarriage have increased in contemporary Europe in the last decades (Coleman, 2014) and blended families have become increasingly common (Chapple, 2009). Previous studies show that siblings from divorced families tend to have more conflict with each other in adulthood, which, in turn, is explained by greater parental conflict in divorce families (Poortman and Voorpostel, 2008). Sibling conflict has been found to be highest in single-mother families (Deater-Deckard, Dunn, and Lussier, 2002).

Sibling conflict is often a result of a sibling competition. Siblings have a high tendency to compete with each other over the attention, time, and resources of their parents (Salmon and Hehman, 2014). Trivers' (1974) parent-offspring conflict theory, which is an expansion of Hamilton's (1964) general theory, may explain the reasons for the competition between siblings. From the offspring's perspective it is always beneficial to get as much parental resources as possible, because the offspring is more genetically related to himself or herself than to his or her sibling (with the exception of monozygotic twins; see Segal and Marelich, 2011; Segal, Seghers, Marelich, Mechanic, and Castillo, 2007). From the parental perspective, by contrast, it may sometimes be more evolutionarily beneficial to invest in other offspring. The existence of siblings means the existence of rivalries over access to parental resources (Salmon and Malcolm, 2011; Tanskanen, Danielsbacka, and Rotkirch, in press).

One outcome of sibling competition is that children are fairly good at detecting differential parental treatment in relation to their siblings. Parental treatment can be assumed to reflect parental investments, and thus, unequal parental treatment means unequal parental investment. In our evolutionary past as well as in pre-modern times, resources were probably much scarcer than in modern welfare states, and competition between siblings might have been more intense and had more importance for survival than today.

Nevertheless, contemporary studies show that children begin to be sensitive to differences in parental treatment by the age of 3 (Dunn and Munn, 1985). From that time, they start to actively observe the relationships between their siblings and their parents and to notice whether there are differences in the parental treatment they receive. According to Trivers' (1974) parent-offspring conflict theory, it should be profitable, from the parent's perspective, to invest resources in all biological children, not only one of them. However, if the mother or father has children with multiple partners, she or he may treat the children

differently due to different family structures. For instance, studies have shown that mother-offspring conflict intensifies more if a younger maternal half-sibling arrives than if a younger full sibling arrives (Schlomer, Ellis, and Garber, 2010), which may indicate that mothers allocate their investment differently between half-siblings. Thus, the perceived differential parental treatment, which small children are so keen to observe, may also act as one function that differentiates full, maternal, and paternal half-sibling relations.

Furthermore, differential parental treatment is found to be associated with the quality of the sibling relationship in childhood, adolescence, and adulthood (e.g., Boll, Ferring, and Filipp, 2003; Brody, Stoneman, and McCoy, 1992; Brody, Stoneman, McCoy, and Forehand, 1992; McHale, Crouter, McGuire, and Updegraff, 1995) as well as with children's behavioral problems (e.g., Coldwell, Pike and Dunn, 2008; Reiss et al., 1995). Perceived unfairness in parental treatment of a same-sex sibling observed by the younger party may even be associated with increased delinquency in adolescence (Scholte, Engels, de Kemp, Harakeh, and Overbeek, 2007). In this article, we study whether the unequal parental treatment differs between sibling sets including adult full siblings only and sibling sets including at least one maternal or paternal half-sibling. In addition, we explore the association between perceived unequal parental treatment and the relationship quality between full siblings, maternal half-siblings, and paternal-half siblings. Moreover, we seek to distinguish whether the perceived unequal parental treatment may mediate the effect of genetic sibling relationship.

The present study

The purpose of this study is twofold. First, based on previous results of differential relationships between full and half-siblings, we seek to determine:

> Q1) Do sibling sets including maternal and/or paternal half-siblings encounter more unequal treatment from their parents than sibling sets including full siblings only?

Our second aim for this study is based on previous findings on the association between the lineage and the degree of genetic relatedness and the quality of the sibling relationship. We also lean on kin detection theory and derive two questions:

> Q2) Is there an association between the category of sibling (full sibling, maternal half-sibling, paternal half-sibling) and the quality of the sibling relationship?

> Q3) Does the perceived unequal parental treatment mediate the relationship quality between maternal half-siblings or paternal half-siblings compared to full siblings?

Finally, we explore the following question with qualitative data:

> Q4) How does unequal parental treatment manifest itself?

Materials and Methods

In this study, we used data from the Generational Transmissions in Finland (Gentrans) project. The aim of Gentrans is to gather data on kin and other social

relationships within Finnish families. The present study uses the survey of younger adults aged between 19 and 50 years (M = 36.3, SD = 5.6). The data was collected in 2012 by Statistics Finland via mail (for details, see Tanskanen, Danielsbacka, and Rotkirch, 2014).

In the Gentrans survey, respondents were asked whether they and their sibling have the same mother and father, same mother only, or same father only. If the respondents had the same mother and father as the sibling, the relationship was coded as a full sibling relationship. In the cases where there was only the same mother or only the same father, the relationship was coded as a maternal or paternal half-sibling relationship, respectively. We included only those observations in which the respondent indicated at least one full or half-sibling. To better assess whether the respondents report unequal parental or unequal step-parental treatment, we excluded those respondents (n = 26) who indicated either of their parents as a non-biological parent. Thus, data are only analyzed using respondents who responded to the question concerning the equality of treatment from their biological parents. Those respondents who have half-siblings might also have a step-parent, but the majority of these respondents did not report equal or unequal treatment from a step-parent but from a non-custodial biological parent. These selections resulted in a total of 1,537 observations. In the survey, specific information was gathered separately for up to four of the respondent's oldest siblings.

For the first analysis (Q1), an indicator was created that separates those respondents who have full siblings only (1), and those who have at least one half-sibling (2). Our first dependent variable measures parents' unequal treatment. In the Gentrans survey, respondents were asked to report whether their mother, their father, neither of them, or both of them have treated all siblings (including the respondent) equally. To study unequal parental treatment, we used multinomial logistic regression analysis. The group "Both parents treated equally" was used as a base group in the analysis. At the first stage of the analysis, we controlled for several potential confounding variables that were available for the respondent and his or her parents and were predicted to associate with unequal parental treatment based on previous research (e.g., Boll et. al., 2003; Salmon and Hehman, 2014; Schlomer, del Giudice, and Ellis, 2011). These were the respondent's age, birth order, gender, number of siblings, education, health, financial situation, whether the respondent has children, the financial situation of the respondent's parents, the respondent's contact with their parents, and whether the respondent has received practical help from their parents.

However, a full model including all aforementioned variables reduced the number of observations by 12.6% of the sample, and due to that we have omitted from the final model all variables that did not significantly correlate with the dependent variable. This resulted in a final model containing the following variables: the respondent's gender and health, whether the respondent has children, the respondent's contact with their parents, and whether the respondent has received practical help from their parents. The exclusion of variables did not affect the main results concerning the association between the main independent variable (sibling set composition) and perceived unequal parental treatment. With the exception of respondent's health, and respondent's contact with parents, all independent variables were categorical. We have transformed these into dummy variables (see Table 1 for descriptive statistics).

Table 1. Descriptive statistics (*n* and %/mean)

Survey Item	*n*	%/mean
Sibling set includes		
Full siblings only	1,313	85.4
At least one half sibling	224	14.6
Sibling relationship		
Full sibling	2,451	86.4
Maternal half sibling	214	7.6
Paternal half sibling	171	6.0
Respondent's gender		
Female	985	64.1
Male	552	35.9
Respondent's health		
Very good	428	27.9
Good	899	58.5
Fair	192	12.5
Poor	18	1.2
Does the respondent have children		
No	560	36.4
Yes	977	63.6
Sibling's age	2,806	35.9
Age difference between respondent and sibling	2,806	6.1
Gender constellation between siblings		
Female and female	917	32.1
Female and male	1,442	50.4
Male and male	501	17.5
Geographical distance between respondent and sibling	2,800	174.8
Conflicts between siblings		
Never	949	33.5
Rarely	1,402	49.4
Now and then	404	14.2
Often	82	2.9
Contacts with parents	1,537	2.9
Received practical help from parents		
No	388	25.2
Yes	1,149	74.8
Perceived unequal parental treatment		
Both treated equally	1,075	73.3
Mother treated equally, father not	92	6.3
Father treated equally, mother not	114	7.8
Both treated unequally	186	12.7

Note: Long format data: sibling relationship, sibling's year of birth, gender constellation between siblings, age difference between respondent and sibling, conflicts between siblings.

In the second and third analyses (Q2 and Q3), the dependent variable measures the perceived emotional closeness towards a specific sibling. In the survey, the respondents were asked how close they feel to each of their four oldest siblings. For the analysis, we reversed the variable to ascending order (from 1 = *very distant* to 5 = *very close*). To study emotional closeness between siblings, we used stepwise multilevel linear regression analysis. The main independent variable separates full siblings, maternal half-siblings, and paternal half-siblings into different categories. At the first stage, we included all potential confounding variables that were available in the data and were predicted to be associated with the relationship quality between siblings based on previous research (for a review, see McHale, Updegraff, and Whiteman, 2012; Pollet, 2007). These variables were the age difference between the respondent and the sibling, gender constellation between the respondent and the sibling, sibling's age, geographical distance between the respondent and the sibling, conflicts between siblings, perceived unequal parental treatment, number of siblings, whether the sibling has a child, respondent's birth order, respondent's education, and financial situation of the respondent's parents.

However, the full model including all aforementioned variables reduced the number of observations by 19.3% of the sample (a 20.8% reduction in the number of groups) and due to that we have omitted from the final model all variables that did not significantly correlate with the dependent variable. This resulted in a final model containing the following variables: age difference between siblings, sibling's age, gender constellation between siblings, geographical distance between the respondent and the sibling, conflicts between siblings, and perceived unequal parental treatment. The variables were entered into the stepwise model within three stages to clarify the effect of perceived unequal parental treatment. The first model controlled only for sibling relationship (full, maternal half, paternal half), the second controls for all other control variables except the unequal parental treatment, and the third controls for all control variables including perceived unequal parental treatment. With the exception of the age difference between the respondent and the sibling, sibling's age, the geographical distance between the respondent and the sibling, and conflict between siblings, all independent variables are categorical. We have transformed them into dummy variables (see Table 1 for descriptive statistics). To formally test whether the unequal parental treatment mediates the relationship quality between maternal half siblings compared to full siblings (Q3) a Sobel z-test for mediation was conducted.

To further study unequal parental treatment (Q4), we then analyzed the qualitative text data which is related to the quantitative survey. In the survey, those respondents who answered that they and their siblings have encountered unequal parental treatment were then asked to report in their own words how this unequal parental treatment presented itself. In total 195 (48%) of those respondents who did report that unequal parental treatment existed wrote up their answer to this question. Women (n = 163) answered more actively than men (n = 32). We coded these texts and analyzed them with qualitative content analysis (Silverman, 2005). First, we systematically read our text data. Second, we identified, counted and categorized themes (i.e., how unequal parental treatment presents itself). Third, we sought typical examples that might help readers to become familiar with the ways that unequal parental treatment appears. The qualitative content analysis does not provide representative information on the subject, but rather provides preliminary results that may show what aspects of unequal parental treatment could be important.

Results

Parents' unequal treatment and siblings' genetic relatedness (Q1)

The results presented in Figure 1 (and in Table 3, the overall model: -2LL = 2333.1; Nagelkerke R^2 = 0.152, n = 1,467) show that the respondents who have only full siblings are less likely to have encountered unequal parental treatment than respondents who have half-siblings. However, the difference is statistically significant only if the mother treated siblings unequally compared to the situation where both parents treated the siblings equally. The predicted probability of reporting unequal maternal treatment among those who have only full siblings is 5.5%, whereas the predicted probability of reporting unequal maternal treatment among those who have at least one half-sibling is 21.5% (p < .001), after a wide range of potentially confounding variables have been controlled for. Correlations between independent variables (see Table 2) show no evidence for multicollinearity.

Figure 1. Predicted probability of perceiving unequal treatment from either one or both parents and 95% CI

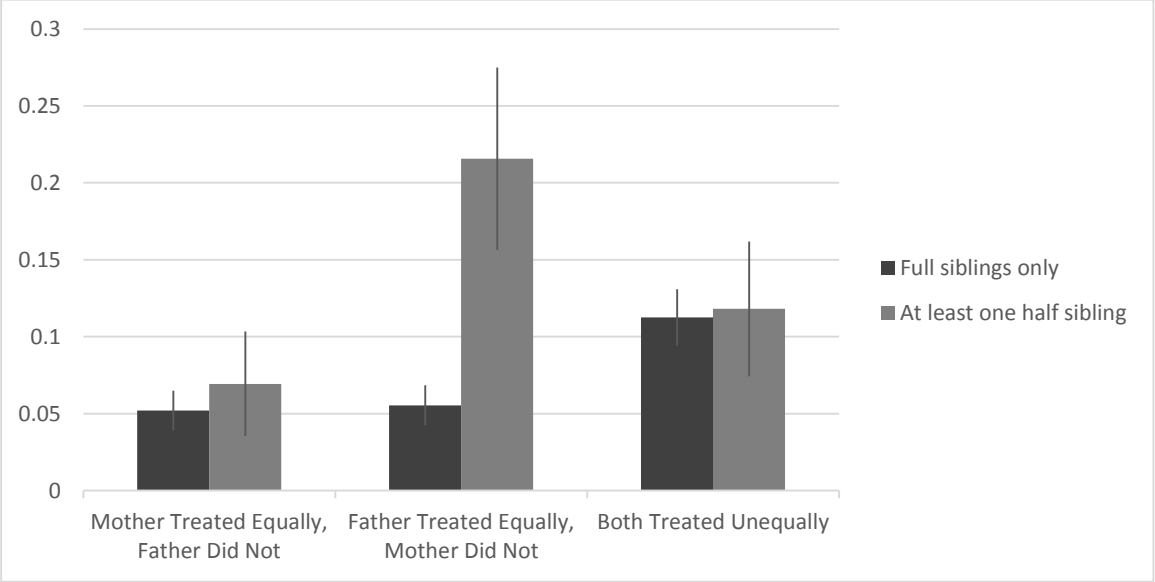

Table 2. Correlations between independent variables in multinomial regression analysis (n = 1,537)

Variable	1	2	3	4	5
1. Sibling set constellation	-				
2. Respondent's gender	0.01	-			
3. Respondent' s health	0.05*	0.06*	-		
4. Does the respondent have child(ren)	-0.01	-0.07*	0.01	-	
5. Contacts with parents	-0.15*	-0.09*	0.02	0.05	-
6. Received practical help from parents	-0.11*	-0.03	-0.001	-0.07*	0.33*

*Note: * p < .05*

In addition to sibling set constellation, other variables were also associated with the perception of unequal parental treatment (see Table 3). Men were less likely to encounter unequal treatment from mothers, fathers, and both parents than women. Frequent contact with parents and receiving practical help from parents were also associated with a smaller likelihood of reporting unequal parental treatment by either parent or both of them. Receiving practical help from parents was significantly associated with unequal parental treatment only when both parents treated siblings unequally. Respondents' health and whether they had children were associated with reporting unequal parental treatment from mothers, fathers, and both of them, although having children was significantly associated only with the likelihood of reporting unequal paternal treatment.

Table 3. Predicting unequal parental treatment. Multinomial logistic regression analysis (relative risk ratios), base group: equal treatment from both parents

Survey Item	Mother Treated Equally, Father Did Not	Father Treated Equally, Mother Did Not	Both Treated Unequally
Sibling set includes			
Full siblings only (ref.)	1	1	1
At least one half-sibling	1.74	5.09***	1.37
Respondent's gender			
Female (ref.)	1	1	1
Male	0.57*	0.56*	0.35***
Respondent's health	1.57**	1.52**	1.43**
Does the respondent have children			
No (ref.)	1	1	1
Yes	2.31**	1.11	1.27
Contacts with parents	0.53***	0.75*	0.60***
Received practical help from parents			
No (ref.)	1	1	1
Yes	0.84	0.80	0.58**

Note: * $p < .05$; ** $p < .01$; *** $p < .001$

Sibling relationship, genetic relatedness, and parents' unequal treatment (Q2 and Q3)

Next, we turn to the relationship quality between siblings. The random effects from stepwise multilevel linear regression models are presented in Table 5 (see Table 4 for correlations between independent variables). In the first model, only sibling relatedness was included and it correlated strongly with sibling relationship quality measured by emotional closeness. Respondents had more distant relationships with their maternal as well as their paternal half-siblings than with their full siblings (see Table 5, Model 1).

The second model includes (in addition to the relatedness variable) the age difference between the respondent and the sibling, the sibling's age, the gender constellation between the respondent and the sibling, the geographic distance between the respondent and the sibling, and conflicts with sibling. The difference between maternal and paternal half-siblings' versus full siblings' emotional closeness remains significant. The greater the age difference between the respondent and the sibling, the more distant they are

emotionally, and the older the sibling is the more distant he or she is with the respondent. Also, female-female sibling pairs are emotionally closer than female-male pairs or male-male pairs. As the geographical distance grows, emotional closeness decreases, and the more conflict between siblings, the more distant they are emotionally.

Table 4. Correlations between independent variables in multilevel linear regression analysis (n = 2,616)

Variable	1	2	3	4	5	6
1. Sibling relationship	-					
2. Age difference between respondent and sibling	0.39*	-				
3. Gender constellation between siblings	-0.01	0.01	-			
4. Sibling's age	-0.06*	-0.21*	0.0004	-		
5. Geographical distance between respondent and the sibling	0.03	-0.01	-0.04*	-0.01	-	
6. Conflicts between siblings	-0.16*	-0.17*	-0.11*	0.04*	-0.03	-
7. Perceived unequal parental treatment	0.16*	0.05*	-0.10*	0.02	-0.05*	0.13*

Note: * $p < .05$

Table 5. Factors associated with emotional closeness between full, maternal, and paternal half siblings. Stepwise multilevel linear regression model (β coefficients)

Survey Item	Model 1	Model 2	Model 3
Sibling relationship			
Full sibling (ref.)			
Maternal half-sibling	-0.27***	-0.17*	-0.13
Paternal half-sibling	-1.14***	-1.15***	-1.10***
Age difference between respondent and sibling		-0.02***	-0.02***
Sibling's age		-0.02***	-0.02***
Gender constellation between siblings			
Female and female (ref.)			
Female and male		-0.49***	-0.50***
Male and male		-0.40***	-0.43***
Geographical distance between respondent and sibling		-0.0002*	-0.0002**
Conflicts between siblings		-0.28***	-0.25***
Perceived unequal parental treatment			
No (ref.)			
Yes			-0.32***
Goodness of fit			
−2 Log Likelihood	7427.14	6854.95	6575.64
AIC	7437.14	6876.95	6599.64
Adjusted R^2	0.0657	0.1437	0.1704
n (obs.)	2,799	2,710	2,623
n (groups)	1,556	1,524	1,456

Note: * $p < .05$; ** $p < .01$; *** $p < .001$

In Model 3, we bring in the perceived unequal parental treatment variable. Those who have encountered unequal parental treatment feel that their siblings are more distant. However, in Model 3 the difference between maternal half-siblings and full siblings is insignificant (p = .077). This indicates that the perceived unequal parental treatment mediates the effect of genetic relationship in the case of maternal half-siblings. To test whether the mediation effect is significant, a Sobel z-test was conducted. According to the Sobel z-test the perceived unequal parental treatment was a mediator ($p < .001$).

The manifestations of unequal parental treatment (Q4)

Table 6 shows that unequal parental treatment may manifest itself in several ways. Analyzing the qualitative text data, we found five categories of unequal treatment: 1) material, 2) emotional, and 3) practical support, 4) distribution of tasks and restrictions, and 5) distribution of emotional and physical violence. It is worth mentioning that these categories are not always clearly defined, since some answers could be classified in more than one category. In such cases, we have classified them into the category that is most relevant. Thus, all themes are classified into one specific category and these categories are mutually exclusive. However, some respondents have mentioned more than one type of unequal parental treatment; in these cases, we have placed the respondent in more than one category. As Table 6 shows, the total number of instances of unequal parental treatment (n = 206) exceeds the number of respondents (n = 195). Many respondents described how unequal parental treatment presented itself in childhood and adolescence. Because all our respondents are adults, unequal parental treatment seems to remain in one's mind for a long time. Of course, there are also descriptions of how parents tend to treat siblings differently in adulthood. In addition, there are some cases where the respondents have not specified the forms of unequal parental treatment. These include instances such as, "my brother was favored in every possible way," and "since early childhood our parents have treated us siblings unequally." These are not classified into any category. Next we consider the five themes presented in Table 6 more precisely.

Table 6. List of unequal parental treatment reported (n = 206)

Unequal Treatment Category	*n*
Material support	75
Emotional support	64
Practical support	14
Tasks and restrictions	42
Emotional and physical violence	11

Material support. Table 6 shows that the majority of the references to unequal treatment concern material support (n = 75), which includes eight sub-themes concerning financial support, education, clothes and items, valuable gifts, leisure interests, inheritances, and privacy. Respondents mentioned both events in which they received more support than a sibling and those in which siblings arguably received more support. For instance, one individual wrote: "I know that my father gives more financial support to me than to my siblings" (Female, 1979, 12_042). In contrast, another respondent answered:

"My oldest sister has always gotten everything she wants and our parents have financially supported her and her family a lot" (Female, 1973, 12_103). Mostly, the unequal material support concerns relatively low-priced items and clothes or small amounts of money. However, in some cases respondents have reported that one sibling has received some valuable object, e.g., a car or a boat, whereas others have received nothing or only cheaper items:

> The most concrete example happened one Christmas when my brother received a summer house as a gift from our parents and I received underpants and a pair of socks (Female, 1971, 12_115).

Even though Finland is a Nordic welfare state wherein free education from elementary school to the university level is guaranteed to all citizens and the state provides universal study grants to all university and college students, there are still references in our data to parental unequal treatment related to education. In many cases, the discriminative support concerning educational issues was not directly financial. It did not involve parental contribution of more money or other financial help to one sibling's education over the other. Respondents mention that often parents might have encouraged one sibling in his or her studies while other siblings have not been encouraged. For instance, one respondent described the situation as follows:

> For some reason I was my parents' pet. They trusted me more, for example, in school issues, than they trusted my other siblings and, thus, I was able to develop for myself better self-esteem and a higher degree of self-respect (Male, 1978, 12_139).

Of course, the aforementioned type of unequal parental treatment is similar to the category of emotional support, but we have classified it as financial support, since it might have included an indirect financial stake. Those who have received greater study support are also more likely to have received more financial support, for example to cover living costs, than their siblings who have not been encouraged to study as much.

Emotional support. In our data, parents' unequal emotional support reveals itself in nine different ways: contact frequencies or spending time together, valuing, attracting parents' interest, emotional backing, closeness or attachment, encouragement, favoring a sibling's mate, solicitude, and trust. Differences in contact frequencies with parents arose within several comments. The reasons presented varied. For instance, one respondent described: "My mother has no contact at all with my sister because of her (i.e., my sister's) sexual orientation" (Female, 1987, 12_151). Another respondent explained:

> My mum and dad divorced when I was 3 years old. I have seen my dad maybe 10 times after that, and mum's two children from the new marriage, one of them is already dead, were much more important to her than me. I am not bitter, things worked out just fine like this (Male, 1969, 12_171).

Respondents also mentioned that their parents have, in general, valued one sibling over the others: "My sister always received more appreciation than me concerning

everything she did" (Female, 1974, 12_066) and "[M]y brother was always right and our parents' opinion was that everybody should follow his example" (Female, 1976, 12_007). In addition, respondents reported that one sibling may attract all the interest of the parents. Although some respondents pointed out that this is the case in adulthood, many more instances occurred in childhood: "My brother enjoyed being the center of attention and acted up all the time, I just went 'with the tide'" (Male, 1980, 12_009). This might have led sibling relations to suffer not only in childhood but also during adulthood. Thus, unequal emotional support provided by parents may have long-term influences on their children in general and on sibling relations in particular.

Practical support. There are only two kinds of remarks concerning unequal parental treatment in the case of practical support. These sub-themes are discriminative grandparenting and unequal practical help. In four of five instances of practical support, there was no specification of the kind of practical help parents had given. Only one mentioned that parents had given help when one sibling has arranged parties, whereas no help to other siblings was provided in similar situations. There were nine respondents who reported that parents have provided a different amount of solicitude to grandchildren. For instance:

> My mother looks after my sibling's children more than my children, my mother cooks more often for my sibling's family, invites them to dinner, buys clothes for my sibling's youngest child – but mother does not do similar things for my family (Female, 1974, 12_113).

> The biggest thing that niggles me is that my father looks after my sister's son but he does not look after my children (Female, 1973, 12_086).

Tasks and restrictions. In our data, there were 42 mentions of unequally distributed tasks and restrictions. Most of these involved discipline. One respondent argued that: "Discipline was much harder in my sister's case than in my case" (Male, 1975, 12_014). Unequal parental discipline manifests itself here in several ways. For instance, some pointed out that there were different upbringing methods between siblings in early childhood. Others, however, argued that different disciplinary approaches existed particularly in adolescence: "When we were younger my brother was permitted to stay out at night but my mother always tried to restrain my going out" (Female, 1978, 12_012).

Our data includes instances that explain how parents have pampered one sibling at the expense of other siblings. One respondent argues that pampering has happened especially in childhood but no longer in adulthood: "As a child, I was my father's pet. In adulthood he has treated all siblings equally" (Female, 1974, 12_097). Sometimes individuals point out that pampering is one form of unequal parental behavior that has started when the pampered child was a small baby or a toddler but has continued into adulthood: "My parents pampered my brother and he is still being served" (Female, 1974, 12_024). In addition to the aforementioned examples, a couple of the respondents mentioned that unequal parental treatment has presented itself in the way that parents' have supported the self-management of one sibling more than the others by placing different kinds of demands on siblings and different demands of responsibility.

Emotional and physical violence. In our text data, the smallest category is unequal parental emotional and physical violence. In the data, emotional violence manifested itself as name-calling, criticism, arguing, and yelling. Here are two examples: "My father has criticized my appearance and personality. I do not believe that he has criticized my brother's appearance" (Female, 1983, 12_033) and "My mother always criticizes everything I do and supports my sister" (Female, 1973, 12_063). There were three mentions of physical violence in the text data. One mention concerned sexual harassment and the other two concerned smacking.

Discussion

In this study, we analyzed whether the degree of genetic relatedness between siblings plays a role in younger adults' perception of unequal parental treatment among siblings and whether unequal parental treatment is associated with the quality of the relationship between full and half-siblings. In addition, we explored the ways in which unequal parental treatment presents itself.

We found that respondents whose sibling sets include half-siblings have encountered more unequal maternal treatment than respondents who have full siblings only. As we excluded those respondents who indicated their mother or father to be a step-parent, the results indicate that respondents' biological mothers had treated the siblings unequally. Thus, it might be that perceived unequal maternal treatment among sibling sets including half-siblings is due to the intensified mother-offspring conflict in cases where a younger maternal half-sibling has arrived (Schlomer et al., 2010). This may convert to differential allocation of maternal resources, which in turn appears for the offspring as unequal maternal treatment.

We also found that the degree of siblings' genetic relatedness as well as perceived unequal parental treatment both correlated with the relationship quality between siblings as measured by emotional closeness. Co-residence and maternal perinatal association are known to be kin detection mechanisms in humans (Lieberman, Tooby, and Cosmides, 2007) and, thus, it can be expected that the relationship between those half-siblings who have probably lived together in childhood (maternal half-siblings) would not diverge from the relationship between full siblings. Contrary to this theoretical assumption, we found that maternal half-sibling relations as well as paternal half-sibling relations diverge clearly from full sibling relations, which were the closest. However, as the stepwise multilevel models show, and the Sobel *z*-test verifies, the perceived unequal parental treatment mediates the difference in relationship quality between maternal half-siblings compared to full siblings. Thus, in light of these results, we may consider if the well-known difference in sibling relationships between full and maternal half-siblings (e.g., Pollet, 2007; Tanskanen and Danielsbacka, 2014) is in part due to biological parents' unequal treatment of those siblings.

Our qualitative analysis reveals that although unequal parental treatment may present itself in various ways, in many cases it is associated with the unequal distribution of parental resources. We found five ways that unequal parental treatment presented itself, and three of these were indisputably related to financial, practical, or emotional resources. This is in line with the assumption that siblings compete with each other for parental resources (Trivers, 1974). However, we also found that, in some cases, unequal parental treatment

takes such negative forms as name calling or physical violence. In addition, our qualitative analysis reveals that unequal parental treatment experienced in childhood appears to remain with a person.

Our study contains some limitations. We assumed that childhood co-residence and equal parental treatment serve as a way to detect more closely related siblings from other non-related or more distantly related peers, and therefore the availability of these cues may also affect the quality of a sibling relationship. However, there may also be some other kin detection mechanisms for which we were not able to control (see e.g., Antfolk et al., 2014). For example, one may be the facial or personality resemblance which can be assumed to be greater in the case of full than half-siblings.

Other limitations include the lack of exact information about which parent the respondents were referring to in blended families. It is well-known that stepparents may treat their own and stepchildren differently (e.g., Anderson, 2005; Gurven, Allen-Arave, Hill, and Hurtado, 2001; Gurven, Hill, Kaplan, Hurtado, and, Lyles, 2000; Ivey, 2000; Tiffret, Jorev, and Nasanovitz, 2010). Respondents from divorced families might have thought about either their own non-residing biological parent or their step-parent who has lived in the same household with them during childhood while answering the question about unequal parental treatment. However, we believe we were able to control this uncertainty by excluding those respondents (n = 26) who defined either one of their parents a step-parent, and thus we may fairly reliably assume that the parent respondents are referring to is their biological parent.

In the survey, the formulation of the unequal treatment question was unclear because it did not take into account which sibling (i.e., the respondent or one of his or her full or half-siblings) has suffered from unequal parental treatment. This may be the reason why some control variables (e.g., birth order) were not correlated with dependent variables in either of the analyses, even though they should have been given previous studies (see e.g., Rohde et al., 2003; Salmon, 1999, 2003; Salmon and Daly, 1998). Finally, there is also the question of how well a research sample from one Western country is generalizable to any other population (e.g., Henrich, Heine, and Norenzayan, 2010). In this study, we have used a representative sample of younger adults in Finland. However, while studying unequal parental treatment, representative data from several different countries are needed.

Our study shows also that there is need for further studies. Larger data samples will be needed to explore whether unequal maternal or paternal treatment differs in different sibling set compositions, for instance, between those who have full siblings only, maternal half-siblings only, paternal half-siblings only, maternal and paternal half-siblings only, or full siblings and at least one half-sibling. Future studies should also investigate whether unequal parental treatment manifests itself differently in the case of full siblings than in the case of maternal or paternal half-siblings. In addition, we will need larger data samples to explore exactly how the presentation of unequal maternal and paternal treatment differs and whether the presentation of unequal parental treatment diverges according to siblings' gender. The unequal parental treatment and its effect on full versus maternal or paternal half-sibling relations should also be studied within small children because, as we saw in our qualitative analysis, the unequal parental treatment encountered in childhood remains in mind until adulthood.

Since we do know from previous studies that unequal parental treatment impairs sibling relations as well as children's development (e.g., Coldwell Pike, and Dunn, 2008;

Shanahan, McHale, Crouter, and Osgood, 2008), the results reported in this study provide important implications for parents. The equal treatment of all children needs more attention in new family constellations because it is clearly more common for those who have half-siblings to have encountered unequal parental treatment.

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VII

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ORIGINAL RESEARCH
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Diluted Competition? Conflicts between Full- and Half-Siblings in Two Adult Generations

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Sibling relations are typically close but ambivalent, including both altruism and competition. Full siblings are often assumed to exhibit more altruism and less competition than half-siblings. However, previous empirical findings indicate that this assumption may not hold for sibling conflicts in contemporary humans. We study self-reported occurrence of sibling conflicts among adults in two generations with nationally representative data from the Generational Transmissions in Finland surveys in 2012. Respondents represent an older generation (born between 1945 and 1950, n = 2,015) and their adult children (born between 1962 and 1993, n = 1,565). Based on kin selection and parent–offspring conflict theory, we expect reports of any conflict to be more likely between full siblings than half-siblings, between maternal half-siblings than paternal half-siblings, and among the younger generation compared to the older generation. Results mostly support our hypotheses. Full siblings were more likely to report conflicts than were maternal and paternal half-siblings in the younger generation. In the older generation, full siblings were more likely to report conflicts with paternal but not maternal half-siblings. The younger generation was also more conflict-prone than the older. Results held when controlling for contact frequency, emotional closeness, unequal parental treatment, and several socioeconomic variables, as well as for within-family effects. Thus, although full siblings are typically closer and have more contact in adulthood than half-siblings do, they also appear to have more conflicts. We suggest that this can be explained by diluted resource competition over parental investment between half-siblings in societies with serial monogamy.

Keywords: sibling conflict, kin selection, parent–offspring conflict, parental investment, sibling competition, sibling relations, stepfamilies, unequal parental treatment

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INTRODUCTION

Sibling competition has been documented across species, and may manifest itself in many forms ranging from minor quarrels to aggression and siblicide (Mock and Parker, 1997; Michalski and Euler, 2008). In humans, milder conflicts and disagreements between siblings are frequent (Pollet and Hoben, 2011), although brothers and sisters are also closely attached which is why this family tie can be characterized as ambivalent (e.g., Cicirelli, 1995; Dunn, 2014).

Human sibling competition is most severe in childhood, when siblings usually co-reside and parental investment matters most (Salmon and Hehman, 2014), but can appear throughout the adult life course (e.g., Lamb and Sutton-Smith, 1982; White, 2001; Spitze and Trent, 2006). Sibling attachment is created early in life through certain cues, including shared residence and maternal care (Westermarck, 1891; Lieberman et al., 2007) and the quality of this bond in childhood affects adult sibling relations (Pollet and Hoben, 2011). For instance, parental unequal treatment experienced in childhood or adolescence may be remembered for a long time and create more emotional distance between siblings in adulthood (Jensen et al., 2013; Danielsbacka and Tanskanen, 2015).

In early adulthood, siblings often compete over parental resources, such as financial transfers, and help with child care. For instance, contemporary Europeans are less likely to have a child if their own parents are already providing care to the young child of a sibling (Aassve et al., 2012). At later life stages, sibling conflicts occur over, for example, access to shared family resources, caring for aging parents, and inheritance (Cicirelli, 1995).

While studies involving siblings are today abundant within the social sciences, siblinghood is often used to control for family effects rather than as a family tie in its own right (Whiteman et al., 2011; among recent studies, see, e.g., Voorpostel and van der Lippe, 2007; Voorpostel and Blieszner, 2008; Blaauboer et al., 2013; Kolk, 2014; Rotkirch et al., 2014). Research on sibling conflicts among adults are quite rare (but see Stewart et al., 2001; Riggio 2006; Salmon and Hehman, 2015). Here, we are interested in exploring conflict occurrence among adults as an indicator of sibling competition.

It is often hypothesized that full siblings should experience less intense sibling competition compared to half-siblings (Trivers, 1974). For humans, emotional closeness among kin is usually related to increased cooperation and fewer conflicts (Kurland and Gaulin, 2005; Curry et al., 2013). When comparing full- and half-siblings, the former have been found to emotionally closer to each other and to interact more (e.g., Pollet, 2007; Tanskanen and Danielsbacka, 2014). This has led to the assumption that full siblings should also be less conflict-prone when compared to half-siblings (e.g., Schlomer et al., 2011; Salmon and Hehman, 2015). Nevertheless, recent evidence, intriguingly, indicates that this may not be always the case. Two recent studies among US college students (Salmon and Hehman, 2015) and British adolescents (Tanskanen et al., 2016) found full siblings to experience more conflicts than half-siblings. Sibling conflict occurrence has not, however, previously been studied among adults using large and representative data, which is the purpose of our study here.

Evolutionary perspectives on sibling competition rely on two fundamental biological theories: *kin selection theory* (Hamilton, 1964; Hughes, 1988) and *parent–offspring conflict theory* (Trivers, 1974; Schlomer et al., 2011). Kin selection theory focuses on the effect of genetic relatedness on altruistic behavior, while parent–offspring conflict theory focuses on the effect of parental investment on parent and offspring relations and, by extension, on sibling competition for limited parental resources. Both theories predict behavior to evolve in order to maximize inclusive fitness, or the proportion of an individual's genes passed on to subsequent generations.

First, kin selection theory predicts that individuals are more likely to provide help and to invest resources in genetically closer kin compared to more distantly related kin and to non-kin (Hamilton, 1964). Consequently, also conflicts between family members can be assumed to decrease as genetic relatedness is higher (Schlomer et al., 2011, 509). Hughes (1988) (pp. 35–56) applied and expanded kin selection theory to humans, showing that both reciprocal exchange and fitness-increasing cooperation are more likely to appear among full siblings than half-siblings. However, his results highlighted the complexity of the effects of sibling relatedness, so that results were not uniformly in favor of full siblings even for simple cooperation models. Hughes (1988) (pp. 42–47) further specified the conditions of nepotistic sharing in human groups in relation to both the degree of relatedness and the reproductive potential of the individuals involved. Reproductive potential is measured as the likelihood to have offspring in the future and, thus, directly related to age. Hughes predicted that altruistic help should be more likely provided from older kin generations to younger generations than among peers, and that peer competition should diminish once individuals are no longer reproducing and their own reproductive potential is 0.

Second, parent–offspring conflict theory states that a parent's evolutionarily optimal level of investment in any given offspring is determined by the relative benefits of investing in that offspring compared to investing in other current and future offspring (Trivers, 1974). Offspring are, thus, expected to compete for limited parental resources (Salmon and Malcolm, 2011). Theoretically, this competition between offspring can be so extreme that it reduces or even negates the prosocial influence of kin altruism on behavior (West et al., 2002). The intensity of sibling competition will depend on many factors, including the amount of resources available and how equally parents are inclined to divide them among offspring. Resource scarcity as well as abundance can both be assumed to increase sibling competition (Pollet and Hoben, 2011). Perceived unfairness from parents is known to increase resentment and competition among siblings (e.g., Danielsbacka and Tanskanen, 2015). Furthermore, individual characteristics, such as age, health, and gender contribute to tensions among siblings, usually so that similarity and proximity feeds competition and promote differentiation (e.g., Feinberg and Hetherington, 2000; Salmon and Hehman, 2015). Thus, being of the same sex can intensify competition over similar types of resources (in addition, two brothers tend to have more conflicts than two sisters; Brody et al., 1985). Also the numbers of siblings, their birth order, and birth intervals are known to influence sibling relations (e.g., Salmon, 1999; Black et al., 2005; Nitsch et al., 2013) – the smaller the age difference, the more conflicts over shared parental resources, albeit large age differences may reduce relationship closeness (Pollet and Hoben, 2011).

The extent of parent–offspring conflict will also depend on the investment each of the individual's original parents provides in case half-siblings are born. If one parent produces additional offspring with a new partner, the other parent and existing offspring can both be affected, but the magnitude of this cost or benefit depends on the mating and parenting system. Lessells and Parker (1999) modeled costs of additional offspring to parents and siblings for a hypothetical species with uniparental care.

They found that in some cases, the offspring's optimal parental investment may be independent of whether a full or half-sibling is born. These authors, therefore, stress that it is not average sibling relatedness *per se*, but the costs that one of the parents causes the other parent in terms of inclusive fitness, that shapes parent–offspring conflict and, by extension, sibling competition.

In humans, both mothers and fathers usually invest in offspring. Half-siblings are typically born either within polygamous marriages (polygamy), as a result of death and remarriage (strict monogamy) as in preindustrial Europe, or as a result of divorce and remarriage (serial monogamy) as in most contemporary countries (e.g., Anderson, 2011; Pettay et al., 2013). Under conditions of serial monogamy, both of the original parents and their kin networks are usually alive and present in the child's life. Such blended families are increasingly common in contemporary Europe, where children usually reside with their mothers if parents have separated, but their biological fathers continue to keep in contact with and provide support for them (Amato, 2010). This creates a crucial difference between full and half-siblings in terms of the kin network they can expect most investment from. Full siblings have exactly the same biological kin network, while half-siblings share only half of their biological kin network. For the overlapping part of the kin network (the shared parent), half-siblings can be predicted to compete more intensely than full siblings do, due to their lower relatedness. This hypothesis has been tested and confirmed for parent–offspring conflict in both birds and humans (Schlomer et al., 2011). By contrast, however, for the non-overlapping part of their kin networks, half-siblings can be predicted to exhibit no or very little competition toward each other. We call this the diluted sibling competition hypothesis (Tanskanen et al., 2016; see also Michalski and Euler, 2008).

Finally, studies on sibling relations should separate between maternal and paternal half-siblings. Previous research shows that although these siblings share a similar level of genetic relatedness, they often differ from each other with regard to relationship quality (e.g., Pollet, 2007; Tanskanen and Danielsbacka, 2014). The main proximate reason is probably co-residence in childhood. In polygynous societies, half-siblings tend to be related through their father; while in contemporary Western societies, children usually co-reside with their mother after divorce, so that maternal siblings on average interact more than paternal siblings do. Also the effect of paternity uncertainty may weaken the bond between paternal siblings, making individuals unconsciously prefer their genetically more certain and maternal kin ties over less certain and paternal kin ties (Laham et al., 2005).

To sum up, the theoretical approaches outlined above provide five main assumptions for the effects of genetic relatedness on sibling relations in contemporary Western societies:

1. Based on inclusive fitness theory, full siblings are more likely to exhibit greater emotional closeness and be more in contact with each other compared to half-siblings.
2. Based on the diluted sibling competition hypothesis, full siblings are more likely to compete with each other than half-siblings are, since the sources of parental investment are fully overlapping among full siblings but only partly overlapping among half-siblings.
3. Based on parent–offspring conflict theory, competition for the overlapping part of the kin network (i.e., the shared parent and his or her kin) should be stronger for half-siblings than for full siblings.
4. Also based on parent–offspring conflict theory, similarity in life stage and the resources being competed for should increase both emotional closeness and competition. Such similarities include sibling age, gender, and co-residence.
5. Based on inclusive fitness theory, individual reproductive potential correlates with sibling competition, which is, therefore, expected to decline with age.

This study touches upon four of these five predictions (excluding number 3). We have two main research questions: Are full siblings more likely to report conflicts compared to maternal and to paternal half-siblings? Is the amount of conflict higher in the younger adult generation compared to their parents' generation?

We expect

(i) full siblings to report more conflicts than half-siblings, and also maternal half-siblings to report more conflicts than paternal half-siblings
(ii) the younger adult generation to report more sibling conflicts than the older generation.

DATA AND METHODS

We use data from the Generational Transmissions in Finland (Gentrans) project. The aim of Gentrans is to gather longitudinal information on two generations: the Finnish "baby boomer" generation born immediately after World War II, between 1945 and 1950 (M = 1947, SD = 1.67) (the older generation), and their adult children, born between 1962 and 1993 (M = 1976, SD = 5.6) (the younger generation). The two family generations represent different cohorts and historical experiences. Fertility was quite high (total fertility rates above 3) and divorces uncommon in Finland in the 1940s and 1950s, when respondents from the older generation were children. In the 1970s–1990s, when the younger generation grew up, total fertility rates were below two and the number of parents divorcing every year had more than doubled compared to the post-war decades (Statistics Finland, 2012). At the study time, the younger adults were closer in time to their childhood, when they probably had more intense competition over parental resources and also more conflicts with their siblings. They were also more likely to have at least one parent alive, compared to the older generation whose parents have usually already both died (Statistics Finland, 2012). Respondents from the younger generation were, furthermore, in the middle of their childbearing and working career years and, thus, had "more at stake," compared to the older generation who were already retired or close to retirement age.

The first wave of the Gentrans surveys was gathered in 2007. Ethical permission for this and subsequent surveys were obtained by the Ethical board of Statistics Finland (decision 2.6.2006). This study uses the second wave, which was collected in 2012 by Statistics Finland via regular mail. The surveys of the older

and younger generations were gathered separately. During the data collection in 2012, respondents from the older generation were around 65 years old (between 62 and 67) and those from the younger generation mostly in their 20s, 30s, and 40s (mean 36, min 19, max 50). The older generation's survey included altogether 2,278 respondents (response rate 65%), and the younger generation's survey included 1,753 respondents (response rate 50%) (Danielsbacka et al., 2013).

In the Gentrans surveys, respondents were asked whether they and their sibling have the same biological mother and father, same mother only, or same father only. If respondents reported having the same mother and father as the sibling, the relationship was coded as a full sibling relationship. For cases with only the same mother or only the same father, the relationship was coded as a half-sibling relationship. Only respondents with at least one full or half-sibling were included in the analysis (older generation: $n = 2{,}015$; younger generation: $n = 1{,}565$). Maternal half-siblings and paternal half-siblings were also separated into different categories. We will assume that maternal half-siblings have been living together in the same household for a longer time. In the last decades in Finland, at least 80% or more of children who do not live with both biological parents were registered as staying with their mothers (Statistics Finland, 2012).

The dependent variable measures sibling conflicts, which the respondents reported separately for up to four of the respondents' oldest siblings. In the questionnaires, the respondents were asked "Have you had conflicts with your sibling? How often?" The question did not define any specific time span for the occurrence of these conflicts. We interpret the responses to measure respondent's overall susceptibility to conflicts in his/her relationship with the specific sibling rather than an exact amount of conflicts in a specific time frame. Respondents reported conflicts with each of their siblings on a scale of 1 = never to 4 = often (mean = 1.64, SD = 0.75 for the older generation; mean = 1.9, SD = 0.76 for the younger generation).

For the analysis, we dichotomized the sibling conflict variable as 0 = never, 1 = at least sometimes. 50.1% of the older generation's and 66.7% of the younger generation's respondents reported having had sibling conflicts. The dependent variables were dichotomized because these were not normally distributed in either survey and, thus, analyses with continuous variables could not have been performed properly. Sensitivity analyses conducted with continuous variables produced similar results (not shown) to analyses with the dichotomized variables, so that the loss of information appears to have been very small. For the purposes of the analyses, the data were reshaped into a long format, so that observations represent the siblings of the original respondents. In the case of the older generation, this resulted in a total of 5,102 observations; and in the case of the younger generation this resulted in 2,801 observations from the data.

In the case of contact frequencies, respondents were asked via a five-point scale (from 0 = never to 4 = several times a week) to report how often they have had contact with their siblings either personally, by phone or by internet during the last 12 months. Contact frequencies were gathered separately for four of the respondents' oldest siblings. Emotional closeness was measured by asking respondents how close they feel to their siblings using a five-point scale (from 0 = very distant, to 4 = very close). Also the ratings of emotional closeness were asked separately for the respondents' four oldest siblings.

Regarding parental equal treatment, respondents were asked whether their mother, their father, neither parent, or both parents have treated all siblings equally. For the analysis, we coded the unequal treatment variable as 0 = both treated equally, 1 = mother treated equally, father not, 2 = father treated equally, mother not, and 3 = both treated unequally. With the exception of the respondent's birth year, the number of siblings, the age difference between siblings, sibling's year of birth, contact frequencies and reported emotional closeness between siblings, all independent variables were categorical and were transformed into dummy variables.

Since sibling conflict may vary by life stage and age, we first studied the two surveyed generations separately. We then merged the data and compared older and younger generations to each other. We ran three regression models. In the first step, we control for respondents' year of birth and in the second step for emotional closeness and frequency of sibling contacts. These may correlate negatively with conflict occurrence, so that those who are closer to their siblings prefer to see each other more often (Salmon and Hehman, 2014) but also positively, since a higher contact frequency allows for more conflicts. In the third model, we further control for respondent age, gender, sibling age difference, sibling birth order, number of siblings, and perceptions of parental unequal treatment, and geographical distance, as well as educational level and wealth, for reasons described in the section "Introduction" (see **Table 1** for descriptive statistics).

We used multilevel logistic regression analysis in which the multiple sibling conflicts reported by the respondents are grouped within respondents. This method takes into account the non-independence of sibling conflicts reported by the same respondent. Regression coefficients were expressed as odds ratios (ORs) for which an OR above 1 indicates a positive association between the independent variable and the outcome, while ORs under 1 indicate a negative association.

RESULTS

The descriptive results (**Table 1**) show that older generation respondents have an average of two and younger generation respondents 1.6 siblings. Around 5% of respondents in the older generation had maternal and 2% had paternal half-siblings. In the younger generation, these numbers were 8% and 6%, respectively.

In both generations, full siblings tend to be emotionally closer with one another than half-siblings (younger generation: full sibling = ref., maternal half-siblings: $\beta = -0.59$, SE = 0.13, $p < 0.001$, paternal half-sibling: $\beta. = -1.87$, SE = 0.15, $p < 0.001$, $n = 2{,}795$; older generation: full sibling = ref., maternal half-sibling: $\beta = -0.73$, SE = 0.12, $p < 0.001$, paternal half-sibling: $\beta = -0.55$, SE = 0.20, $p = 0.005$, $n = 5{,}045$). Full siblings also have more contacts with each other compared to

TABLE 1 | Descriptive statistics (*n* and %/mean).

	Younger generation			Older generation		
	n	**%/mean**	**SD**	***n***	**%/mean**	**SD**
Sibling relationship (%)						
Full sibling	2,425	86.6		4,749	93.1	
Maternal half-sibling	209	7.5		258	5.1	
Paternal half-sibling	167	6.0		95	1.9	
Respondent's birth year (mean)	1,565	1976	5.60	2,015	1947	1.67
Respondent's education (%)						
Primary or lower secondary level	52	3.4		643	32.6	
Upper secondary level	662	42.7		996	50.5	
Lower degree level tertiary education	424	27.3		128	6.5	
Higher degree level tertiary education or doctorate education	414	26.7		206	10.4	
Respondent's perceived financial condition (%)						
Low income	461	29.7		899	45.0	
Middle income	766	49.3		751	37.6	
Comfortably off or wealthy	326	21.0		350	17.5	
Respondent's number of siblings (mean)	1,556	2.0	1.52	1,958	3.7	2.41
Respondent's birth order (%)						
First born	624	40.3		584	29.7	
Later born	923	59.7		1,384	70.3	
Sex of respondent and sibling (%)						
Female and female	896	32.1		1,546	30.6	
Female and male	1,409	50.4		2,451	48.5	
Male and male	489	17.5		1,060	21.0	
Sibling's birth year (mean)	2,755	1976	6.52	4,961	1947	7.31
Age difference between respondent and sibling (mean)	2,755	6.2	4.55	4,961	5.7	4.26
Geographical distance between respondent and siblings (%)						
Less than 1 km	53	1.9		121	2.5	
1–5 km	192	6.9		429	8.8	
5–25 km	736	26.6		938	19.2	
25–100 km	528	19.1		1,037	21.2	
100–500 km	939	33.9		1,801	36.9	
More than 500 km	320	11.6		558	11.4	
Emotional closeness (mean)	2,795	2.8	0.99	5,045	2.7	0.91
Contact frequencies (mean)	2.796	2.1	1.09	5.012	1.7	1.01
Did parents treat all siblings equally (%)						
Both treated equally	1,091	73.1		1,503	79.2	
Mother treated equally, father not	95	6.4		145	7.6	
Father treated equally, mother not	114	7.6		111	5.9	
Both treated unequally	193	12.9		140	7.4	

Basic data: respondent's birth year, education, financial condition, number of siblings, birth order, and parental treatment; long format data: sibling relationship, sex of respondent and sibling, sibling's birth year, age difference, geographical distance, emotional closeness, and contact frequencies.

half-siblings (younger generation: full sibling = ref., maternal half-sibling: $\beta = -1.00$, SE = 0.13, $p < 0.001$, paternal half-sibling: $\beta = -2.14$, SE = 0.16, $p < 0.001$, $n = 2{,}796$; older generation: full sibling = ref., maternal half-sibling: $\beta = -0.76$, SE = 0.12, $p < 0.001$, paternal half-sibling: $\beta = -0.71$, SE = 0.20, $p < 0.001$, $n = 5{,}012$).

Conflicts in the Younger Generation

Conflicts in the younger generation were more likely to be reported among full siblings than among either maternal or paternal half-siblings (**Table 2**). Compared to full siblings (ref., OR = 1.00), the ORs were 0.19 and 0.04 for maternal and paternal half-siblings, respectively, in the first model with no other covariates than respondent's birth year. The results are affected to only a very slight degree by including emotional closeness and contact frequency into the regression. In the fully adjusted model, the difference between full siblings and maternal half-siblings is smaller but still significant, while the difference to paternal half-siblings is not much affected (see **Figure 1**). In the maximally adjusted model the difference between maternal and paternal half-siblings is statistically significant (maternal half-siblings (ref): OR = 1.00; paternal half-siblings: OR = 0.15, $p < 0.001$; $n = 2{,}540$).

To adjust for all stable differences between different respondents, we conducted a within-respondent analysis using

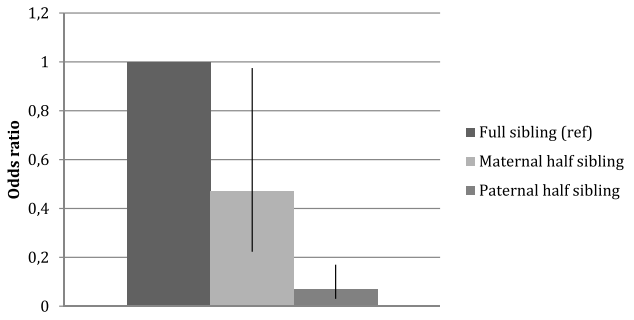
TABLE 2 | Younger generation: associations of sibling characteristics with sibling conflicts (odds ratios).

	Model 1					Model 2					Model 3				
				95% CI					95% CI					95% CI	
	OR	SE	*p*	Lower	Upper	OR	SE	*p*	Lower	Upper	OR	SE	*p*	Lower	Upper
Sibling relationship															
Full sibling (ref)	1.00					1.00					1.00				
Maternal half-sibling	0.19	0.06	<0.001	0.10	0.35	0.22	0.07	<0.001	0.12	0.41	0.47	0.18	0.043	0.22	0.98
Paternal half-sibling	0.04	0.01	<0.001	0.02	0.08	0.04	0.02	<0.001	0.02	0.09	0.07	0.03	<0.001	0.03	0.17
Respondent's birth year	1.00	0.02	0.977	0.97	1.03	1.00	0.02	0.797	0.96	1.03	1.05	0.03	0.051	1.00	1.10
Respondent's education															
Primary or lower secondary level (ref)											1.00				
Upper secondary level											1.02	0.66	0.979	0.29	3.62
Lower degree level tertiary education											1.13	0.76	0.855	0.30	4.20
Higher degree level tertiary education or doctorate education											0.55	0.38	0.384	0.15	2.10
Respondent's perceived financial condition															
Low income (ref)											1.00				
Middle income											1.39	0.38	0.222	0.82	2.37
Comfortably off or wealthy											1.44	0.50	0.294	0.73	2.83
Respondent's number of siblings											0.79	0.06	0.001	0.69	0.90
Respondent's birth order															
First born (ref)											1.00				
Later born											0.73	0.21	0.281	0.42	1.29
Sex of respondent and sibling															
Female and female (ref)											1.00				
Female and male											0.30	0.06	<0.001	0.20	0.46
Male and male											0.73	0.21	0.281	0.42	1.30
Sibling's birth year											0.999	0.02	0.940	0.97	1.03
Age difference between respondent and sibling											0.87	0.02	<0.001	0.83	0.91
Geographical distance between respondent and sibling															
Less than 1 km (ref)											1.00				
1–5 km											0.70	0.52	0.626	0.16	2.97
5–25 km											0.55	0.38	0.379	0.14	2.10
25–100 km											0.45	0.31	0.254	0.12	1.77
100–500 km											0.42	0.29	0.209	0.11	1.63
More than 500 km											0.59	0.29	0.462	0.10	1.63
Emotional closeness between siblings						0.56	0.06	<0.001	0.46	0.69	0.55	0.07	<0.001	0.43	0.71
Contact frequencies between siblings						1.92	0.19	<0.001	1.58	2.34	1.47	0.17	0.001	1.17	1.86
Did parents treat all siblings equally															
Both treated equally (ref)											1.00				
Mother treated equally, father not											2.45	1.16	0.058	0.97	6.22
Father treated equally, mother not											1.50	0.62	0.329	0.66	3.39
Both treated unequally											3.06	1.10	0.002	1.51	6.20
n (number of observations)			2,801					2,790					2,540		
n (number of respondents)			1,555					1,553					1.411		

Model 1, univariate association, adjusted for age.
Model 2, adjusted for age, contacts, and emotional closeness.
Model 3, multivariate association, maximally adjusted.

fixed-effect regressions that included 240 respondents ($n = 675$ sibling observations) who had variance in the outcome variable. ORs for the within-respondent analysis (full siblings (ref): OR = 1.00; maternal half-siblings: OR = 0.18, $p < 0.001$; paternal half-siblings: OR = 0.09, $p < 0.001$) were similar to those for the total analysis.

As **Table 2** also shows, the odds of sibling conflict decrease with higher emotional closeness but increase with higher contact



Note: Bars indicate odds ratios from the full regression model controlling for several family and socioeconomic variables; error bars are 95% confidence intervals.

FIGURE 1 | Younger generation: associations of sibling relationships with sibling conflicts (maximally adjusted).

frequency. In the third and fully adjusted model, the age of respondents has a marginally significant effect increasing the odds of reporting conflicts. Having more siblings and a larger age difference was associated with decreased odds of conflicts. Female–female constellations were more likely to report conflicts than were female–male constellations. As expected, respondents who thought that both of their parents had not treated all siblings equally had greater odds to have conflicts compared to respondents who thought parents had treated all siblings equally.

Conflicts in the Older Generation

Next, we conducted the same analyses for the parents of the younger generation. Respondents from the older generation have greater odds of having conflicts with their full than with their half-siblings (**Table 3**). However, this difference was statistically significant only in the case of paternal half-siblings. The odds for having conflicts with paternal half-siblings are similar in minimally and maximally adjusted regression models, and they are also similar to those for paternal half-siblings among the younger generation (see **Table 2**). In the third model, which includes all studied variables in the same regression, the difference in the likelihood to have conflicts between full and maternal half-siblings has almost disappeared (see **Figure 2**). In the maximally adjusted model the difference between maternal and paternal half-siblings is statistically significant (maternal half-siblings (ref): OR = 1.00; paternal half-siblings: OR = 0.05, $p = 0.001$; $n = 4{,}263$).

The corresponding within-respondent analysis included 439 respondents ($n = 1{,}402$ sibling observations) with all types of siblings. The trend was the same for within-family analysis (full siblings (ref): OR = 1.00; maternal half-siblings: OR = 0.52, $p = 0.087$; paternal half-siblings: OR = 0.12, $p = 0.010$) as in the main analysis.

As for the younger generation, higher emotional closeness among the older generation was associated with decreased odds of having conflicts and higher contact frequency with increased odds. However, in the case of contact frequencies, the difference was no longer statistically significant after all other variables were controlled for in the third model. Sister–sister pairs had greater probability for conflicts than did other sibling constellations. Having more siblings and having a larger age difference were both associated with decreased conflict proneness. Perceived unequal treatment of parents was related to higher odds of reporting conflicts compared to those who reported equal treatment. Unequal treatment from the father or from both parents gave the strongest associations with reported conflicts. Longer geographical distance between siblings was associated with decreased probability of conflicts. Finally, comfortably off or wealthy respondents, were both less likely to report conflicts than those with low income.

A Comparison between Generations

Finally, we combined both data sets and compared the probability of conflicts between the two studied family generations, in order to test our second hypothesis. Using the older generation as the reference category, the younger generation had significantly greater odds of reporting sibling conflicts. The results were similar in minimally (OR = 1.98, SE = 0.13, $p < 0.001$, $n = 8{,}008$) and maximally (OR = 1.85, SE = 0.38, $p = 0.003$, $n = 6{,}801$) adjusted models.

DISCUSSION

Sibling relations are usually life-long, important and complex, yet relatively few studies have investigated the conflictual side of sibling relations in adulthood using large data. We studied how the likelihood of sibling conflict is associated with genetic relatedness in two adult family generations from contemporary Finland. Based on inclusive fitness theory and parent–offspring conflict theory as applied to human societies with serial monogamy, our hypotheses were that full siblings would be more likely to report any conflict compared to half-siblings, and that among half-siblings, the maternal siblings would report more conflict compared to paternal siblings. We also hypothesized that the younger generation would be more likely to report having any conflicts with a sibling compared to the older generation. The hypotheses were largely confirmed. In the case of the younger generation, who were mostly in their 20s–40s at the time of the study, full siblings had more conflicts than half-siblings and maternal half-siblings more than paternal ones. In the case of the older generation, whose respondents were 62–67 years old, conflicts were more likely to be reported with full siblings compared to paternal half-siblings, while the difference between full siblings and maternal half-siblings was not statistically significant. Maternal half-siblings were more likely to have conflicts than paternal half-siblings. Notably, all these results held also after controlling for emotional closeness, contact frequencies, unequal parental treatment, and other demographic and socioeconomic family variables as well as for within-family effects.

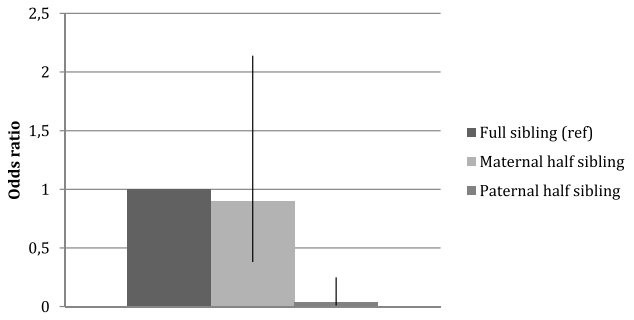
As expected, the older adult generation reported lower likelihood of having any conflict with a sibling. The two generations studied here differed from each other also in other respects, partly due to them representing different historical experiences, with the older "baby boomer" generation being born immediately after World War II. The older generation had fewer half-siblings overall, and especially less paternal half-siblings, and probalby more often had acquired any half-siblings due to remarriage following widowhood.

TABLE 3 | Older generation: associations of sibling characteristics with sibling conflicts (odds ratios).

	Model 1					Model 2					Model 3				
				95% CI					95% CI					95% CI	
	OR	SE	*p*	Lower	Upper	OR	SE	*p*	Lower	Upper	OR	SE	*p*	Lower	Upper
Sibling relationship															
Full sibling (ref)	1.00					1.00					1.00				
Maternal half-sibling	0.69	0.21	0.230	0.37	1.27	0.53	0.18	0.065	0.27	1.04	0.90	0.40	0.817	0.38	2.14
Paternal half-sibling	0.06	0.04	<0.001	0.02	0.21	0.04	0.03	<0.001	0.01	0.15	0.04	0.04	<0.001	0.01	0.25
Respondent's birth year	1.10	0.07	0.126	0.97	1.24	1.13	0.07	0.73	0.99	1.28	1.14	0.09	0.104	0.97	1.33
Respondent's education															
Primary or lower secondary level (ref)											1.00				
Upper secondary level											1.63	0.49	0.103	0.91	2.93
Lower degree level tertiary education											2.62	1.45	0.082	0.88	7.75
Higher degree level tertiary education or doctorate education											1.84	0.91	0.218	0.70	4.84
Respondent's perceived financial condition															
Low income (ref)											1.00				
Middle income											0.72	0.21	0.254	0.41	1.27
Comfortably off or wealthy											0.28	0.11	0.001	0.13	0.61
Respondent's number of siblings											0.84	0.05	0.001	0.75	0.93
Respondent's birth order															
First born (ref)											1.00				
Later born											0.92	0.29	0.779	0.49	1.69
Sex of respondent and sibling															
Female and female (ref)											1.00				
Female and male											0.40	0.07	<0.001	0.28	0.57
Male and male											0.54	0.13	0.012	0.33	0.87
Sibling's birth year											0.998	0.02	0.898	0.97	1.02
Age difference between respondent and sibling											0.94	0.02	<0.001	0.91	0.97
Geographical distance between respondent and sibling															
Less than 1 km (ref)											1.00				
1–5 km											0.76	0.38	0.577	0.29	2.01
5–25 km											0.47	0.23	0.122	0.18	1.22
25–100 km											0.28	0.14	0.009	0.11	0.73
100–500 km											0.26	0.13	0.006	0.10	0.60
More than 500 km											0.21	0.11	0.003	0.08	0.58
Emotional closeness between siblings						0.26	0.03	<0.001	0.21	0.32	0.24	0.03	<0.001	0.19	0.31
Contact frequencies between siblings						1.46	0.12	<0.001	1.24	1.71	1.08	0.11	0.449	0.89	1.31
Did parents treat all siblings equally															
Both treated equally (ref)											1.00				
Mother treated equally, father not											14.35	7.02	<0.001	5.50	37.46
Father treated equally, mother not											2.58	1.37	0.073	0.91	7.28
Both treated unequally											4.25	2.07	0.003	1.64	11.03
n (number of observations)			5,102					4,992					4,263		
n (number of respondents)			1,977					1,962					1,697		

Model 1, univariate association, adjusted for age.
Model 2, adjusted for age, contacts, and emotional closeness.
Model 3, multivariate association, maximally adjusted.

Our results are in line with a series of studies, which suggest that although full siblings are often very close and supportive, they are also more conflict-prone than half-siblings. For instance, a previous study of young children measured sibling negativity (conflict and aggression) within a sample of 192 families and found it to be higher among full siblings compared to half-siblings (Deater-Deckard et al., 2002). Research by Salmon and Hehman (2015) investigated sibling conflicts with a sample



Note: Bars indicate odds ratios from the full regression model controlling for several family and socioeconomic variables; error bars are 95% confidence intervals.

FIGURE 2 | Older generation: associations of sibling relationships with sibling conflicts (maximally adjusted).

of 345 US college students and Tanskanen et al. (2016) studied over 7,500 young adolescents from the UK, both studies finding more conflicts among full siblings compared to half-siblings.

This body of evidence, expanded to young adulthood and older adulthood by the present study, suggests that siblings do not confirm to general predictions about family ties and genetic relatedness (Trivers, 1974; Schlomer et al., 2010). Higher relatedness does correlate with a higher quality of the sibling relationship (as measured by, e.g., emotional closeness and frequency of contacts). It can also correlate with lower levels of parent–offspring competition for a particular shared parent, as studied among birds (e.g., Briskie et al., 1994) and humans (Schlomer et al., 2010). However, full siblings appear to compete more overall. We suggest that this may be explained by the diluted sibling competition hypothesis. This hypothesis takes into account the often overlooked fact that full siblings compete over the same two parents, and their kin networks. Half-siblings have only one shared parent and, thus, the option to receive investment from their other biological parent, diluting the focus of parent–offspring competition among them. When both parents continue parental investment after divorce, as is usually the case in serially monogamous contemporary Western societies, one may, thus, predict lower levels of competition and conflicts between half siblings than full siblings (Tanskanen et al., 2016). One would still predict, however, fewer conflicts between monozygotic and dizygotic twins, as found in Smith (2007), since among these full siblings only the degree of relatedness varies but not the parental network. The diluted competition hypotheses may explain the lack of difference between maternal half and full siblings found in the older generation in the present study, although we could not test this with available data. If a mother remarried and had more children after the death of her first spouse during the war, her children did not have access to the same diluted kinship network as children of divorced parents do. Theoretical criticism of Trivers (1974) original article on parent–offspring and sibling competition has similarly stressed that sibling competition depends on the ensuing family constellations and need not always be sharper among half than full siblings (Lessells and Parker, 1999), although this line of thought has not been applied to humans.

Resources, measured here as economic situation and level of education, often diminished the likelihood of sibling conflict. Older generation respondents who were comfortably off had a significantly decreased likelihood to have conflicts with siblings compared to low-income respondents, in line with previous research showing higher family tensions in lower income groups (Pollet and Hoben, 2011). The likelihood of conflict decreased with increasing geographical distance among the older generation. Other studies have shown that siblings prefer to live close to each other, especially if they follow convergent life course patterns (Blaauboer et al., 2013; Kolk, 2014).

Emotional closeness toward a particular sibling was related to decreased likelihood of conflicts. Having more siblings and having large age differences decreased the likelihood of reporting conflicts in adulthood. This was expected regarding age differences, but somewhat of a surprise concerning the number of siblings, since having more children should intensify competition for parental resources. Some earlier studies also found fewer conflicts (Stewart et al., 2001) and happier memories (if not better relationships as adults) (Riggio 2006) in larger sibships, suggesting that having more options with whom to interact may reduce conflicts. We further found that brother–sister pairs were also significantly less likely to report conflicts than were sister–sister pairs in both generations. For the older generation, brothers were also less likely to have conflicts than sisters were. This gender effect contradicts our assumption and former results (Brody et al., 1985; Campione-Barr and Smetana, 2010) showing that boys and opposite-sex siblings have more conflicts in childhood and in adolescence, while sisters are often represented as the most harmonious type of siblings. We conducted a separate analysis to explore if the higher conflict proneness among sisters was due to their higher contact frequency, but found no interaction between these variables in either family generation; therefore, this finding awaits replication and explanation.

Among the advantages of the study is that our data are large and nationally representative, and that we controlled for within person-effects as well as many confounding sociological variables. We expanded the topic of sibling conflicts to include younger and older adults, finding partly similar if weaker effects with age. A limitation of our data is that we did not have exact information on co-residence of siblings during childhood. However, because we know that in Finland children typically stay with their mothers if parents separate, we can assume that most maternal half-siblings have grown up together.

Another limitation is that the data are cross-sectional and we could use only a general assessment of conflict occurrence, which did not distinguish between types of conflicts or the time when they occurred.

The results could be different if one measured severe conflicts, such as direct aggression and fall outs. A study of UK children found that half-siblings were more likely to be injured in the household compared to full siblings, which can be interpreted as an expression of more extreme sibling competition among half-siblings (Tanskanen et al., 2015). It is also important to remember that not all conflicts will reflect sibling competition over parental resources. However, the strong effect of unequal parental

treatment on the likelihood of reporting any sibling conflict does indicate that conflicts are related to parental resources and attention (cf. Brody et al., 1992a,b).

In sum, we found evidence for higher conflicts proneness between full siblings and maternal and, especially, paternal half-siblings, suggesting that sibling ties do not always confirm to general predictions about family ties and genetic relatedness. Our findings may be explained by the diluted sibling competition hypothesis. This hypothesis is indirectly present in an early suggestion by Hughes (1988) (pp. 132) who proposed to study how step-paternal treatment of a child varies when the child receives investment from its biological father, thus alluding to the complex interactions of blended family networks. The diluted competition hypothesis has to our knowledge not been properly quantified or tested, for which one would need data with measurements of both sibling relations and the non-residing parent's investments. Future studies could also expand the diluted sibling competition hypothesis to include all the possible forms of kin investment in a child – by grandparents, aunts, uncles, and so on – that become larger in blended compared to nuclear families.

AUTHOR CONTRIBUTIONS

AT, MD, and AR designed the study and acquired data; AT and MJ conducted the statistical analyses; all authors interpreted the results; and AR and AT wrote the article.

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