



The sibling uncertainty hypothesis: Facial resemblance as a sibling recognition cue

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ABSTRACT

For the same reason that fathers could not have been certain their mates' offspring were their genetic progeny during human evolutionary history, full siblings could not have been certain that they shared paternal genes. Previous kin recognition research suggests facial resemblance is a cue men use to help solve the adaptive problem of paternity uncertainty and identify their biological offspring. Facial resemblance may also be a cue individuals use to identify siblings who share paternal genes. In the current study, facial resemblance between siblings was hypothesized to be positively associated with their emotional closeness and altruism, and inversely related with their frequency of conflict. Within families, individuals reported greater closeness and altruism toward siblings who more closely resembled them. In contrast with previous offspring recognition research, the effects of resemblance were not sex-differentiated, suggesting that facial resemblance is a cue both sexes use in sibling recognition.

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1. Introduction

Siblings, whose relationship can endure longer than any other human tie (Mancini & Maxwell, 1990), play an integral role in each other's social, cognitive, and psychosocial development (Brody, 1998). Some siblings sacrifice their own interests to come to one another's aid, but sibling relationships can also be characterized by strife, conflict, and aggression. In spite of wide variation in sibling relationship quality, little research has explored the factors governing this variation. An evolutionary psychological perspective may help us understand individual differences in sibling relationship quality.

Altruistic behavior toward kin can evolve when the benefit to the recipient, multiplied by the recipient's genetic relatedness to the actor, exceeds the costs to the actor (Hamilton, 1964). The ability to recognize and discriminate among kin of differing degrees of relatedness enables individuals to adaptively modify their sexual (DeBruine, 2004a; Fessler & Navarrete, 2004; Lieberman, Tooby, & Cosmides, 2003, 2007), parental (Alvergne, Faurie, & Raymond, 2009, 2010; Burch & Gallup, 2000; Platek, Burch, Panyavin, Wasserman, & Gallup, 2002), and social behaviors (DeBruine, 2002, 2004b).

Recent research suggests that kin recognition influences sibling relationship quality. Lieberman and colleagues (2003, 2007) identified two cues that predict altruistic behavior between siblings: maternal perinatal association (MPA) – the observation of a neonate nursing from one's own mother, and coresidence – the

duration of sibling cohabitation. For siblings, maternal association cues such as MPA and coresidence would have represented reliable indicators of shared maternal ancestry because ancestral women were certain of the maternity of their offspring. The adaptive problem of identifying full siblings, however, would have required recognizing siblings who shared the same mother and biological father.

Recognizing siblings of common paternal ancestry would have required recognition cues other than MPA and coresidence because MPA and coresidence would not have reliably indicated sharing paternal genes. Anthropological data from traditional societies indicate that women commonly have children with multiple men through extramarital affairs or serial marriages (Hill & Hurtado, 1996). As a consequence, successive children of the same woman may have been just as likely to be maternal half siblings as full siblings in ancestral conditions (Daly, Salmon, & Wilson, 1997). Distinguishing between full and maternal half siblings would thus have been a recurrent selection pressure during human evolution. Full siblings are twice as likely as half siblings to share specific genes, a difference in genetic relatedness equal to the total relatedness between grandparents and grandchildren (Michalski & Shackelford, 2005). Individuals able to discriminate between their full and half siblings, compared to individuals unable to make this distinction, could have preferentially directed altruistic acts toward individuals who were twice as likely to share specific genes with them, giving them a selective advantage in the propagation of their own genes into future generations (Hamilton, 1964). Due to paternity uncertainty and cuckoldry, however, paternal association cues between one's putative father and one's putative sibling would have been fallible indicators of shared paternal ancestry.

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Other cues to relatedness should thus be involved in the recognition of siblings of common paternal ancestry.

1.1. Facial resemblance

Previous kin recognition research suggests men use facial resemblance as a cue to offspring recognition but women do not, reflecting that men, but not women, faced the problem of paternity uncertainty (Alvergne et al., 2010; Platek et al., 2002, 2003, but see DeBruine, 2004b and Bressan, Bertamini, Nalli, & Zanutto, 2009). Nonetheless, some men would have been cuckolded and unwittingly invested in children that were not their own offspring (Cerdeira-Flores, Barton, Marty-Gonzalez, Rivas, & Chakraborty, 1999). The adaptive problem of paternity uncertainty would thus have cascaded down into the next generation, resulting in “sibling uncertainty” – the adaptive problem of not knowing which allegedly “full” siblings share paternal genes with oneself. If facial resemblance helps solve the adaptive problem of paternity uncertainty, it may also help solve the related problem of sibling uncertainty.

Previous research provides evidence that humans use facial resemblance as a kin recognition cue. Supporting the hypothesis that resemblance matters more to men due to paternity uncertainty, men’s investment in their offspring varies as a function of their resemblance to them (Apicella & Marlowe, 2004), and individuals’ self-reported solicitude toward children positively correlates with the children’s resemblance to them, an effect stronger among men than women (Platek et al., 2002, 2003). Parent–child facial resemblance also predicts fathers’, but not mothers’, emotional closeness to their children (Alvergne et al., 2010). Functional magnetic resonance imaging (fMRI) data provide convergent evidence for a sex difference in resemblance effects; men show greater cortical activity than women in response to self-resembling children’s faces (Platek, Keenan, & Mohamed, 2005; Platek et al., 2004). However, multiple studies have not found greater resemblance effects among men than women. DeBruine (2002, 2004b, 2005) found that resemblance influenced men and women equally, and Bressan and colleagues (2009) found that resemblance influenced women’s, but not men’s, hypothetical investment in children.

The different contexts in which previous studies investigated resemblance effects may account for this apparent inconsistency. Platek and colleagues (2002, 2003) examined prosocial behavior toward children. Because of paternity uncertainty, facial resemblance would be expected to have a greater effect on men’s than women’s parental investment. DeBruine (2002, 2004a, 2005), on the other hand, assessed prosocial behavior toward peer-aged individuals. The adaptive problem of uncertainty of relatedness to non-descendant kin is identical for men and women – men and women may both use facial resemblance as a sibling recognition cue (Bressan et al., 2009; DeBruine, Jones, Little, & Perrett, 2008). Previous studies also used artificially generated face morphs, making it impossible to know whether descendant or collateral kin recognition mechanisms were activated, and leaving the effect of resemblance on actual kin relationships, including those between siblings, unknown.

1.2. The current study

The current study examined the relationship between siblings’ facial resemblance and their emotional closeness, altruism, and conflict. College undergraduates who reported having one or more full biological siblings were recruited to participate in the study. Participants electronically submitted photographs of their siblings and had their photograph taken by researchers prior to completing a questionnaire assessing their closeness, altruism, and conflict

with their siblings. Both self-reported and independent ratings of resemblance were obtained to avoid the potential confound that participants could report looking similar to some siblings *because* they were emotionally closer to them (Volk, Darrell-Cheng, & Marini, 2010).

I predicted participants would report greater closeness and altruism and lower levels of conflict with siblings of greater resemblance to them. In contrast with offspring recognition, I predicted resemblance effects would not be greater for men because men and women alike faced the adaptive problem of sibling uncertainty.

2. Method

2.1. Participants

Participants were 85 undergraduates (20 men, 65 women; mean age 19.0 ± 1.8 yr) enrolled in an introductory psychology course at The University of Texas. To be eligible, participants were required to have at least one putative full biological sibling. Participants reported having from 1 to 3 full siblings (mean 1.29 ± 0.63). These siblings (112 total; 46 men, 66 women) ranged in age from 1 to 29 (mean age 19.1 ± 5.0 yr). A separate sample of 56 undergraduates enrolled in an introductory psychology course at the same university provided independent ratings of facial resemblance between participants and their siblings. All participants provided informed consent and received course credit for their participation.

2.2. Materials

2.2.1. Sibling relationship questionnaire

Participants completed a researcher-generated questionnaire assessing emotional closeness, altruism, and conflict between siblings. Closeness was assessed with nine items. Three items, such as “How emotionally close are you to this sibling?” assessed participants’ subjective closeness to their siblings, a proximate indicator of kinship highly correlated with genetic relatedness (Neyer & Lang, 2003). Six items, such as “told [this sibling] a secret”, assessed participants’ frequency of engaging in acts of emotional support and trust; close kin engage in greater encouragement and entrustment with personal concerns than less closely related kin or non-kin (Neyer & Lang, 2003). Altruism was assessed with 13 items. Six items assessed participants’ hypothetical altruism toward their siblings in times of illness or crisis, situations in which individuals preferentially treat kin (Stewart-Williams, 2007). Sample items included questions asking participants their likelihood of letting their sibling live with them if the sibling “lost his/her job” or “became homeless”. Seven questions assessed actual financial and behavioral altruism, which sibling recognition cues predict (Lieberman et al., 2003, 2007). Using the root question “How many times in the past 6 months have you done the following with your sibling?”, sample items included “Bought this sibling a gift” and “Canceled plans to help this sibling”. Conflict was assessed with four items. Participants were asked how many times in the past 6 months they had “insulted”, “yelled at”, “gotten angry”, and “tried to physically hurt” their sibling. In keeping with previous sibling recognition research, the questionnaire recorded participants’ and siblings’ ages, the duration of their coresidence, and their age range during this coresidence. From these items, coresidence and MPA were computed (see Lieberman et al., 2003, 2007 for details). One item assessed participants’ resemblance to their siblings: “How similar do you and your sibling look?” Participants responded to this question on an 11-point scale ranging from 0 (we look nothing alike) to 100 (we look like identical twins) in increments of 10.

2.2.2. Facial resemblance

Arrays of participants' and their siblings' photographs were created using Microsoft Word and printed on high quality color photographic paper. Photographs were standardized by cropping the images so that the top of the depicted individual's head was at the superior border, the base of the individual's neck was at the inferior border, and the edges of the individual's ears were at the lateral borders. Participant photographs were printed on the top half of each sheet, with sibling photographs printed on the bottom half. In the middle of each page was the question, "Ignoring any age or sex differences, how similar do these two people look?" Responses were recorded on an 11-point scale ranging from 0 (they look nothing alike) to 100 (they look like identical twins) in increments of 10.

2.3. Procedure

A prescreening survey was used to identify potential participants with putative full siblings. Potential participants were contacted by the researcher and invited to participate. Before arranging a laboratory testing session, each participant submitted two high-resolution photographs of each of their siblings. Photographs were reviewed for clarity and unobstructed views of the siblings' faces. If necessary, participants submitted additional photographs before their session.

Researchers took two photographs of each participant in the laboratory. The photographs were taken from the neck up while participants stood at a fixed distance (4 ft/1.2 m) from the camera in front of a neutral-colored background. Researchers photographed each participant while smiling and while maintaining a neutral expression in anticipation of sibling photographs exhibiting these same expressions (all sibling photographs exhibited one of these expressions). Participants then completed the sibling relationship questionnaire. Finally, researchers verified that participants were unaware of the purpose of the study and debriefed them.

Researchers provided the separate sample of raters with the facial resemblance arrays and an answer sheet on which to record their ratings of sibling resemblance.

3. Results

3.1. Statistical analysis

To prevent extreme scores on single items and between-item differences in variance from skewing scores for the closeness, altruism, and conflict scales, composite scores were generated by standardizing each scale's respective items and computing the mean of these values. All three scales showed good reliability (all α s > .81). High inter-rater reliability was confirmed for the third party raters of resemblance (ICC > .90).

Testing study hypotheses required hierarchical linear modeling (HLM), as the number of siblings varied between participants. Using the statistical software package R (v. 2.6.2), the relationship between facial resemblance and closeness, altruism, and conflict was tested using mixed effect models, with sibling pairs nested within families.

Given that independent ratings are inherently objective, but individuals' interactions with their siblings in real-life may enable them to detect cues to resemblance that cannot be assessed in static, two-dimensional stimuli, composite facial resemblance scores were generated by standardizing the self-reported and independent ratings of resemblance and computing their mean. Independent ratings of resemblance predicted participants' self-reported ratings of resemblance [HLM: $t(26) = 2.09, p < .05$], confirming that

in the current study self-reported resemblance tapped actual resemblance. Nonetheless, given that closeness may increase subjective perceptions of resemblance (Volk et al., 2010), I also conducted separate analyses for self-reported and independent ratings of resemblance. Results presented correspond to the composite resemblance measure, with results for self- and third-party ratings in brackets.

To test for an effect of facial resemblance on sibling closeness, altruism, and conflict independent of known sibling recognition cues, statistical models included MPA, coresidence, and their interaction, which predict sibling-directed altruism (Lieberman et al., 2003, 2007). To explore the possibility of interactive effects between facial resemblance and other sibling recognition cues, I began with full factorial models predicting closeness, altruism, and conflict. Because all study hypotheses were directional, one-tailed probability estimates are reported.

3.2. Emotional closeness

Facial resemblance between siblings predicted their closeness, HLM: $t(26) = 2.79, p < .01$ [self-ratings: $t(26) = 2.43, p = .01$, independent ratings: $t(26) = 1.86, p = .04$]. Within families, siblings of greater resemblance scored higher in closeness (Fig. 1). Facial resemblance did not interact with MPA or coresidence to predict closeness. When MPA, coresidence, and their interaction were

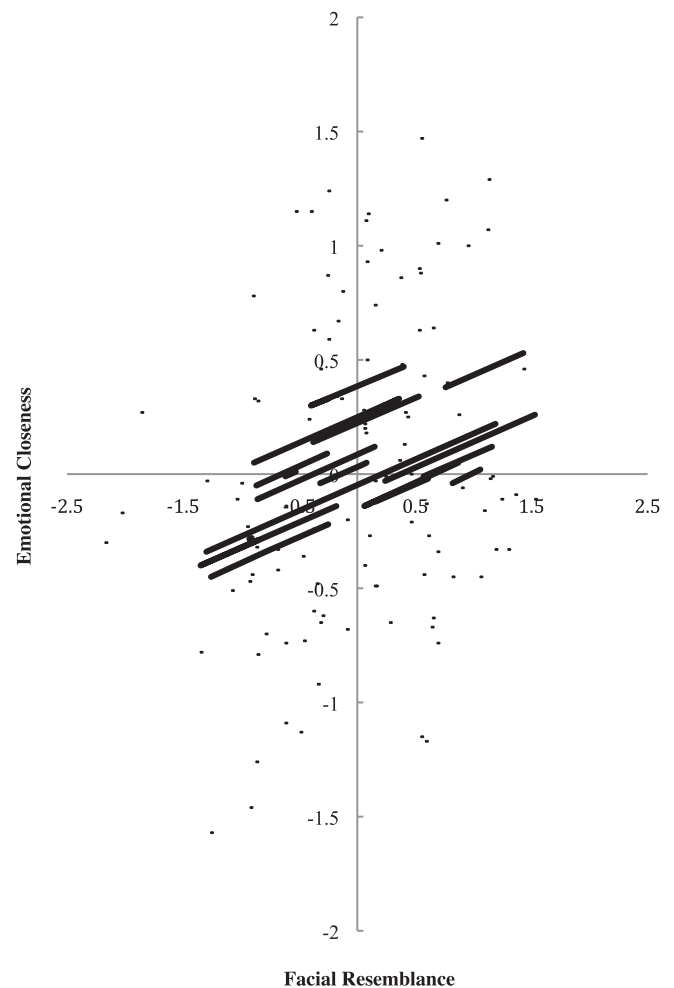


Fig. 1. Emotional Closeness vs. Facial Resemblance. Dots represent observed data points. Positively sloped lines depict predicted closeness between siblings as a function of facial resemblance; within families, sibling closeness increased as a function of facial resemblance.

incorporated in the model, facial resemblance [$t(23) = 2.68$, $p < .01$], coresidence [$t(23) = 2.44$, $p = .01$], and MPA [$t(23) = 1.69$, $p = .05$] predicted closeness, but the interaction between MPA and coresidence was not statistically significant [$t(23) = -1.28$, $p = .11$].

3.3. Altruism

Facial resemblance also predicted sibling-directed altruism, $t(26) = 2.24$, $p = .02$ [self-ratings: $t(26) = 2.12$, $p = .02$, independent ratings: $t(26) = 1.44$, $p = .08$]. Within families, siblings of greater resemblance reported higher levels of altruism (Fig. 2). Facial resemblance did not interact with MPA or coresidence to predict altruism. In the model incorporating all three sibling recognition cues and the interaction between MPA and coresidence, only facial resemblance predicted altruism, $t(23) = 2.22$, $p = .02$. The effects of coresidence [$t(23) = .57$, $p = .28$], MPA [$t(23) = 1.21$, $p = .12$], and their interaction [$t(23) = -1.02$, $p = .16$] were all in the expected direction, but were not significant.

3.4. Conflict

Facial resemblance did not independently predict conflict, $t(26) = -.49$, $p = .31$ [self-ratings: $t(26) = -.88$, $p = .19$, independent ratings: $t(26) = .06$, $p = .48$]. However, facial resemblance interacted with coresidence to predict conflict, $t(26) = -2.16$, $p = .02$. Among siblings of lower resemblance, longer durations of coresidence predicted greater conflict, but among siblings of higher resemblance, longer durations of coresidence were associated with

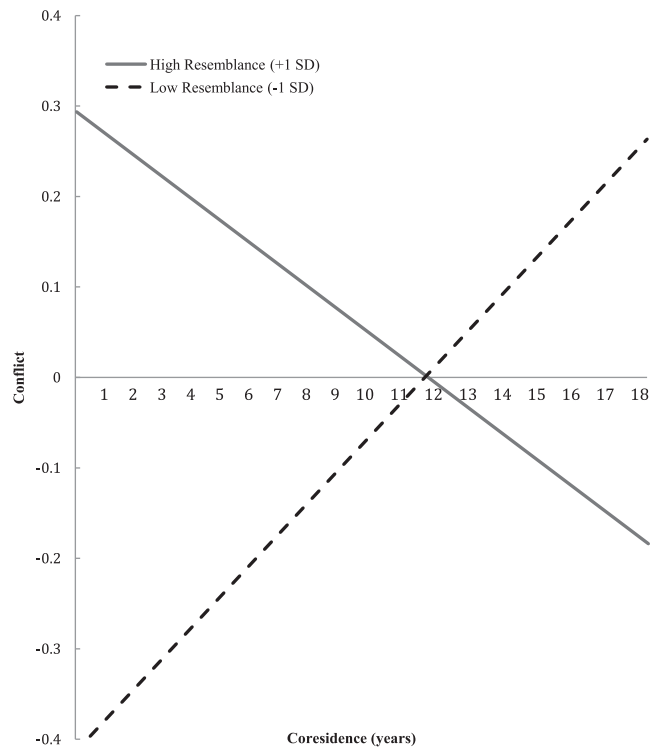


Fig. 3. Conflict vs. Facial Resemblance and Coresidence. Lines represent predicted conflict levels among siblings of greater resemblance (+1 SD) and lesser resemblance (-1 SD) as a function of coresidence. Within families, increased coresidence duration predicted decreased conflict among siblings of greater resemblance, but increased conflict among siblings of lesser resemblance.

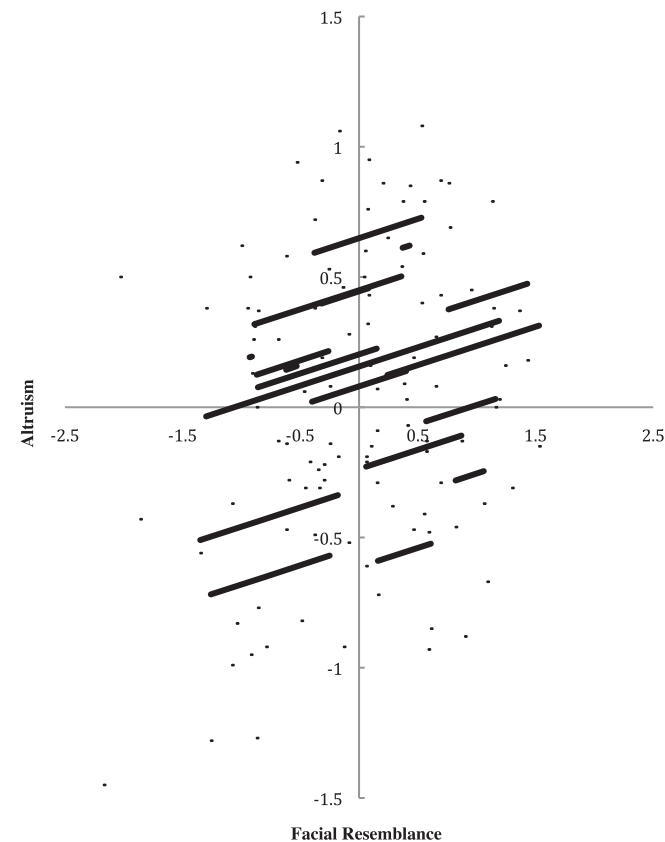


Fig. 2. Altruism vs. Facial Resemblance. Dots represent observed data points. Positively sloped lines depict predicted altruism between siblings as a function of facial resemblance; within families, sibling-directed altruism increased as a function of facial resemblance.

lower levels of conflict (Fig. 3). The interaction between MPA and coresidence also predicted conflict, $t(23) = -2.29$, $p = .02$. Longer durations of coresidence predicted lower levels of conflict when MPA was present, but predicted increased conflict when MPA was absent.

3.5. Sex-differentiated effects of resemblance

In contrast to findings from offspring recognition research, there were no sex differences in the effects of facial resemblance on closeness [HLM: $t(25) = -.43$, $p = .34$] or altruism [HLM: $t(25) = .23$, $p = .42$].

4. Discussion

Within families, siblings of greater resemblance reported greater emotional closeness and altruism than siblings of lesser resemblance. Individuals were more likely to view their siblings of greater resemblance as valuable social partners, share private information with them, and experience greater feelings of closeness, a proximate motivator of helping behaviors predicted by actual genetic relatedness (Korchmaros & Kenny, 2001). Individuals more frequently sacrificed their own time and interests and incurred direct financial costs to provide benefits to siblings of greater resemblance, and reported being more willing to make major life sacrifices to come to the aid of a sibling when that sibling more closely resembled them. These findings indicate that facial resemblance represents an important, previously unexplored factor governing individual differences in sibling relationship quality.

Greater resemblance did not independently predict lower levels of conflict, but the interaction between resemblance and

coresidence may reveal a design feature of sibling recognition. Among siblings of greater resemblance, longer durations of coresidence predicted lower levels of conflict, but among siblings of lesser resemblance, increased durations of coresidence predicted higher levels of conflict. Whereas coresidence may be interpreted as an additional cue to genetic relatedness for siblings of greater resemblance, coresidence with a sibling of low resemblance may be taken as an indicator of cohabitation with a competitor for limited parental resources.

These effects of resemblance were not sex differentiated, which may inform previous research findings. Whereas Platek and colleagues (2002, 2003) found that resemblance had a greater effect on men's decisions to invest in children, DeBruine (2002, 2004b, 2005) found that resemblance affected men and women equally. DeBruine (2004b) concludes that her research calls into question the finding that resemblance affects men more than women in "the domain of investment decisions about children." From an evolutionary perspective, children do not represent a unified kin domain. Rather, offspring and siblings represent different types of kin that may be associated with distinct recognition cues for men and women. There are compelling theoretical reasons to expect a greater effect of resemblance on men's than women's parental investment decisions. However, the benefits of using facial resemblance to help solve relatedness uncertainty for collateral relatives are identical in men and women. Consistent with these theoretically expected differences between offspring and sibling recognition, Platek and colleagues have found sex differences in brain activation to self-resembling young child faces (Platek et al., 2004), but not self-resembling adult, including sibling, faces (Platek & Kemp, 2009). The current study indirectly reconciles these findings by demonstrating that, unlike in offspring recognition, resemblance effects are not sex differentiated in sibling recognition.

The finding that established sibling recognition cues did not have as strong effects in the current study as observed in previous research may also shed light on sibling recognition. MPA and coresidence predicted closeness between siblings, and MPA and coresidence interacted to predict sibling conflict, but they did not predict altruism. The absence of a relationship between these sibling recognition cues and altruism ostensibly contrasts with previous studies (i.e. Lieberman et al., 2003, 2007). However, an understanding of the analytical approaches employed by this and previous studies clarifies why this may not actually be an inconsistency. Because previous studies (e.g. Lieberman et al., 2003, 2007) either treated data from sibling pairs from the same family (i.e. non-independent data) as independent or sampled only one sibling pair per family, their analyses were inherently tests of between-family effects. In the current study, the non-independence of data points from the same family was accounted for by incorporating random intercepts, which control for between-family differences. In short, previous studies have found strong between-family effects of MPA and coresidence, whereas the current study found that the effects of these variables may not be as strong within families.

Sex differences in parental investment may account for why MPA and coresidence have strong between-family effects and facial resemblance has within-family effects. Children tend to remain with their mother throughout childhood, irrespective of paternal ancestry (Hill & Hurtado, 1996). MPA and coresidence may thus reflect stability of maternal investment, which may vary more between than within families. If facial resemblance is a cue to sharing paternal genes, however, it would be expected to have within-family effects because different paternal lineages may be represented within a single home. The current study's findings suggest that the distinctions between cues to paternal and maternal kinship as well as within-family and between-family effects

may be important constructs to consider in kin recognition research.

4.1. Potential confounds and limitations

Several potential confounds were controlled for but did not change study findings. Previous research found that sex and age differences did not influence judgments of resemblance of child sibling faces (Maloney & Dal Martello, 2006), perhaps because these variables are uninformative about kinship, but DeBruine and colleagues (2009) found that perceptions of resemblance among adult siblings were greater for same-sex than opposite-sex kin. Raters in the current study were explicitly instructed to ignore sex and age differences, and analysis revealed no statistical association between raters' perceptions of sibling resemblance and the siblings' sex or age differences. Furthermore, the effects of resemblance remained after controlling for participant sex, sibling sex, participant age, and sibling age. Frequency of contact was also addressed as a potential confound. Frequency of contact may be an indicator of genetic relatedness (Kurland & Gaulin, 2005), but siblings who have more frequent contact have more opportunities to engage in positive and negative behaviors toward one another. In the current study, the effects of facial resemblance remained unchanged after controlling for frequency of contact.

Findings from the present study should be interpreted within the context of methodological limitations that future research should consider. The sibling photographs in the current study were standardized to the greatest degree possible, but future studies should ideally involve photographs of siblings taken in an experimenter-controlled setting. Additionally, because of the absence of a pre-existing, psychometrically validated sibling relationship strength instrument, the sibling relationship questionnaire was developed to assess closeness, altruism, and conflict, constructs tested in previous kin relationship research (e.g., Korchmaros & Kenny, 2001; Neyer & Lang, 2003; Stewart-Williams, 2007). Reliability analyses suggested the scales had good internal consistency, but future research is needed to further establish their construct validity and reliability.

4.2. Future directions

Future research should continue to integrate two largely separate literatures on human kin recognition: that on contextual cues such as MPA and coresidence, and that on phenotypic cues such as facial resemblance. The interaction between coresidence and resemblance in predicting sibling conflict adds to recent research demonstrating interactions between contextual and phenotypic cues. DeBruine et al. (2011) found that women with opposite-sex siblings are more averse to self-resembling faces in sexual contexts; the effect of resemblance on inbreeding avoidance mechanisms depends on coresidence with opposite-sex siblings. Together with coresidence's mediation of prosocial behaviors and anti-incestuous sentiment toward siblings only when MPA is absent (Lieberman et al., 2007), these findings suggest that incorporating multiple kin recognition cues and investigating their interactive effects is a fruitful avenue for future research.

The current study makes several novel contributions to the human kin recognition literature. This study is the first to demonstrate an association between facial resemblance and emotional closeness and altruism among siblings. The current study is also the first to demonstrate an interaction between phenotypic cues to kinship and contextual cues, such as coresidence, in producing cost-inflicting behaviors – the dark side of kin recognition. These findings represent a modest but important extension to evolutionary research on paternity uncertainty, resemblance, and human kin recognition.

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References

- Alvergne, A., Faurie, C., & Raymond, M. (2009). Father-offspring resemblance predicts paternal investment in humans. *Animal Behaviour*, 78, 61–69.
- Alvergne, A., Faurie, C., & Raymond, M. (2010). Are parents' perceptions of offspring facial resemblance consistent with actual resemblance? Effects on parental investment. *Evolution and Human Behavior*, 31, 7–15.
- Apicella, C. L., & Marlowe, F. W. (2004). Perceived mate fidelity and paternal resemblance predict men's investment in children. *Evolution and Human Behavior*, 25, 371–378.
- Bressan, P., Bertamini, M., Nalli, A., & Zanutto, A. (2009). Men do not have a stronger preference than women for self-resembling child faces. *Archives of Sexual Behavior*, 38, 657–664. doi:10.1007/s10508-008-9350-0.
- Brody, G. H. (1998). Sibling relationship quality: Its causes and consequences. *Annual Review of Psychology*, 49, 1–24. doi:10.1146/annurev.psych.49.1.1.
- Burch, R. L., & Gallup, G. G. Jr., (2000). Perceptions of paternal resemblance predict family violence. *Evolution and Human Behavior*, 21, 429–435.
- Cerda-Flores, R. M., Barton, S. A., Marty-Gonzalez, L. F., Rivas, F., & Chakraborty, R. (1999). Estimation of nonpaternity in the Mexican population of Nuevo Leon: A validation study with blood group markers. *American Journal of Physical Anthropology*, 109, 281–293. doi:10.1002/(SICI)1096-8644(199907)109:3<281::AID-AJPA1>3.0.CO;2-3.
- Daly, M., Salmon, C., & Wilson, M. (1997). Kinship: The conceptual hole in psychological studies of social cognition and close relationships. In J. Simpson & D. Kenrick (Eds.), *Evolutionary social psychology* (pp. 265–296). Mahwah, NJ: Erlbaum.
- DeBruine, L. M. (2002). Facial resemblance enhances trust. *Proceedings of the Royal Society of London: B*, 269, 1307–1312. doi:10.1098/rspb.2002.2034.
- DeBruine, L. M. (2004a). Facial resemblance increases the attractiveness of same-sex faces more than other-sex faces. *Proceedings of the Royal Society of London: B*, 271, 2085–2090. doi:10.1098/rspb.2004.2824.
- DeBruine, L. M. (2004b). Resemblance to self increases the appeal of child faces to both men and women. *Evolution and Human Behavior*, 25, 142–154. doi:10.1016/j.evolhumbehav.2004.03.003.
- DeBruine, L. M. (2005). Trustworthy, but not lust-worthy: Context-specific effects of facial resemblance. *Proceedings of the Royal Society B*, 272, 919–922. doi:10.1098/rspb.2004.3003.
- DeBruine, L. M., Jones, B. C., Little, A. C., & Perrett, D. I. (2008). Social perception of facial resemblance in humans. *Archives of Sexual Behavior*, 37, 64–77. doi:10.1007/s10508-007-9266-0.
- DeBruine, L. M., Jones, B. C., Watkins, C. D., Roberts, S. C., Little, A. C., Smith, F. G., & Quist, M. (2011). Opposite-sex siblings decrease attraction, but not prosocial attributions, to self-resembling opposite-sex faces. *Proceedings of the National Academy of Sciences*, 108, 11710–11714. doi:10.1073/pnas.1105919108.
- DeBruine, L. M., Smith, F. G., Jones, B. C., Roberts, S. C., Petrie, M., & Spector, T. D. (2009). Kin recognition signals in adult faces. *Vision Research*, 49, 38–43. doi:10.1016/j.visres.2008.09.025.
- Fessler, D. M. T., & Navarrete, C. D. (2004). Third-party attitudes toward sibling incest: Evidence for Westermarck's hypotheses. *Evolution and Human Behavior*, 25, 277–294.
- Hamilton, W. D. (1964). The evolution of social behavior. *Journal of Theoretical Biology*, 7, 1–52.
- Hill, K., & Hurtado, A. M. (1996). *Ache life history: The ecology and demography of a foraging people*. Hawthorne, New York: Aldine de Gruyter.
- Korchmaros, J. D., & Kenny, D. A. (2001). Emotional closeness as a mediator of the effect of genetic relatedness on altruism. *Psychological Science*, 12, 262–265.
- Kurland, J. A., & Gaulin, S. J. C. (2005). Cooperation and competition among kin. In D. M. Buss (Ed.), *The handbook of evolutionary psychology* (pp. 447–482). Hoboken, NJ: Wiley.
- Lieberman, D., Tooby, J., & Cosmides, L. (2003). Does morality have a biological basis? An empirical test of the factors governing moral sentiments relating to incest. *Proceedings of the Royal Society of London: B*, 270, 819–826. doi:10.1098/rspb.2002.2290.
- Lieberman, D., Tooby, J., & Cosmides, L. (2007). The architecture of human kin detection. *Nature*, 445, 727–731. doi:10.1038/nature05510.
- Maloney, L. T., & Dal Martello, M. F. (2006). Kin recognition and the perceived facial similarity of children. *Journal of Vision*, 6, 1047–1056. doi:10.1167/6.10.4.
- Mancini, J. A., & Maxwell, J. W. (1990). Sibling relationships in adulthood: Contact patterns and motivations. *Journal of Marriage and Family*, 52, 431–440.
- Michalski, R. L., & Shackelford, T. K. (2005). Grandparental investment as a function of relational uncertainty and emotional closeness with parents. *Human Nature*, 16, 292–304.
- Neyer, F. J., & Lang, F. R. (2003). Blood is thicker than water: Kinship orientation across adulthood. *Journal of Personality and Social Psychology*, 3, 121–144.
- Platak, S. M., Burch, R. L., Panyavin, I. S., Wasserman, B. H., & Gallup, G. G. Jr., (2002). Reactions to children's faces: Resemblance affects males more than females. *Evolution and Human Behavior*, 23, 159–166. doi:10.1016/S1090-5138(01)00094-0.
- Platak, S. M., Critton, S. R., Burch, R. L., Frederick, D. A., Myers, T. A., & Gallup, G. G. Jr., (2003). How much paternal resemblance is enough? Sex differences in hypothetical investment decisions but not in detection of resemblance. *Evolution and Human Behavior*, 24, 81–87. doi:10.1016/S1090-5138(02)00117-4.
- Platak, S. M., Keenan, J. P., & Mohamed, F. B. (2005). Sex differences in the neural correlates of child facial resemblance: An event-related fMRI study. *NeuroImage*, 25, 1336–1344.
- Platak, S. M., & Kemp, S. M. (2009). Is family special to the brain? An event-related fMRI study of familiar, familial, and self-face recognition. *Neuropsychologia*, 47, 849–858.
- Platak, S. M., Raines, D. M., Gallup, G. G., Jr., Mohamed, F. B., Thomson, J. W., Myers, T. E., et al. (2004). Reactions to children's faces: Males are more affected by resemblance than females are, and so are their brains. *Evolution and Human Behavior*, 25, 305–394.
- Stewart-Williams, S. (2007). Altruism among kin vs nonkin: Effects of cost of help and reciprocal exchange. *Evolution and Human Behavior*, 28, 193–198.
- Volk, A. A., Darrell-Cheng, C., & Marini, Z. A. (2010). Paternal care may influence perceptions of paternal resemblance. *Evolutionary Psychology*, 8, 516–529.