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UNIVERSITY OF MIAMI

CUES TO PATERNITY: AN EVALUATION OF OFFSPRING RESEMBLANCE, PARTNER FIDELITY, AND MATERNAL PERINATAL ASSOCIATION

By

Joseph Billingsley

A THESIS

Submitted to the Faculty
of the University of Miami
in partial fulfillment of the requirements for
the degree of Master of Science

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CUES TO PATERNITY: AN EVALUATION OF OFFSPRING RESEMBLANCE, PARTNER FIDELITY, AND MATERNAL PERINATAL ASSOCIATION

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Cues to Paternity: An Evaluation of Offspring Resemblance, Partner Fidelity and Maternal Perinatal Association

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Despite the profound influence of relatedness on mating and cooperative behavior in humans, the cues men use to assess paternity and guide offspring-directed behavior have yet to be fully resolved. According to leading theories of kin detection, kinship cues should influence both sexual and altruistic motivations, because of fitness consequences associated with inbreeding and welfare tradeoff decisions, respectively. Prior work with paternity assessment, however, has generally evaluated candidate cues solely by demonstrating associations with altruism. Here I (i) replicate past work that found effects of phenotypic resemblance and perceived partner fidelity on offspring investment; (ii) evaluate whether these two cues meet the more stringent criteria suggested by theory—that is, whether they predict both altruistic motivations and inbreeding aversions; (iii) propose and test a novel candidate cue to paternity: observations of maternal-infant perinatal association (MPA); and (iv) examine whether the significant effects of empirically validated kinship cues on altruistic and sexual motivations are mediated by reported certainty of relatedness. I conduct these tests using existing datasets, one from a population-based sample of Finnish fathers ($N = 390$), the other a Mechanical Turk sample ($N = 744$).

Results provide the strongest evidence yet assembled in support of perceived partner fidelity as a cue to paternity; support for resemblance as a cue to paternity is limited by comparison. No evidence is found to support a role for MPA in paternity assessment. Findings regarding self-reported relatedness certainty as a possible mediator of the effects of paternity cues are mixed.

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Chapter 1: Introduction

Kin detection—discerning kin from non-kin and discriminating between different degrees of genetic relatives—is an adaptation that functions to avoid the deleterious consequences of inbreeding (Bittles & Neel, 1994; Tooby, 1982) and to preferentially allocate resources as predicted by inclusive fitness theory (Hamilton, 1964). Across taxa ranging from microbe (Mehdiabadi et al., 2006) to primate (Parr & de Waal, 1999), scientists have documented the multiple solutions natural selection engineered to solve the problem of detecting kin (Pfennig & Sherman, 1995). The need to solve kin detection problems successfully is particularly acute for males in species marked by paternal investment because investments directed toward genetically unrelated juveniles can reduce the level of investment available for genetically related young (Trivers, 1972). Factoring in the opportunity costs of forgone mating effort, the effects of suboptimal paternal investment on male inclusive fitness are potentially severe (Buss, 2002).

Prompted by Hamilton's theory of inclusive fitness in conjunction with accumulating evidence of inbreeding depression, researchers began investigating the mechanisms by which individuals of various species identify genetic relatives in order to adaptively regulate behavior. With respect to paternity assessment, males detect offspring and regulate parental investment by registering the various cues that reliably correlated, on average, with the genetic relatedness of putative offspring in ancestral contexts. In non-human species, such cues include olfactory chemical signatures, physical resemblance, indications of female extra-pair copulations, and timing of birth relative to first copulation (Borries, 1997; Clutton-Brock, 1991; Hrdy, 1980; Kazem & Widdig, 2013; Mallory & Brooks, 1978; Møller & Birkhead, 1993; Neff, 2003; Sheldon, Räsänen,

& Dias, 1997; Westneat & Sherman, 1993; Widdig, 2007). In humans, studies of offspring recognition in men have examined a variety of cues to paternity. These include coresidence duration, phenotypic resemblance, and partner fidelity (e.g. Alvergne, Faurie, & Raymond, 2010; Apicella & Marlowe, 2004, 2007; Gaulin & Schlegel, 1980; Prokop, Obertová, & Fedor, 2010; Williams & Finkelhor, 1995).

To date, phenotypic resemblance and assessments of partner fidelity have been two putative cues to paternity examined extensively in the human literature, and are the focus here (e.g. Alvergne, Faurie, & Raymond, 2009; Alvergne et al., 2010; Apicella & Marlowe, 2004, 2007; DeBruine, 2004b; Platek, Burch, Panyavin, Wasserman, & Gallup Jr, 2002; Platek et al., 2003; Prokop et al., 2010). Coresidence duration, conceptualized as a period of shared parental investment (Lieberman & Billingsley, 2016), has been shown to operate specifically as a cue for detecting siblings (Lieberman, Tooby, & Cosmides, 2007) and has not been a significant predictor of daughter-directed investments (e.g., Williams & Finkelhor, 1995). Below, I review literature supporting the suggestion that phenotypic resemblance and partner fidelity serve as cues to kinship. I then discuss three critical gaps in the literature, providing the impetus for the current research.

Offspring Resemblance

Phenotypic resemblance of offspring has been proposed to operate as a human kinship cue in a number of kin detection contexts (Alvergne, Faurie, & Raymond, 2007; Bressan & Zucchi, 2009; DeBruine, 2002, 2005; DeBruine, Jones, Little, & Perrett, 2008; Kaminski, Dridi, Graff, & Gentaz, 2009) and the theoretical attractiveness of the proposition is clear. To function in a psychological mechanism that evolved to detect kin, a suggested cue should correlate with genetic relatedness, and do so at a level detectable

by the kin in question. There is growing evidence that phenotypic similarity—facial resemblance, for instance—meets this standard. Resemblance correlates positively with genetic relatedness and has been shown to be detectable by third-party observers (Alvergne et al., 2007, 2009; Dal Martello, DeBruine, & Maloney, 2015; DeBruine et al., 2009; Kaminski et al., 2009; Maloney & Dal Martello, 2011; Maloney & Dal Martello, 2006). However, some studies find that the human ability to discern adult/offspring relatedness on the basis of physical similarity is only slightly better than chance (Nesse, Silverman, & Bortz, 1990), and that the perceived resemblance of kin is largely a function of pre-existing beliefs in their genetic relatedness (Bressan & Dal Martello, 2002). Nevertheless, literature within evolutionary psychology continues to show the effects of resemblance on kin-associated behaviors.

With respect to paternity, numerous studies have investigated the possibility that offspring facial resemblance and overall phenotypic resemblance serve as a kinship cue for offspring detection by males, on the basis of which men regulate paternal investment toward the offspring in question (Alvergne et al., 2009, 2010; Apicella & Marlowe, 2004; Daly & Wilson, 1982; Platek, 2003; Regalski & Gaulin, 1993; Wilson, 1992). For instance, in a sample of men from a London airport and train station, Apicella and Marlowe (2004, 2007) found that a father's perceived resemblance to his putative offspring (a measure that included resemblance in both physical appearance and personality) positively correlated with the man's reported investment level, operationalized as attention, time spent with the child, and help with homework. Dolinska (2013) replicated this finding in Poland, but ascertained that this effect does not only apply to fathers: resemblance of children to mothers predicted maternal investment

as well. Yet most studies report this effect only for men. For instance, Alvergne et al. (2009) sampled a rural, polygynous population in Senegal and reported that males invested more heavily in putative offspring who were more similar to them in facial resemblance, as well as in odor. Father/offspring resemblance likewise positively correlated with paternal investment in a Slovakian undergraduate sample (Prokop et al., 2010), a sample of visitors to a French museum (Alvergne et al., 2010), and a sample of Dutch adults (Heijkoop, Dubas, & van Aken, 2009), while in a Chinese sample it moderated the association between harsh paternal parenting and child characteristics such as emotional dysregulation (Li & Chang, 2007). Men's self-reported perceptions of resemblance to their own children further predicted their hypothetical adoption decisions, but not those of mothers (Volk & Quinsey, 2002), as well as self-reported relationship quality with their children and abusive behavior toward their spouse (Burch & Gallup, 2000). Consistent with Alvergne et al.'s (2009) results, Dubas, Heijkoop, and Van Aken (2009) found that fathers' ability to identify their own child's odor was related to greater affection and less neglect.

Indirect evidence that men may monitor offspring for cues of phenotypic similarity comes from studies suggesting that mothers may strategically emphasize the resemblance of infants to the putative father, presumably to up-regulate paternity certainty (Daly & Wilson, 1982; McLain, Setters, Moulton, & Pratt, 2000; Regalski & Gaulin, 1993). Additional evidence provides ominous hints concerning the potential fitness benefits of such maternal strategizing: Men who commit infanticide often refer to the child's lack of physical resemblance—and the concomitant lack of relatedness—as a cause of the act (Daly & Wilson, 1984). Not all evidence, however, is consistent with the

notion that physical resemblance mitigates physical abuse. For instance, in a Brazilian sample, child abuse at the hand of a father was uncorrelated with reported father-offspring resemblance (Alexandre et al., 2011). In this case, however, resemblance was reported by the mother, so it is unclear how the father's perceptions of similarity predict his inclinations to abuse. Regardless, the literature reviewed above makes clear that there is a growing body of evidence strongly linking resemblance to paternal investment, consistent with the hypothesis that resemblance is a kinship cue and plays a role in kin-directed behavior.

Partner Fidelity

A second paternity cue that has received much attention is perceived partner fidelity. Decades of research from biology support the notion that in many taxa the relatedness between parent and offspring varies between broods, and that for males this variation is a function of partner sexual fidelity (Clutton-Brock, 1991; Westneat & Sherman, 1993). Research also indicates that in some of these taxa males appear to regulate paternal investment as a function of partner fidelity, reducing it as perceived fidelity decreases (Dixon, Ross, & O'Malley, 1994; Ewen & Armstrong, 2000; Hunt & Simmons, 2002; Møller & Birkhead, 1993; Møller, 1988, 1991; Neff, 2003; Neff & Gross, 2001; Neff & Sherman, 2005; Sheldon & Ellegren, 1998; Sheldon et al., 1997).

The hypothesis that males use partner fidelity as a paternity cue assumes variation in sexual fidelity and the possibility that males can be duped into rearing another male's child. In humans, this is a real possibility. Cross-cultural investigations of human infidelity make clear that although cuckoldry rates vary extensively between societies, the rate is greater than zero (Schmitt et al., 2004), and that in hunter-gather populations

anywhere from 2%-9% of men unwittingly raise children not their own (Baker & Bellis, 1995; Neel & Weiss, 1975). A cross-cultural review of cuckoldry in 67 societies found that the median non-paternity rate among men with high confidence in their partner's fidelity was 1.7%, while among men with low confidence in partner fidelity, median non-paternity was 29.8% (Anderson, 2006) . This finding suggests not only that partner infidelity poses a real threat to male fitness, but also that men are somewhat accurate in their fidelity assessments (Anderson, 2006).

Given these data and the body of comparative research, investigators of human parenting behavior expected perceived partner fidelity to exert a significant influence on male parental investment decisions (e.g., Geary, 2000). Consistent with that expectation, in a study of 135 pre-industrial societies, Gaulin and Schlegel (1980) found that widespread, extensive male investment in their wives' children is generally found only in societies where paternity confidence is high. In societies marked by low paternity confidence, male investment is targeted elsewhere. In an analysis of inheritance patterns across 22 societies, Hartung (1981) likewise found that when spousal fidelity is low, males are more likely to transfer wealth to their siblings' offspring than to their own. Some within-culture research suggests that investment biases toward matrilineal rather than patrilineal kin may reflect low mate fidelity (Bishop, Meyer, Schmidt, & Gray, 2009; Euler & Weitzel, 1996; Gaulin, McBurney, & Brakeman-Wartell, 1997; Regalski & Gaulin, 1993), though additional results imply instead that such differences may indicate socially determined laterality preferences (Liefbroer, Kaptijn, Silverstein, & Thomése, 2013; Pashos, 2000).

Direct, within-culture studies of the predictors of paternal investment likewise implicate paternal assessments of partner fidelity, though with some caveats. Fox and Bruce (2001) found in a Tennessee community sample that low confidence in partner fidelity predicted fathers' affective involvement with their children, and an overall composite of fathering that encompassed three additional measures: responsivity, harshness, and behavioral engagement (though it did not predict these three measures individually). In a New Mexico sample, paternity confidence predicted not only the likelihood that men will divorce their spouses but also the extent to which men are engaged with their child's education and how much time men spend with the child in a group (though not one-on-one), controlling for divorce (Anderson, Kaplan, & Lancaster, 2007). Finally, across their entire sample of 170 men approached at two London transit centers, Apicella & Marlowe (2004) found that perceived partner fidelity predicted reported paternal investment, after controlling for age of parent and child, ethnicity, number of hours worked, and perceived father/child resemblance. Although the association held for fathers still in a relationship with the child's mother, the effect reduced to statistical insignificance when the study considered only men who were no longer in a relationship with the child's mother. In a subsequent analysis of the same data using a different model, Apicella & Marlowe (2007) again found that across the entire sample mate fidelity predicted paternal investment, even controlling for the father's perceived mate value. However, mate fidelity did not predict paternal investment when the sample was broken into men still in a relationship with the mate, vs. men no longer in a relationship with the mate—null results that the authors suggest may be due to the

reduced power of the sub-samples and lack of variation in fidelity scores for each sub-sample.

Convergent evidence derived from multiple methods and approaches thus implicates perceived partner fidelity as a driver of paternal investment and altruism. Such findings are consistent with claims that partner fidelity is a crucial cue by which men assess paternity and regulate offspring-directed behavior.

Outstanding issues

Although the empirical evidence linking phenotypic resemblance and perceived partner fidelity to paternal investment is robust, there are at least three issues with the broader claim that these factors serve as kinship cues in an evolved male psychology designed to detect genetically related offspring. First, prominent models of human kin detection (e.g. Lieberman et al., 2007) argue that the strongest evidence for any valid kinship cue derives from the cue's ability to predict *both* altruistic and sexual motivation simultaneously. Critically, many previous studies, including those reviewed above, focus primarily on altruism and tend not to address whether the candidate cues predict sexual motivations (Alvergne, Faurie, & Raymond, 2007; Alvergne et al., 2009, 2010; Apicella & Marlowe, 2004; Burch & Gallup, 2000; DeBruine, 2004b; Dolinska, 2013; Heijkoop et al., 2009; Platek et al., 2002; Platek et al., 2003; Volk & Quinsey, 2002; for exceptions, see for instance DeBruine 2004a, 2005). The proposal by Lieberman et al. (2007) is that only one kin detection system exists, generating a single estimate of relatedness, which is taken as input by two separate motivational systems: one regulating motivations to pursue an individual sexually and one regulating decisions regarding welfare trade-off decisions. From this model, it follows that the most stringent test of a kinship cue is its ability to

predict both altruistic and sexual motivation simultaneously, something yet to be tested in the context of paternity.

A second issue is that little consideration has been given to the information-processing requirements actually implied by the hypothesis that fidelity serves as a cue to paternity. Consider a design in which a male offspring detection mechanism inferred genetic relatedness solely on the basis of perceived partner fidelity. If knowledge regarding fidelity were the only parameter used, how would the male distinguish between his own offspring and the many other children in the social environment? Would every child his mate came into contact with have the same probability of relatedness? A design that solely utilized information regarding fidelity would be drastically over-inclusive, leading to rampant inefficiency and the strong likelihood of being outcompeted by less error-prone designs. The prospect of widespread over-inclusion calls attention to a computation that we might expect to logically precede, or at least accompany, estimations of offspring relatedness on the basis of mate fidelity. For mate fidelity to reliably aid in male offspring detection, the kin detection system should link the fidelity of the mate to the probability that a particular child is the mate's genetic offspring.

If this reasoning is correct, then a male offspring detection system that draws upon cues of perceived partner fidelity should also assess mother/child relatedness via reliable cues. Such a system would link an estimate of partner fidelity with cues of maternal relatedness. Given our mammalian phylogenetic heritage, one strong cue of maternity is maternal perinatal association (MPA), defined as observations of parenting effort directed toward a neonate. MPA narrows in on maternal investments in newborns because such investments (e.g. breast-feeding and intense care) provide evolutionarily

reliable information regarding maternity. MPA has already received strong support as a cue to siblingship (Lieberman, 2009; Lieberman & Billingsley, 2016; Lieberman et al., 2007; Sznycer, de Smet, Billingsley, & Lieberman, 2016): The correct identification of one's mother means that other young she births and nurtures are biological siblings. Here I suggest that psychological systems tasked with detecting paternity may well take advantage of the same reliable correlation and integrate that information with estimates of partner fidelity. That is, male paternity assessments might take advantage of female offspring detection systems, such that a man who observes his mate investing in a particular child can be quite confident that the child is his own based on assessments of fidelity. Children his mate is not investing in are not likely to be her—and therefore not his—offspring. If true, we should expect paternal investment and sexual attraction to offspring to be better predicted by perceived partner fidelity in conjunction with MPA than by perceived partner fidelity alone.

The final issue relates to Lieberman et al.'s (2007) proposition that the kin detection system generates—for each individual in the social environment—a single kinship estimate. This kinship estimate, or "kinship index," is a summary variable integrating information from all available kinship cues and represents the probability that another individual is a close genetic relative. If all cues regarding the relatedness of a specific social target are captured by a single internal variable, the resulting kinship estimate might manifest itself in conscious experience as a felt sense of relatedness certainty. This felt sense might then mediate the effect of kinship cue presence on altruism and sexual aversion. Prior researchers have generally suggested that the effects of physical resemblance and/or perceived partner fidelity upon paternal investment are a

function of paternal assessments of relatedness to offspring (Alvergne et al., 2007, 2009, 2010; Apicella & Marlowe, 2004; Burch & Gallup, 2000; DeBruine, 2004b; Dolinska, 2013; Heijkoop et al., 2009; Platek et al., 2002; Platek et al., 2003; Volk & Quinsey, 2002). But prior research has not tested the hypothesis that these effects are explicitly mediated by self-reported relatedness certainty.

The Current Research: Hypotheses

The current research set out to address each of these three gaps, specifically, whether offspring resemblance and perceived partner fidelity each predict both daughter-directed altruism *and* sexual attraction, whether the cue of mother/offspring relatedness known as maternal perinatal association may also inform paternity estimation, and whether self-reported relatedness certainty mediates the effects of candidate cues to paternity on both altruism and sexual attraction. The research relied upon two existing datasets that provided information on multiple paternity cues in men, including perceived partner fidelity, perceived facial resemblance to offspring, and maternal perinatal association, as well as measures bearing on paternal investment, sexual attraction, and certainty of relatedness. Because offspring-directed sexual attraction was an outcome of interest, each sample was limited to father-daughter relationships. Across two samples, then, the following specific hypotheses were tested:

1. Kinship cues should regulate altruism and sexual aversions. Specifically,

i) Offspring resemblance correlates positively with daughter-directed altruism, but negatively with daughter-directed sexual attraction, controlling for perceived partner fidelity;

ii) Perceived partner fidelity correlates positively with daughter-directed altruism, but negatively with daughter-directed sexual attraction, controlling for physical resemblance;

2. Maternal perinatal association is a cue to paternity and interacts with fidelity. Specifically,

iii) Maternal perinatal association correlates positively with daughter-directed altruism, but negatively with daughter-directed sexual attraction, controlling for perceived partner fidelity;

iv) The linear combination of MPA and perceived partner fidelity better predicts both altruism and daughter-directed sexual attraction than does perceived partner fidelity alone.

v) The interaction of perceived partner fidelity with MPA significantly predicts both daughter-directed altruism and sexual attraction, such that the effect of fidelity is stronger when MPA is present rather than absent, and MPA-present men with high fidelity mates should exhibit both the highest levels of altruism and the lowest levels of sexual attraction;

3. For a specific target individual in the social environment, a single kinship estimate should integrate information from all kinship cues. Specifically,

vi) Significant effects of any candidate cues on altruism and sexual motivation are mediated by self-reported paternity certainty.

To test these predictions, the following two studies were conducted.

Chapter 2: Method

Study 1

Participants. Study 1 drew upon an existing web-based Finnish sample (Albrecht et al., 2014). A total of 4000 men were contacted via The Population Registry Center of Finland and asked to complete a web-based survey that included questions about a daughter. Of the 1399 men who completed the survey, 390 heterosexual men reported having at least one daughter (age range: 20-50, *M*=40.06, *SD*= 6.11). These men were part of a larger study on kinship relations in Finland (for more details on methods and the population-based sample, see Albrecht et al., 2014). The Institutional Review Board at Åbo University, Finland, approved the study reported herein and informed consent was obtained from participants.

Materials and Procedures. Participants completed a web-based survey that included questions about a daughter. From questionnaire responses, variables were created that captured the candidate kinship cues of interest, three outcome measures, and one potential mediator, each described in turn.

Measures: Candidate Kinship Cues.

Physical resemblance. This variable assessed the father's rating of how closely the daughter resembles him physically, using a single item with a scale ranging from 0 (not at all) to 100 (very much), *M*=64.37, *SD*=20.68.

Perceived partner fidelity. Questionnaires included two items asking fathers to assess the fidelity of the daughter's mother toward him: "Have you ever suspected your daughter's mother of cheating on you (i.e., having sex) with another man?" and "To what extent has your daughter's mother caused you to feel jealous?" both rated on a scale

ranging from 0 (Never) to 100 (Often). Responses correlated positively with one another, $r = .59$, $p < .001$. These two questions were averaged and reverse coded to create a variable called *Fidelity* (α=.73); higher scores reflect greater fidelity, *M*=74.63, *SD*=23.87.

Maternal perinatal association. Fathers answered two items regarding past residency with the daughter and with her mother: (i) whether the man lived in the same household as the daughter after her birth; and (ii) whether the man lived in the same household as the daughter's mother after the daughter's birth. The latter two questions were used to compute a variable labeled *maternal perinatal association*, *MPA*. MPA is equal to 1 if the man reported living in the same household with his daughter and the daughter's mother after the daughter's birth. MPA is zero if otherwise, *M*=.98, *SD*=.12.

As these descriptives indicate, variation in MPA was negligible in this sample, precluding any examination of whether MPA might interact with perceived partner fidelity to predict both sexual and altruistic motivation. Accordingly, Hypothesis 2 was not tested in Study 1. This shortcoming of the dataset prompted the second study, using a broader online sample from Mechanical Turk, in which greater variability in MPA might be found.

Measures: Outcomes.

Altruism. Men reported on a scale of 0 (not willing at all) to 100 (extremely willing) how willing they would be to donate a kidney to their daughter. These responses formed the variable labeled *Altruism*, *M*=92.74, *SD*=17.38. Note, participants also responded to questions regarding doing jail time in their daughter's stead and giving half of one month's salary to their daughter. Following significant results of Bartlett's Test of

Sphericity (X^2 (3) = 104.67, p < .001), exploratory factor analysis was conducted using principal axis factoring and interpreted using Kaiser's rule and a scree plot. Results suggested a single factor underlying all three items. That factor, however, accounted for only 35.1% of variance, and reliability among the three items was low (α<.53). Accordingly, the latter two questions were not used, and the item pertaining to kidney donation was designated the preferred measure of altruism based on precedent in kin detection research (Lieberman et al., 2007; Snzycer et al. 2016).

Sexual attraction. To assess sexual attraction, each man was asked how arousing he would find having sex with his daughter, making out with his daughter, and sitting naked side-by-side in a sauna with his daughter as she touchers his inner thigh. Exploratory factor analysis was conducted using principal axis factoring, following significant results of Bartlett's Test of Sphericity, X^2 (3) = 816.06, p < .001. Results interpreted using both a scree plot and Kaiser's cutoff criterion suggested that a unidimensional construct underlay the items, accounting for 78.2% of variance. Responses to the three questions were averaged to create a composite variable labeled *sexual arousal* (α=.91), *M*=3.81, *SD*=14.79.

Sexual disgust. Each man was asked how disgusting he would find the same three scenarios described above for sexual arousal. Exploratory factor analysis was again conducted using principal axis factoring, following significant results from Bartlett's Test of Sphericity, X^2 (3) = 895.66, p < .001. Results interpreted using both a scree plot and Kaiser's cutoff criterion again suggested that a unidimensional construct underlay the items, accounting for 72.04% of variance. However, the factor loading for the item involving sitting with the daughter in a sauna was notably lower than the loadings for the

other two items (.55 vs. .95 and .94), and reliability analyses suggested that although overall reliability with the three items was adequate (.80), reliability would be markedly improved by deleting the sauna question. On the whole, these results suggested the possibility that the sauna scenario was introducing measurement error by not consistently evoking a sexual context, and the item was accordingly dropped. Responses to the two items were averaged to create a composite labeled *sexual disgust*, (α=.96), *M*=97.34, *SD*=12.74).

Measures: Mediator and control variables.

Certainty of relatedness. A single item assesses how certain the man believes himself to be related to the target daughter. Responses were provided on a scale ranging from 0 (not at all certain she is related) to 100 (completely certain she is related), response range: 0-100, *M*=95.90; *SD*=13.48.

Father's age: A single item asked fathers to provide their age, in years (*M*=40.06, *SD*= 6.11).

Daughter's age: A single item assessed the age of the target daughter, in years (*M* = 10.5, *SD* = 6.46, maximum = 27).

Study 2

Participants. In this second sample, participants were recruited from Amazon's Mechanical Turk population. English-speaking men at least 18 years old with a living daughter (also at least 18 years of age) were invited to complete a questionnaire assessing various aspects of their relationship with their eldest daughter and with that daughter's mother. Potential participants were informed that the questionnaire should take

approximately twenty minutes to complete, and that participants who completed the survey would receive $.80 (in U.S. dollars).

An advertisement for 1000 participants was posted on Mechanical Turk during April and May of 2016. 1682 individuals responded to the advertisement but not all completed the questionnaire, as follows. 213 of these responses were from individuals who reported basic demographic information that conflicted with the study's eligibility criteria and were immediately forced from the survey. These responses included individuals who reported that they were female or that they did not have a daughter. An additional 454 responses reflect incomplete surveys—abandoned well before the end of the questionnaire. Additionally, two duplicates were identified and deleted. Thus, 1013 usable responses were collected.

Of these 1013 usable responses, 31 were from participants who indicated that their oldest daughter was younger than 18 years old; these responses were excluded from all analyses. Additionally, test completions of the survey suggested that the questionnaire could not be reasonably filled out in less than six minutes. Accordingly, responses with completion times of less than six minutes (26 cases) were excluded from analysis. Finally, a number of participants reported a young age potentially at odds with having a daughter at least 18 years old. 83 participants reported an age of 30 or less; an additional 93 reported an age of 31 to 36; 41 participants reported no age. Out of an abundance of caution, all 217 of these participants were excluded from analysis.

The final sample thus consisted of 744 men, 89.8% of whom were self-reported heterosexuals, and 69% of whom were married. Participant ages ranged from 37 to 81 years old (M = 48.06, SD = 7.85). A large majority of participants (94.1%) reported on a

biological daughter rather than on a step, foster, or adopted daughter. The reported number of daughters for each participant ranged from 1 to 6 (M = 1.33, SD = .64); most participants (73.9%) reported having only one daughter. The median household income range for the final sample was $40,001-$50,000 US dollars.

Procedure. Fathers who were recruited from Amazon's Mechanical Turk population filled out an online survey in which they were asked questions about their oldest daughter and that daughter's mother. After agreeing to informed consent, participants were assured that their responses would remain anonymous. Participants completed survey items assessing basic demographic characteristics; residential history with their oldest daughter and that daughter's mother; assessments of physical resemblance to the daughter and of the mother's sexual fidelity; altruistic and sexual motivation with respect to the daughter; assessments of the daughter's and the participant's own mate value; and other questions pertaining to the participant's daughter, the daughter's mother, and their relationship together. Participants who completed the survey were compensated $.80. The study was approved by the Institutional Review Board of the University of Miami.

Measures: Candidate Cues.

Resemblance. Resemblance was assessed using six items. Three items assessed the degree to which the participant reported he resembles his daughter, using a scale of 1 (Not at all) to 7 (A lot). The first item measured facial resemblance, the second measured resemblance "in terms of your personality," and the third measured resemblance "in terms of your behavior." Three additional items asked the participant to report how much *other individuals* tend to think that the participant resembles his daughter. As with the

previous trio of items, the first item measured facial resemblance, the second measured resemblance "in terms of your personality," and the third measured resemblance "in terms of your behavior."

Following significant results of Bartlett's Test of Sphericity (X^2 (15) = 2291.82, p < .001), exploratory factor analysis of these six resemblance items was conducted using SPSS Version 23. An initial extraction was undertaken using principal components extraction, to estimate number of factors; results indicated a two-factor solution, with both factors collectively accounting for 77.19% of variance. Principal axis factoring with direct oblimin rotation was then conducted, on the assumption that the two factors were likely correlated. The rotated factor matrix revealed that the four items pertaining to behavioral and personality resemblance loaded heavily onto Factor 1 (all loadings > .76), while the two facial resemblance items loaded heavily onto Factor 2 (all loadings > .74), with minimal cross-loadings. This pattern suggested that the behavior and personality resemblance items reflected the same underlying construct, which was termed "behavioral resemblance," and that the remaining two items tapped into a distinct construct, which was termed "facial resemblance." Given these results, two separate variables were created, reflecting each of these two factors.

"Behavioral resemblance" was calculated as the average of the four items gauging behavioral and personality resemblance, with potential and actual scores ranging from 1 (Not at all) to 7 (A lot), M = 5.09, SD = 1.32. Reliability of this four-item sub-scale was very good (alpha = .90).

"Facial resemblance" was calculated as the average of the two items gauging facial resemblance, with potential and actual scores ranging from 1 (Not at all) to 7 (A lot), $M = 4.95$, $SD = 1.51$. Reliability of this two-item sub-scale was good (alpha = .85).

The correlation between the average behavioral and facial resemblance scores was .49 ($p < .01$). Factor analysis supported an underlying unidimensionality to the two subscales, with one item accounting for 74.8% of the variance. Thus, a variable capturing overall resemblance was created by averaging the behavioral resemblance sub-scale average and the facial resemblance subscale average. Potential and actual scores on this overall resemblance measure ranged from 1 to 7, $M = 5.02$, $SD = 1.22$. Reliability of the full scale was good (alpha = .87).

Given the focus on facial resemblance in much of the existing literature (Bressan & Dal Martello, 2002; Dal Martello et al., 2015; DeBruine, 2002, 2005; DeBruine et al., 2009; Maloney & Dal Martello, 2011; Maloney & Dal Martello, 2006; Platek et al., 2002), and the fact that facial resemblance most closely approximates the measure of physical resemblance used in Study 1, priority was given to the facial resemblance sub-scale as an outcome measure. For all Study 2 analyses reported below, *Facial resemblance* was thus the outcome variable to be predicted by candidate cues.

Perceived partner infidelity. Participants reported on the perceived sexual faithfulness of their daughter's mother in three items: 1) "To what extent has [target's] mother caused you to feel jealous?; 2) Have you ever suspected [target's] mother of cheating on you?; and 3) "How certain are you that [target's] mother was faithful to you throughout your relationship?" Each items was scored on a scale from 1 to 7, with 1 indicating high confidence in fidelity and 7 indicating strong suspicion of infidelity.

Following significant results of Bartlett's Test of Sphericity (X^2 (3) = 682.00, p < .001), exploratory factor analysis using principal axis factoring was undertaken. Results interpreted on the basis of a scree plot and Kaiser's cutoff suggested a single construct underlying the items, with a single factor accounting for 55.7% of variance. Thus, a composite variable was created by averaging the scores of all three items. Because higher scores reflected greater suspicion of infidelity, we termed this variable *Infidelity*. Reliability using this three-item scale was adequate (α = .74). However, item analysis suggested that reliability would be substantially improved if the item assessing feelings of jealousy were deleted, and inspection of communalities revealed that the underlying factor accounted only for 16% of variance in the item. This item was therefore deleted, resulting in a final two-item scale with a reliability of .853. The final variable was created by averaging the two items. Potential and actual scores of this composite variable ranged from 1 to 7, M = 2.20, SD = 1.80.

Maternal perinatal association (MPA). MPA is a dichotomous variable that attempts to capture whether or not a man observed his putative daughter being cared for by the man's mate shortly after the daughter's birth. The variable was created by coding the responses of two items: 1) "Did you live in the same household with [daughter] right after she was born?"; and 2) "Did you live in the same household with [daughter's] mother right after [daughter] was born?" Participants were coded "1" (for MPA-positive) when they responded "Yes" to both items. Participants were coded "0" (for MPA-negative) when they responded "No" to at least one item. 654 participants (87.9%) were MPA-positive (M = 0.89, SD = 0.32).

Interaction of infidelity with MPA. This variable was simply the product of MPA and the centered *Infidelity* variable.

Measures: Outcomes.

Altruism. Altruism was assessed via eight questions, based upon Lieberman et al. (2007) and Sznycer et al. (2016). This battery assessed the subject's willingness to provide different forms of help to the target: willingness to donate a kidney to the target; to serve jail time on the target's behalf; to give the target half a year's salary if she were in dire financial need; to loan the target $1,000; to *give* the target $1,000; to work for a year to pay for her education; to dedicate six months to help her recuperate from a serious accident; and to stay with the target in the hospital helping her recover from illness. Answers to each question ranged from 1 (least willing) to 7 (most willing).

Following significant results of Bartlett's Test of Sphericity (X^2 (28) = 3058.20, p < .001), exploratory factor analysis was conducted, with factor extraction based upon principal axis factoring. Results interpreted using Kaiser's cutoff and a scree plot suggested a unidimensional construct, with one factor accounting for 53.53% of item variance. Scores from all eight items were averaged to create a single variable measuring altruism, with higher scores indicating greater altruism. Actual and potential scores on this measure of total altruism ranged from 1 to 7, M = 6.14, SD = 1.02. Reliability of this eight-item scale was good (α = .89).

Sexual appeal. Participants were asked to rate how they would find each of the following scenarios involving themselves and their daughter: 1) "You and [daughter] tongue-kissing"; 2) "You seeing [daughter] naked"; 3) "[Daughter] making a sexual advance toward you"; 4) "You dreaming of having sex with [daughter]"; and 5) "You

actually having sex with [daughter].” Each item was scored on a scale ranging from -5 (“Extremely Disgusting”) to +5 (“Extremely Erotic”), with 0 labeled as “Neither Disgusting Nor Erotic.”

Following a significant result of Bartlett’s Test of Sphericity (X^2 (10) = 3647.45, p < .001), exploratory factor analysis based on principal axis factoring was conducted. Result interpreted using Kaiser’s cutoff and a scree plot suggested that a single construct would underlie all five items, with one component accounting for 77.03% of variance. Accordingly, we created a composite variable termed *Sexual Appeal*. It consisted of the sum of all five items, with higher (more positive) scores indicating more erotic responses, and lower (more negative) scores indicating more intense disgust responses. Potential and actual scores ranged from -25 to +25 (M = -19.12, SD = 10.74). Reliability of the five-item scale was excellent (α = .94).

Measures: Mediator and control variables.

Certainty of relatedness. As in Study 1, the participant’s certainty of relatedness to his daughter was assessed with a single item: “On a scale of 0 to 100, where 0 equals not at all certain and 100 equals “absolutely certain,” how certain are you that [target] is your biological daughter?” Reported scores ranged from 0 to 100 (M = 93.76, SD = 22.53).

Father’s age: A single item assessed the father age, in years (M = 48.06, SD = 7.85).

Daughter’s age: Age of the target daughter in years was ascertained with one item (range 18-55; M = 22.08, SD = 5.46).

Household income: A single item gauged the range of the father's annual household income, in U.S. dollars. Options were provided on a 1-9 scale, with "1" indicating income from $0-10,000, increasing up the scale in increments of $10,000 to a maximum of $80,000+ ($M$ = 5.20, SD = 2.58, indicating an average household income range between $40,001 and $50,000).

Daughter attractiveness: To assess daughter attractiveness, each father responded to the following item: "Objectively, compared to others of her age and sex, how physically attractive is [your daughter]?" The item was gauged on a scale from 0 ("Not at all") to 6 ("Extremely") (M = 4.59, SD = 1.15).

Data Analyses

In testing Hypotheses 1 and 2, two broad types of analyses were conducted. One set of analyses adopted the approach of prior kin detection researchers, who have generally used multiple regression techniques to analyze the effects of candidate kinship cues on one outcome measure at a time. In most studies, candidate cues are analyzed as a predictors only of target-directed altruism. In a few sibling detection studies (e.g. Lieberman et al., 2007), candidate cues may also be examined as predictors of sexual motivation, but even in these studies, the outcome variables are analyzed separately rather than in conjunction. The first set of analyses reported here reflects this prior methodology: to test Hypothesis 1, multiple linear regression models were constructed to determine whether the candidate cues of perceived partner fidelity and self-reported resemblance each uniquely predicted daughter-directed altruism and, separately, daughter-directed sexual motivation. For each sample, first, altruism was regressed on the linear combination of perceived partner fidelity and resemblance plus control variables.

Then, secondly, sexual motivation was regressed on the linear combination of perceived partner fidelity and resemblance plus control variables. In these regression models, perceived partner fidelity and resemblance were entered simultaneously, with one another and with control variables. Analyses of these models determined which if any variable predicted both altruism and sexual attraction.

To test Hypothesis 2 (the interaction of MPA with partner fidelity) using standard linear regression methods, partner fidelity was entered as a baseline predictor into regression models predicting, first, altruism, and then, separately, sexual motivation. MPA was then entered into the models, followed by the interaction of MPA with the baseline predictor(s). The interaction of MPA with partner fidelity was then examined for statistical significance.

Although this first type of analysis follows precedent in using multiple linear regression on one outcome variable at a time, the approach is arguably not optimal in that it does not link together the outcome variables. Because the theoretical model adopted here posits correlated outcomes, the ideal analytical treatment would take this expectation into account. Structural equation modeling is typically well suited to this task, but generally requires three or more indicators per latent construct for reliable results (Kline, 2005). Because the kin detection model postulates a latent variable inferred on the basis of only two indicators (altruistic and sexual motivation), structural equation modeling was eschewed in favor an alternative strategy for linking the two outcome domains. In this alternative approach, participants were categorized on the basis of their joint outcomes on altruistic and sexual measures.

Because this analytic strategy had not been previously employed in paternity detection research, we explored two methods of categorizing by joint outcome. First, participants were categorized according to whether they were multivariate outliers on altruism and sexual outcomes, as defined by Mahalanobis distances that exceeded a critical value determined by an alpha of .05. This approach took advantage of the skewed nature of the outcome variables: because of the extreme skew in the sexual aversion and altruism data, any multivariate outlier must be a case extreme in its combination of *low altruism and high sexual appeal*. (Alternative combinations—such as extremely high altruism and extremely low sexual appeal—were not possible in this particular dataset, as confirmed by visual inspection of identified multivariate outliers.) Logistic regression was then used to evaluate candidate cues as predictors of participants being or not being a multivariate outlier on the combination of altruism and sexual motivation.

As an additional approach, we performed latent class analysis (LCA), a statistical method which accounts for observed responses to variables such as questionnaire items by identifying distinct subpopulations—latent classes--within the data (Lazarsfeld & Henry, 1968). As described in more detail under "Results," both a two-class and a three-class solution were successfully estimated. Because the two-class solution for both samples revealed a clear split between cases that were simultaneously high on sexual disgust and altruism (Class 1) vs. cases that were low on both sexual disgust and altruism (Class 2), this two-class solution was used as the basis for logistic regression in which candidate cues were evaluated as predictors of latent class membership.

Hypothesis 3 was tested by a series of straightforward path analyses to determine if significant effects of any candidate cues (perceived partner fidelity, offspring

resemblance, MPA, and the interaction of MPA with baseline predictors) on altruism and sexual attraction were mediated by self-reported relatedness certainty.

All independent variables except the dichotomous variable MPA were centered prior to analysis. Regression analyses were conducted in SPSS Version 23 and Mplus 7.0. All p-values were two-tailed. Indirect effects and their 95% confidence intervals for mediation analyses were calculated in Mplus Version 7.0, using bootstrapped 95% confidence intervals generated from 2000 iterations. Latent class analysis was conducted in Mplus 7.0.

Data Screening and Categorization of Cases

For both samples, all variables were screened in SPSS Version 23 for accuracy, outliers, and fit of assumptions to planned analyses. No out-of-bounds values were identified in either dataset. However, in both datasets, several variables—those relating to altruism, sexual motivation, and certainty of relatedness—displayed extreme skew. In the case of items pertaining to altruism, sexual disgust and certainty of relatedness, extreme negative skew was observed; in the case of items pertaining to sexual arousal or sexual appeal, extreme positive skew was observed. The extreme skew observed for these variables rendered tradition outlier detection techniques problematic, in that many participants toward the skewed end of the distribution fell outside traditional thresholds for outlier status, such as a *z*-score more extreme than +/- three. All outliers beyond this threshold were visually inspected, but no grounds for excluding them were found, and thus all outliers were retained for analysis, unless otherwise stated. In an attempt to minimize skew, square root and logarithmic transformation of variables relating to altruism, sexual motivation, and relatedness certainty were attempted. Test regressions

revealed, however, that even with transformed variables, the assumption of normally distributed residuals could not be maintained. Given the severe skew of outcome variables, bootstrapping methods were therefore employed for all analyses, to address violations of the assumption of normally distributed residuals.

The datasets were also examined for missing data using the Missing Values Analysis function of SPSS Version 23. In the case of Study 1, all relevant data were present. In the case of Study 2, missing data did not appear to be of great concern, with most variables missing data on only a handful of cases. However, two variables were missing data on more than five total cases, and therefore Little's MCAR test was performed. Results indicated that data could be assumed to be Missing Completely at Random, X^2 (320) = 321.07, p = .473, and thus analyses for Study 2 were conducted without adjustment for missing data.

To categorize Study 1 participants based on their status as multivariate outliers on altruism and sexual motivation, case number was regressed first on altruism and sexual disgust, then separately on altruism and sexual arousal, and Mahalanobis distances were saved. Cased were coded as multivariate outliers (1 for "Yes"; 0 for "No") if they exceeded the critical X^2 value corresponding to alpha = .05. This procedure resulted in 18 multivariate outliers on the combination of altruism and sexual disgust, and 22 outliers on the combination of altruism and sexual arousal. The sample from Study 2 was then analyzed using the same approach as in Study 1. Case number was regressed on altruism and sexual appeal and Mahalanobis distances were saved. Cased were coded as multivariate outliers (1 for "Yes"; 0 for "No") if they exceeded the critical X^2 value corresponding to alpha = .05. This procedure resulted in 50 multivariate outliers on the

combination of altruism and sexual appeal. Because Study 2, unlike Study 1, contained only one measure of sexual motivation, no further categorization based on multivariate outliers was needed.

The second approach to categorizing participants based on joint outcomes was latent class analysis (LCA), conducted in Mplus 7.0. LCA was performed on both Study 1 and Study 2 datasets in an effort to empirically derive statistically supported participant categories that combined outcomes on both altruism and sexual motivation. The resulting classifications would then be used as the dependent variable in a logistic regression, with candidate cues as predictors. This effort was successful in the case of Study 2, but in the case of Study 1, LCA produced classes with too few participants (8 out of 390) to proceed with logistic regression. Thus only the derivation of latent classes for Study 2 is detailed here.

In Study 2, the eight items assessing altruism were scored on a Likert scale from 1 to 7 and were treated in Mplus as categorical variables. The five items assessing sexual motivation were on a scale ranging from -5 to +5, and were treated as continuous variables. The use of continuous variables in this context is sometimes specifically referred to as latent profile analysis; here the term “latent class analysis” encompasses analyses involving the identification of latent classification structure using any combination of categorical or continuous variables.

In latent class analysis, proper parameter estimation is jeopardized by the possibility that the obtained solution reflects a local rather than a global maximum (Geiser, 2012). To avoid this, the use of numerous random starts and multiple iterations is thus essential. All latent class models reported here were accordingly estimated using 500

randomized start values in the first step of the optimization, and the best 50 start values in the second step of the optimization, along with 50 initial stage iterations, as recommended by Geiser (2012). Furthermore, for each model the parametric bootstrapped likelihood ratio test (which is used to evaluate relative model fit) was performed using 500 bootstrap samples, along with 50 random start value sets for the first step of the optimization, and 20 start values for the second step, again as recommended by Geiser (2012). Estimation method was maximum likelihood with robust standard errors. With these specifications in place, a two-class model was generated first, followed by a three-class model. A four-class model was attempted, but failed to terminate normally due to a non-positive definite Fisher information matrix; models with more than four classes were not attempted.

Table 1 presents fit statistics for the two- and three-class models. Results of the Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (VLMR-LRT), the Lo-Mendell-Rubin Adjusted Likelihood Ratio Test (LMRA-LRT), and the Parametric Bootstrapped Likelihood Ratio Test (PB-LRT) all suggested that a two-class model fit the data better than a model in which no latent classes were assumed (all p-values < .05). Evidence regarding the relative fit of the two-class vs. the three-class model was mixed. The VLMR-LRT (p = .761) and the LMRA-LRT (p = .761), together with the entropy statistic (.998 for the two-class model vs. .948 for the three-class model), favored the two-class solution. The PB-LRT (p < .001), together with fit indices such as the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), favored the three-class model. For purposes of the present research, it was not essential to resolve this discrepancy. Given that the evidence suggested that at least a two-class model fit the data

better than a model with no latent class structure, the primary concern was how to interpret the classes suggested by the two- and three-class models, and whether—based upon these interpretations—the latent groupings should be predictable by the kinship cues under consideration.

For the two-class model, a clear interpretation readily emerged from the pattern of latent means and odds ratio results, as shown in Table 2. Latent Class 1, comprised of approximately 647 cases, was characterized first of all by extremely low reported levels of daughter sexual appeal: mean scores for Class 1 on four of the five sexual motivation items (with a scale of -5 to +5) ranged from -4.58 to -4.92, and was -3.11 on the fifth item. By contrast, mean scores on these items for the approximately 53 cases in Latent Class 2 hovered around +2.5, suggesting moderate levels of sexual *arousal* with respect to the target daughter, rather than the sexual *disgust* reported by members of Latent Class 1. What of altruistic motivation toward the daughter? Because these items were treated as categorical, the relevant comparative statistics were odds ratios rather than means. For each of the seven response categories within each of the eight items, an odds ratio summarizes the odds of a member of Latent Class 1 responding in a higher response category, relative to a member of Latent Class 2. The pattern of results was again clear. For virtually all response categories across all items, the odds of Latent Class 1 cases selecting a higher (more altruistic) response were significantly greater than the odds of a member of Latent Class 2 doing so. Table 2 presents the odds ratios with respect to selecting a response option greater than the midway point of four. For all eight items, odds ratios ranged from 1.46 to 6.02, indicating significantly greater odds of a higher response from Latent Class 1 vs. Latent Class 2. The odds ratio data for altruism, when

combined with the data on means for sexual motivation, therefore made clear that Latent Class 1 consists of individuals who are high on sexual disgust and relatively high on altruism, whereas Latent Class 2 consists of individuals who are relatively low on altruism and much lower on sexual disgust—indeed they report positive levels of sexual arousal with respect to the target daughter. This is precisely the classification pattern that is relevant to kin detection, and thus there is a strong expectation that the proposed cues of perceived partner infidelity, facial resemblance, and MPA should significantly predict membership in Latent Class 1 vs. Latent Class 2.

Before proceeding with logistic regression of Latent Class 1 vs. Latent Class 2 on candidate kinship cues, the three-class model was examined to determine if its alternative class structure might afford additional opportunities to test the kin detection model. Descriptive statistics regarding the nature of the three latent classes are presented in Table 3, and interpretation was again relatively straightforward. Inspection of means from the three-class model revealed that Latent Classes 1 and 2 were both characterized by extremely low reported levels of daughter sexual appeal: mean scores on four of the five sexual motivation items (with a scale of -5 to +5) ranged from -4.38 to -4.93, and from -3.02 to -3.31 on the fifth item—all indicating high levels of sexual *disgust* with respect to the target daughter. By contrast, Latent Class 3 was characterized by positive levels of sexual motivation across all items, with means ranging from +2.26 to +2.75. This result, together with the fact that 53 cases were assigned to Latent Class 3, suggested the possibility that Class 3 in the three-group model was identical to Latent Class 2 in the two-group model, a possibility confirmed by visual inspection of the cases. This finding further made clear that the 3-class model was essentially subdividing into two groups the

650 high altruism/high sexual disgust individuals in Latent Class 1 of the two-group model. Both of these subgroups remained uniformly high on sexual disgust; what distinguished them was that the first subgroup consisted of individuals extremely high on altruism—their odds of scoring higher on altruism were at least eight times those of the other subgroup, depending on the item. For the three-class model, the kin detection perspective thus most strongly predicted that cues will be associated with differences between Latent Class 1 and Latent Class 3, whereas cues would not be not as strongly expected to predict differences among other classes. Because of the essential overlap between Latent Class 2 in the two-group model and Latent Class 3 in the three-group model, logistic regression was performed only using classification results from the two-group model—Latent Class 1 (high sexual disgust/high altruism) vs. Latent Class 2 (low sexual disgust/low altruism).

As mentioned earlier, this same procedure was performed for the Study 1 sample, and resulted in the same two-class structure as in Study 2, but with only eight individuals classified in the low sexual disgust/low altruism group. This was deemed too few individuals to conduct logistic regression, and thus findings based on LCA reflect only the Study 2 sample.

Chapter 3: Results

Results are presented in order of the three major hypotheses. For each hypothesis, the results of traditional multiple linear regression analyses are presented first, followed by logistic regression analyses of categorization based upon the two methods of establishing joint outcomes.

Hypothesis 1: Do Perceived Partner Fidelity and Self-Reported Resemblance Predict Both Altruism and Sexual Motivation?

Linear regression analyses of separate outcomes. Presented first are the results of linear regression analyses using one outcome variable at a time, consistent with prior kin detection research. Results of these traditional bootstrapped multiple linear regression analyses are displayed in Tables 4 and 5. All parameter estimates reflect unstandardized values.

In Study 1, three linear regression models were constructed, each using the linear combination of perceived partner fidelity, physical resemblance, father age, and daughter age to predict a single outcome of interest. Results showed that this linear combination of variables significantly predicted each of the three Study 1 outcomes of interest taken one at a time (altruism: $F(4, 385) = 5.92$, $p < .001$, $R^2 = .058$; sexual arousal: $F(4, 385) = 6.58$, $p < .001$, $R^2 = .064$; sexual disgust: $F(4, 385) = 6.02$, $p < .001$, $R^2 = .059$). In Study 2, two linear regression models were constructed, each using the linear combination of perceived partner infidelity, facial resemblance, father age, daughter age, father's household income range, and daughter attractiveness to predict the outcomes of interest taken one at a time. Results showed that this linear combination likewise predicted each of the two Study 2 outcomes of interest, altruism and sexual appeal (altruism: $F(6, 638) =$

29.92, $p < .001$, $R^2 = .22$; sexual appeal: $F(6, 657) = 3.93$, $p = .001$, $R^2 = .035$). We now consider the models more closely, examining each candidate cue individually to determine if it predicted outcomes in both the altruistic and sexual domains.

Cues of partner fidelity.

Altruism. In Study 1, perceived partner fidelity significantly predicted altruism, $b = .12$, 95% BCa CI [.01, .24], se = .06, $p = .041$, indicating as expected that perceptions of increased partner fidelity are associated with increased daughter-directed altruism, controlling for physical resemblance, father's age, and daughter's age. In Study 2, first controlling only for father age and daughter age so as to match the procedure of Study 1, perceived partner infidelity significantly predicted altruism, $b = -.11$, 95% BCa CI [-.16, -.07], se = .02, $p < .001$. This result held when the additional controls of father's household income range and daughter attractiveness were included in the model, $b = -.11$, 95% BCa CI [-.15, -.07], se = .02, $p < .001$, indicating as expected that increased perceptions of partner infidelity are associated with decreased daughter-directed altruism.

Sexual motivation. In Study 1, perceived partner fidelity was a significant predictor of sexual arousal, $b = -.14$, 95% BCa CI [-.27, -.04], se = .06, $p = .022$, controlling for physical resemblance, father's age, and daughter's age. This result indicates as expected that increased perception of partner fidelity is associated with decreased levels of sexual arousal toward the target daughter. In Study 1, perceived partner fidelity was also associated with sexual disgust, $b = .11$, 95% BCa CI [.01, .22], se = .05, $p = .063$, controlling for physical resemblance, father's age, and daughter's age. In Study 2, first controlling only for father age and daughter age so as to match the procedure of Study 1, perceived partner infidelity significantly predicted sexual appeal,

the sole measure of sexual motivation in the study, b = .65, 95% BCa CI [.15, 1.19], se = .26, p = .015. This result held when the additional controls of father's household income range and daughter attractiveness were included in the model, b = .68, 95% BCa CI [.19, 1.21], se = .26, p = .008. This result indicates that increased perceptions of mate infidelity were associated with increases in reported overall sexual appeal of the daughter, a measure that combines both sexual disgust and sexual arousal on a single scale.

Cues of resemblance.

Altruism. In Study 1, contrary to expectation, there was no significant association between physical resemblance and daughter-directed altruism, b = .02, 95% BCa CI [-.07, .12], se = .05, p = .650, controlling for perceived partner fidelity, father's age, and daughter's age. In Study 2, controlling only for the same factors as in Study 1, facial resemblance did significantly predict daughter-directed altruism, b = .22, 95% BCa CI [.15, .29], se = .03, p < .001. Results held when controlling additionally for father's annual household income range and daughter attractiveness, b = .16, 95% BCa CI [.10, .23], se = .04, p < .001. This finding indicated as expected that increased self-reported facial resemblance was associated with increased daughter-directed altruism.

Sexual motivation. In Study 1, there was no significant relationship between physical resemblance and sexual arousal, controlling for perceived partner fidelity, father's age, and daughter's age (b = -.05, 95% BCa CI [-.13, .03], se = .04, p = .286). In Study 1, physical resemblance was likewise not associated with sexual disgust, when controlling for perceived partner infidelity, father's age, and daughter's age (b = .06, 95% BCa CI [-.01, .13], se = .04, p = .137). Because Study 1, unlike Study 2, included men reporting on daughters less than 18 years of age and thus not sexually mature, the finding

might be considered biased against a positive result. However, these null results with regard to physical resemblance and sexual motivation held when the Study 1 sample was restricted to men with daughters at least 14 years of age, which is slightly above the average age of menarche reported for Finnish females in 1969 (Kantero & Widbolm, 1971): in this subset of fathers, physical resemblance predicted neither sexual arousal (b = -.016, 95% BCa CI [.12, .08], se = .05, p = .82), nor sexual disgust (b = .02, 95% BCa CI [.-.06, .10], se = .04, p = .759). In Study 2, we found no significant association between facial resemblance and sexual appeal, when controlling for the same factors as in Study 1, b -.18, 95% BCa CI [-.85, .45], se = .34, p = .597. Results were substantively unchanged when additionally controlling for father's annual household income range and daughter attractiveness, b -.51, 95% BCa CI [-1.23, .17], se = .36, p = .143.

Logistic regression analyses of categorization by joint outcome.

Do candidate kinship cues predict categorization of participants based on their status as multivariate outliers on altruism and sexual motivation? Beginning with Study 1 participants, multivariate outlier status—Yes (1) vs. No (0)—was regressed on both candidate cues—perceived partner fidelity and physical appearance—simultaneously, using bootstrapped 95% confidence intervals that were bias-corrected and accelerated, and based on 2000 samples. Two logistic regression models were constructed, one for multivariate status based upon the variables altruism and sexual disgust, the other for multivariate status based upon the variables altruism and sexual arousal. Results for both models are presented in the first two columns of Table 6.

For the first logistic regression, involving the variables altruism and sexual disgust, the overall model was significant, X^2 (2) = 11.22, p = .004, R^2 = .091

(Nagelkerke), with non-significant results of the Hosmer and Lemeshow Test suggesting an appropriate model (X^2 (8) = 6.91, p = .547. Inspection of each candidate cue used in the model revealed that perceived partner fidelity predicted multivariate outlier status, b = -.023 [-.042, -.004], se = .01, p = .005. The 95% confidence interval for the odds ratio ranged from .96 to .99, indicating that for each unit increase in perceived partner fidelity, the odds of being a multivariate outlier decreased (as expected). Although this change in odds ratio may seem to indicate a small effect size, it is important to recall that in Study 1, both the scale and the observed range for partner fidelity run from 0-100. Expanding the effect upon odds across the entire 100-point scale suggests that the odds of someone at maximal perceived partner fidelity being a multivariate outlier would be .11 times those of a man reporting zero partner fidelity—a more considerable reduction in odds. These results held when controlling for father age and daughter age, b = -.023 [-.041, -.003], se = .01, p =.017, with unchanged effect sizes. By contrast, based on bootstrapped confidence intervals, physical resemblance did not significantly predict multivariate outlier status controlling for perceived partner fidelity, regardless of whether father and daughter age were included in the model (b = -.013 [-.034, .009], se = .01, p = .171) or not (b = -.02 [-.043, .003], se = .01, p = .044).

Study 1 results were much the same for the when categorization was based on being a multivariate outlier on the combination of altruism and sexual arousal. When multivariate status (Yes vs. No) on this combination of dependent variables was regressed on the two candidate cues simultaneously, the overall model was again significant, X^2 (2) = 12.15, p = .002, R^2 =.087 (Nagelkerke), with non-significant results of the Hosmer and Lemeshow Test again indicating an appropriate model, X^2 (8) = 7.47,

p = .487. Turning to specific candidate cues, perceived partner fidelity again predicted multivariate outlier status, b = -.025 [-.040, -.008], se = .01, p < .001. The 95% confidence for the odds ratio again ranged from .96 to .99, indicating as expected that for each unit increase in perceived partner fidelity, the odds of being a multivariate outlier decreased. Results were unchanged when controlling for father age and daughter age, b = -.023 [-.039, -.006], se = .01, p = .001. By contrast, physical resemblance did not predict multivariate outlier status, neither when controlling only for perceived partner fidelity, b = -.015 [-.037, .008], se = .01, p = .137, nor when adding father age and daughter age as controls, b = -.009 [-.029, .013], se = .01, p = .314.

The sample from Study 2 was then analyzed using the same approach as in Study 1. Multivariate outlier status—Yes (1) vs. No (0)—was regressed on both candidate cues—perceived partner fidelity and physical appearance—simultaneously, but for Study 2 only one logistic regression model was constructed, with multivariate outlier status based upon the variables altruism and sexual appeal. Results are displayed in the third column of Table 6. The overall model was significant, X^2 (2) = 17.22, p < .001, R^2 =.064 (Nagelkerke), with a non-significant result of the Hosmer and Lemeshow Test suggesting an appropriate model, X^2 (8) = 7.17, p = .518. With regard to specific candidate cues, perceived partner infidelity predicted multivariate outlier status, b = .24 [.11, .37], se = .07, p < .001. The 95% confidence for the odds ratio ranged from 1.11 to 1.45. Note that in Study 2, greater scores indicate greater perceived *infidelity*. Thus, for each unit increase in perceived partner infidelity, the odds of being a multivariate outlier *increased*, as expected but in the opposite direction from Study 1. These results held when controlling for father and daughter age as in Study 1 (b = .23 [.08, .38], se = .07, p =

.002), and when including father's annual household income range and daughter attractiveness as additional controls (*b* = .23 [.09, .40], se = .07, *p* = .001).

In contrast to Study 1 findings, facial resemblance in Study 2 also significantly predicted multivariate outlier status, controlling for perceived partner infidelity (*b* = -.28 [-.49, -.04], se = .12, *p* = .013). This finding indicates that for every unit increase in reported facial resemblance (on a 1-7 scale), the odds of being a multivariate outlier *decreased* as expected, by .76 times. Extended across the full scale, this parameter estimate suggests that the odds of a man who reported maximum facial resemblance being a multivariate outlier are about .19 times those of a man reporting minimal resemblance. This effect held when adding father age and daughter age as controls (*b* = -.28 [-.50, -.04], se = .12, *p* = .013), and when further controlling for father's annual household income range and daughter attractiveness (*b* = -.30 [-.52, -.07], se = .12, *p* = .011).

These analyses of candidate cues as predictors of multivariate outlier status with respect to key dependent variables raise the question of whether the effects of candidate cues are robust to outlier removal. This question is addressed in the Appendix.

Do candidate kinship cues predict categorization of participants based on Latent Class Analysis? Using the Study 2 sample only, logistic regression was conducted in SPSS Version 23, using as the dependent variable assignment to Latent Class 1 vs. Latent Class 2 from the two-group model. As detailed earlier, Latent Class 1 consisted of participants quite high on both sexual disgust and relatively high on altruism, whereas Latent Class 2 consisted of participants quite low on sexual disgust and relatively low on altruism. A set of logistic regression models was constructed in which class membership was regressed

on candidate cues. In the first model, facial resemblance and perceived partner infidelity were entered simultaneously as predictors. The expectation was that increased levels of perceived partner infidelity would be associated with *increased* odds of assignment to Latent Class 2, whereas increased levels of facial resemblance would be associated with *decreased* odds of assignment to Latent Class 2. Results indicated that the two candidate cues collectively improved the baseline model, X^2 (2) = 7.66, p = .022, R^2 = .03 (Nagelkerke), with a non-significant result of the Hosmer and Lemeshow Test suggesting an appropriate model, X^2 (8) = 13.72, p = .089. Consistent with theory, perceived partner infidelity increased the odds of assignment to Latent Class 2, b = .19 [.07, .31], se = .06, p = .001. The point estimate for the odds ratio was 1.21, with a 95% confidence interval for the odds ratio ranging from 1.06 to 1.38, indicating as expected that for every unit increase in perceived partner infidelity, the man's odds of being assigned to Latent Class 2 increased relative to the odds of being assigned to Latent Class 1. Facial resemblance, by contrast, did not predict latent class assignment, b = -.04 [-.27, .21], se = .12, p = .714. This pattern of results held when controlling for father age, daughter age, father's annual household income range, and daughter attractiveness (for perceived partner infidelity, b = .22 [.08, .35], se = .07, p = .002; for facial resemblance, b = -.13 [-.35, .13], se = .11, p = .23). Results of the final model, with control variables, are collected in Table 7.

Hypothesis 2: Does the Interaction of Perceived Partner Fidelity with Maternal Perinatal Association Serve as a Kinship Cue?

Linear regression analyses of separate outcomes. To test whether the interaction of MPA and mate infidelity serves as a cue to paternity, we first constructed a series of multiple linear regression models in SPSS Version 23, using all Study 2

participants reporting on a biological daughter. (As previously noted, the Study 1 sample exhibited virtually no variation in MPA, precluding its use in testing this particular hypothesis.) The first set of models used altruism as the dependent variable, the second set of models, sexual appeal. For each dependent variable, there were three models. Beginning with models using altruism as the outcome, Model 1 regressed altruism on perceived partner fidelity; Model 2 regressed altruism on perceived partner fidelity and MPA; Model 3 regressed altruism on perceived partner infidelity, MPA, and the interaction of the two. Next, we considered sexual appeal as an outcome. Model 4 regressed sexual appeal solely on perceived partner infidelity; Model 5 regressed sexual appeal on perceived partner infidelity and MPA; Model 6 regressed sexual appeal on perceived partner infidelity, MPA, and their interaction. In all regression models, variables were entered simultaneously, and all continuous independent variables were centered. Because the assumption of normality of errors appeared to be violated, we employed bootstrapping methods, based on 2000 samples and using Bias-corrected and accelerated (BCa) 95% confidence intervals. Results of these bootstrapped multiple linear regression analyses are displayed in Table 8.

Altruism. Let us first consider Models 1 through 3, in which altruism was the outcome variable. Model 1 was significant, $F(1, 648) = 32.25$, $p < .001$, $R^2 = .047$, indicating as reported previously that perceived partner fidelity exhibits a significant negative association with daughter-directed altruism ($b = -.12$, 95% BCa CI [-.17, -.07], se = .03, $p < .001$. Neither Model 2 nor Model 3, however, significantly improved predictive power (Model 2 F_{change} (1, 647) = 3.24, $p = .072$, R^2 Change = .005; Model 3 F_{change} (1, 646) = .004, $p = .951$, $R^2 = .000$. MPA did not predict altruism, either in Model

2 (b = .27, 95% BCa CI [-.08, .63], se = .18, p = .136) or in Model 3 (b = .27, 95% BCa CI [-.08, .66], se = .183, p = .139). Most importantly, the interaction of MPA with perceived partner infidelity failed to significantly predict altruism in Model 3, b = -.004, 95% BCa CI [-.17, .19], se = .09, p = .958. Results were unchanged when the control variables of father age, daughter age, father household income, and daughter attractiveness were included in the model with MPA and the interaction of MPA and perceived infidelity (for MPA, b = .25 95% BCa CI [-.07, .61], se = .18, p = .145; for the interaction of MPA with perceived infidelity, b = -.05 BCa CI [-.21, .14], se = .18, p = .614. These findings provide no evidence for the hypothesis that MPA and perceived partner fidelity play a role in paternal kinship estimation, nor any evidence that MPA might act in isolation as a cue to paternity.

***Sexual motivation*.** We now turn to Models 4 through 6, in which sexual appeal was the outcome variable. Model 4 significantly predicted sexual appeal, though with a low R^2, $F(1, 666) = 6.30$, p = .012, R^2 = .009, duplicating the previous finding that increased partner infidelity is associated with increased sexual appeal of the target daughter, b = .56, 95% BCa CI [.11, 1.04], se = .24, p = .017. Model 5, with MPA added as a predictor, was only a marginal improvement, F_{Change} (1, 665) = 3.02, p = .083. R^2 Change = .004. MPA was a significant predictor of sexual appeal, both in this model (b = 2.71, 95% BCa CI [.80, 4.48], se = .97, p = .007, and in Model 6, b = 2.74, 95% BCa CI [1.02, 4.37], se = .86, p = .002. Interestingly, and counter to what might be expected from a kin detection perspective, MPA-presence (vs. absence) was associated with increased rather than decreased sexual appeal in these models. Finally, Model 6 produced no evidence that the interaction of MPA with perceived partner infidelity significantly

predicted sexual appeal, F_{Change} (1, 664) = .004, p = .952; b = -.05, 95% BCa CI [-1.01, .88], se = .48, p = .926. These results are unchanged when the control variables of father age, daughter age, father household income, and daughter attractiveness are included in the model (for MPA, b = 2.80, 95% BCa CI [.85, 4.48], se = .48, p = .007; for the interaction of MPA with perceived infidelity, b = -.23, 95% BCa CI [-1.39, .79], se = .51, p = .661. Paralleling the results regarding altruism, these findings fail to support the notion that the interaction of MPA with perceived partner fidelity predicts sexual motivation, and thus they offer no evidence for the hypothesis that the interaction of MPA with perceived partner fidelity plays a role in paternity assessments.

Logistic regression analyses of categorization by joint outcome.

Does MPA or the interaction of MPA with perceived partner infidelity predict categorization of participants based on their status as multivariate outliers on altruism and sexual motivation? In using logistic regression to test MPA and the interaction of MPA with perceived partner infidelity as possible cues to paternity, we followed the same procedure outlined above for Models 1-6, with the exception that the dependent variable was categorization based upon participant status as a multivariate outlier on altruism and sexual appeal. Because there was only dependent variable, only one set of three models—A to C—was constructed. Perceived infidelity was entered first in Model A; Model B then added MPA; and, finally, Model C added the interaction of MPA with perceived infidelity. As before, these analyses involving MPA were conducted only with the Study 2 sample.

Results of these logistic regressions mirrored the findings produced by linear regression, as shown in Table 9. Adding MPA to the model containing only perceived

partner infidelity failed to significantly improve fit, X^2 (1) = .003, p = .956, and the parameter estimate for MPA did not differ from zero, *b* = .03, 95% BCa [-1.10, 19.00], se = 2.67, *p* = .936. Likewise, adding the interaction of MPA with perceived partner infidelity failed to improve fit relative to Model B, X^2 (1) = .107, *p* = .743. The parameter estimate for the interaction did not differ significantly from zero, *b* = .08, 95% BCa [-.47, .60], se = .81, *p* = .715. This pattern of results remained unchanged when the control variables of father age, daughter age, father household income, and daughter attractiveness were included in the model (for MPA, *b* = .02, 95% BCa CI [-1.13, 18.85], se = 6.68, *p* = .949; for the interaction of MPA with perceived infidelity, *b* = .06, 95% BCa CI [-1.03, .65], se = 1.56, *p* = .778.

Does MPA or the interaction of MPA with perceived partner infidelity predict categorization of participants based on Latent Class Analysis? The logistic regressions reported for Models A-C were repeated just as described above, but with participant assignment to Latent Class 1 vs. Latent Class 2 used as the dependent variable, rather than participant status as a multivariate outlier on altruism and sexual appeal. As reported previously, Latent Class 1 consisted of participants quite high both sexual disgust and relatively high on altruism, whereas Latent Class 2 consisted of participants quite low on sexual disgust and relatively low on altruism. Because there was again only dependent variable, only one set of three models—D to F—was constructed. Perceived infidelity was entered first in Model D; Model E then added MPA; and, finally, Model F added the interaction of MPA with perceived infidelity. As above, these analyses involving MPA were conducted only with the Study 2 sample.

When MPA was added to the model containing only perceived partner infidelity, model fit did not improve significantly, X^2 (1) = .01, p = .921, and the parameter estimate for MPA was not significantly different from zero, *b* = .05, 95% BCa [-.88, 18.76], se = 2.20, *p* = .897. Similarly, the interaction of MPA with perceived partner infidelity failed to improve fit relative to Model E, X^2 (1) = 2.26, p = .133. The parameter estimate for the interaction did not differ from zero, *b* = -.43, 95% BCa [-9.82, .04], se = 5.69, *p* = .05, although the 95% confidence interval contained many negative values and only narrowly extended beyond zero to positive values. And, indeed, when the control variables of father age, daughter age, father household income, and daughter attractiveness were included in the model (Model G), overall model fit improved substantially, and the interaction of MPA with perceived partner fit became a statistically significant predictor of latent class, *b* = -.45, 95% BCa [-1.33, -.11], se = 4.87, *p* = .026. Although the interaction of MPA with perceived partner infidelity is significant in the full model with control variables, its directionality runs counter to theory. The logic of kin detection suggested that the effect of perceived partner infidelity would be greater for MPA-positive men (who have observed their mate caring for the newborn daughter) than for MPA-negative men (who made no such observations). In the current context, this means that as cues signaling infidelity increase, these cues should more strongly increase the odds of an MPA-positive man being assigned to Latent Class 2 (low sexual disgust, low altruism) than the odds of an MPA-negative man being assigned to Latent Class 2. Here, we see the reverse trend. The data (summarized in Table 10) reveal that for men lacking the cue of maternal perinatal association (MPA = 0), the effect of perceived partner infidelity is .614. This coefficient implies that for men lacking MPA, with each unit

increase in perceived partner infidelity, the odds of being assigned to Latent Class 2 increase by 1.8 times. By contrast, for men who have observed their mate caring for the newborn daughter (MPA = 1), the effect of perceived partner infidelity is *reduced* rather than enhanced. For these MPA-positive men, the effect of perceived partner infidelity is only .167. This relatively lower coefficient means that for men with MPA, for each unit increase in perceived partner infidelity, the odds of being assigned to the low-disgust, low-altruism Latent Class 2 increase by only 1.2 times, not 1.8 times. Logistic regression in conjunction with latent class analysis thus provides no evidence consistent with the hypothesis that the effect of perceived partner infidelity is stronger for men who observe their mates caring for a newborn daughter, vs. those men who do not.

Hypothesis 3: Does Relatedness Certainty Mediate the Effect of Potential Kinship Cues Upon Altruism and Sexual Motivation?

Study 1 and Study 2 furnished evidence that perceived partner fidelity influenced both daughter-directed altruism and daughter-directed sexual motivation, consistent with the hypothesis that partner fidelity serves as a cue to paternity. Study 2 also provided evidence that facial resemblance predicted daughter-directed altruism (but not sexual motivation), offering partial support for the hypothesis that facial resemblance serves as a cue to paternity. Next we consider whether self-reported relatedness certainty mediated these effects, as might be the case if perceived partner fidelity and facial resemblance serve as cues to paternity.

Study 1. Path analysis results for Study 1 appear in Figure 1 and in Table 11. All parameter estimates reflect the two control variables used in Study 1—father age and daughter age—but these variables are not shown on Figure 1 for clarity of presentation.

Overall model fit was good, χ^2 (2) = 1.45, p = .484, CFI = 1.00, RMSEA = .000, SRMR = .008.

The predictor of primary interest here is perceived partner fidelity, which was associated across studies with both altruistic and sexual motivation toward the target daughter, making it the most strongly supported candidate kinship cue. Table 6 provides 95% confidence intervals for the indirect effects of perceived partner infidelity on altruism, sexual appeal, and sexual disgust via relatedness certainty, and demonstrates that all such effects are statistically significant in the expected direction. As Figure 1 indicates, perceived partner fidelity significantly predicted self-reported relatedness certainty (b = .21, 95% BCa CI [.10, .32], se = .06, p < .001), controlling for physical resemblance. Relatedness certainty, in turn, significantly predicted all three outcome variables, holding perceived partner fidelity, physical resemblance and control variables constant (for altruism, b = .61, 95% BCa CI [.28, .95], se = ,.17 p < .001; for sexual appeal, b = -.64, 95% BCa CI [-.97, -.31], se = .17, p < .001; and for sexual disgust, b = .69, 95% BCa CI [.36, 1.01], se = .17, p < .001),. As Figure 1 further makes clear, when relatedness certainty was added as a predictor, all direct effects of perceived partner fidelity reduced to statistical non-significance (all p's > .05), providing evidence for full mediation.

Figure 1 and Table 11 also display results for physical resemblance, even though it was not strongly supported as a kinship cue in either study. As Figure 1 shows, physical resemblance was not significantly associated with self-reported relatedness certainty, b = .05, 95% BCa CI [-.01, .10], se = .03, p = .113. As a result, all indirect effects of physical

resemblance via self-related relatedness certainty are statistically non-significant (see Table 11).

Study 2. Path analysis results for Study 2 are displayed in Figure 2 and in Table 12. Note that in Figure 2 the displayed results account for the effects of four control variables on altruism and sexual appeal—father age, daughter age, father's household income range, and daughter attractiveness—but for ease of presentation, these control variables and their associated effects are not shown. Overall model fit was good, χ^2 (4) = 6.24, p = .182, CFI = .99, RMSEA = .029, SRMR = .014.

As Figure 2 makes clear, both facial resemblance and perceived partner infidelity exerted statistically significant effects in the expected directions on relatedness certainty, the proposed mediator (for facial resemblance: b = 1.00, 95% BCa CI [.30, 1.71], se = .36, p = .005; for perceived partner infidelity: b = -.33, 95% BCa CI [-.64, -.01], se = .16, p = .045). The proposed mediator, however, showed no significant effect on either altruism or sexual appeal, holding constant facial resemblance, perceived partner infidelity, and the four control variables (for altruism: b = .02, 95% BCa CI [-.004, .04], se = .01, p = .107; for sexual app: b = -.11, 95% BCa CI [-.25, .03], se = .07, p = .112). Given this lack of an effect, it is not surprising that the statistically significant direct effects of perceived partner infidelity upon altruism and sexual appeal, and of facial resemblance on altruism, remained significant even when controlling for relatedness certainty. These findings of course rule out the hypothesis of full mediation. It is also not surprising that there were no significant indirect effects of facial resemblance or perceived partner infidelity upon either altruism or sexual appeal, as summarized by Table 12. Study 2 thus provided no evidence that relatedness certainty mediates the effect

of facial resemblance or perceived partner infidelity on daughter-directed altruism or sexual motivation.

Chapter 4: Discussion

In two samples of men with putative biological daughters—one a web-based survey of Finnish men, the other a Mechanical Turk sample—I investigated the psychology of paternity assessment. The aims of the research were threefold: 1) to use the most stringent criteria suggested by theory to test prior claims that perceived partner fidelity and offspring resemblance serve as cues to paternity; 2) to apply these same criteria to a novel candidate cue, the interaction of partner fidelity with maternal perinatal association; and 3) to determine whether the effects of any proposed cues on offspring-directed behavior were mediated by self-reported relatedness certainty.

Perceived Partner Fidelity and Offspring Resemblance as Cues to Paternity

Prior research has established that partner fidelity and offspring resemblance are linked to the levels of investment and altruism that fathers direct toward their offspring, consistent with the hypothesis that these factors serves as cues to paternity assessment. Leading theories of kinship estimation, however, require that candidate kinship cues influence not only altruistic motivation but also sexual motivation toward the putative relative. Accordingly, this research subjected the candidate cues of partner fidelity and offspring resemblance to the most rigorous test possible, by determining whether each candidate cue was simultaneously associated with both altruistic motivation and sexual motivation. In doing so, it employed not only the statistical methods favored by prior kin detection researchers (e.g. Sznycer et al., 2016)—linear regression using candidate cues to predict one motivational outcome at a time—but also quantitative techniques novel to kin detection research, which tested whether candidate cues predict categorization of participants based on combining altruistic and sexual outcomes.

Overall results for previously research candidate cues to paternity are summarized in the central columns of Table 13. In the case of perceived partner fidelity, the evidence is clear: perceived partner fidelity was a significant predictor of the designated outcome in every test conducted, regardless of sample or outcome measure. Considering tests in which motivational outcomes were used as dependent variables taken one at a time, perceived partner fidelity consistently predicted daughter-directed altruism, in both Study 1 and Study 2. Moreover, perceived partner fidelity consistently predicted daughter-directed sexual motivation: in Study 1, it predicted a measure of sexual arousal and a separate measure of sexual disgust, while in Study 2 it predicted daughter's sexual appeal, the sole measure of sexual motivation in that study. In each of these tests, increased partner fidelity was associated, as expected, with increased altruism but with decreased motivation for sex.

Perceived partner fidelity was equally consistent in predicting joint outcomes involving categorization of participants based on both altruism and sexual motivation. In Study 1, perceived partner fidelity significantly predicted whether participants were multivariate outliers on the combination of altruism and sexual disgust, and on the combination of altruism and sexual arousal. In Study 2, perceived partner fidelity significantly predicted whether subjects were multivariate outliers on the combination of altruism and sexual appeal. Moreover, a latent class analysis was conducted for the Study 2 sample, yielding a readily interpretable two-class structure; perceived partner fidelity significantly predicted assignment to the appropriate latent class as well. For each of these tests, the effect of perceived partner fidelity was in the direction expected by theory: increased perceptions of partner infidelity increased the likelihood that

participants would be classified in the category marked by low levels of altruism and low levels of sexual disgust.

Altogether, the results summarized in Table 13 provide some of the strongest evidence yet collected that perceived partner fidelity operates as a cue which men use to assess paternity.

The evidence regarding offspring resemblance, however, was decidedly weaker. With respect to tests of motivational outcomes taken one at a time, resemblance predicted altruism in Study 2, but not in Study 1. Perhaps more notably, however, resemblance did not predict any of three measures of sexual motivation (as a sole outcome). It did not predict sexual arousal in Study 1, nor sexual disgust in Study 1, nor sexual appeal in Study 2. When categorization based on joint outcomes was used as the dependent variable, results were mixed. Resemblance significantly predicted classification of participants as multivariate outliers on the combination of altruism and sexual appeal in Study 2, but it did not predict multivariate outlier status in Study 1—using either the combination of altruism and sexual disgust, or the combination of altruism and sexual arousal. Nor did resemblance predict latent classification in Study 2. These findings thus provide only limited support for the hypothesis that offspring resemblance serves as a cue to paternity.

With regard to offspring resemblance, prior research has frequently though not always found an effect of resemblance upon paternal investment. Thus, it was a bit surprising that this effect failed to emerge in Study 1, though it did emerge in Study 2. Reasons for the divergent findings are unclear. The single-item measure of altruism in Study 1 (willingness to donate a kidney) may be suspected, but the identical measure was

sufficient to detect an effect of perceived partner fidelity in the same Study 1 sample. Moreover, if the Study 2 data are analyzed using only the same single item, rather than the 8-item composite, results remain unchanged, with both resemblance and partner fidelity predicting altruism. Use of the single-item measure thus seems unlikely to be the sole cause of the null findings in Study 1 regarding an effect of resemblance upon altruism, though analyses from Study 2 do suggest that the full 8-item altruism scale produced slightly lower standard errors and thus higher power (as we would hope and expect) vs. the single kidney-donation item. An additional possibility is that in Study 1, items asked about "physical resemblance" rather than "facial" resemblance in Study 2. Other studies, however, have assessed "physical" rather than "facial" resemblance (Heijkoop et al., 2009) and obtained significant results.

In our view, the findings reported here provide insufficient grounds to reject the large literature documenting effects of resemblance on offspring-directed altruism and investment, a literature to which the findings of Study 2 contribute. Instead, we call attention to the null findings from both Study 1 and Study 2 regarding resemblance and sexual motivation. The lack of any discernible effect of resemblance on sexual motivation as a single outcome—using three different measures across two samples—may cast doubt on the widespread conclusion that resemblance is likely to be a cue males use to assess paternity. Support for this conclusion relies heavily upon the array of studies we reviewed in our introduction linking father/offspring resemblance to investment. As we noted, however, such studies have not sought evidence linking resemblance to sexual motivation, the other behavioral domain necessary to establish kin detection. In the studies reported here, resemblance predicted joint categorization in only one out of the

four relevant tests that were conducted, and did not predict sexual motivation in any of the three studies in which such motivation was the sole outcome measure.

Let us note an additional source of support for the suggestion that resemblance is likely a cue to paternity: a body of experiments involving morphing of facial images (e.g., DeBruine, 2005). Such experiments tie facial resemblance to increased prosocial motivation and reduced sexual motivation simultaneously, thus meeting the stringent criteria for kin detection outlined above. However, these facial morphing studies employ roughly same-age participants and are not conducted in a context in which parent/offspring behaviors are made salient. This opens up the possibility that facial resemblance may serve as a cue to relatedness in some kin detection contexts, notably sibling detection, but perhaps not in other kin detection contexts, such as paternity assessment. If this possibility has merit, the body of research linking father/offspring resemblance to increased investment and altruism might then be explained not by resemblance serving as a cue of genetic relatedness, but by resemblance promoting an alternative pathway toward increased altruism. Of the various non-kin alternative pathways—both ultimate and proximate—that researchers have put forth to explain altruism, similarity as a cue to more valued association (Tooby and Cosmides, 1996) and as a proximate driver of emotional closeness (Korchmaros and Kenny 2001, 2006) may be possibilities worthy of consideration in this context. Additional research will be needed to address these and other possibilities.

There is no doubt that the theoretical case for offspring resemblance as a paternity cue is strong, and of course the results provided here regarding resemblance and offspring-directed sexual motivation will need to be replicated. For now, let us simply

note that the strongest case for any candidate kinship cue involves showing that it simultaneously affects both altruistic and sexual motivation toward putative kin. In two samples involving father/daughter relationships, perceived partner fidelity reliably met this standard; offspring resemblance did not.

Does the Interaction of Maternal Perinatal Association with Partner Fidelity Influence Paternity Estimates?

As the preceding discussion made clear, evidence strongly suggests that assessments of partner fidelity play a role in paternal offspring detection. Analyzing the task of paternal offspring detection from a computational perspective, however, provides grounds to suspect that assessments of partner fidelity by themselves may be inadequate to solving the adaptive problem. An offspring detection system that infers the relatedness of putative offspring solely on the basis of partner fidelity runs the risk of counting as kin the many unrelated children who are in contact with a faithful sexual partner. To avoid errors of this type, an offspring detection mechanism might integrate cues to partner fidelity with assessments of maternity certainty. Prior research has identified maternal perinatal association—observations of a mother caring for a newborn—as a reliable correlate of maternal/offspring relatedness that operates as a kinship cue in sibling detection contexts. Thus, we hypothesized that males might assess paternity by linking cues of partner fidelity with cues of maternal perinatal association. On this view, paternal investment and sexual motivation should be better predicted by the interaction of partner fidelity with MPA than by partner fidelity in isolation. We expected that the effect of fidelity would be stronger when MPA was present rather than absent, and that the highest

kinship estimates—manifested in increased altruism but decreased sexual motivation—should result from MPA-present men with high-fidelity mates.

As the rightmost columns of Table 13 reveal, the current research furnished no support for this hypothesis. Only Study 2 data were adequate to test the hypothesis, but in that study, the interaction of partner fidelity with MPA, as well as MPA alone, failed to predict either altruism, sexual appeal, or joint classification based on those outcomes, in the expected direction. Given that we found significant effects on these outcome measures by another candidate cue—partner fidelity by itself—it is difficult to attribute the null results to inadequate measures. Although power is of course reduced when attempting to detect interactions, our Study 2 sample included 50 MPA-negative participants. Perhaps higher-powered studies may profitably investigate this hypothesis in the future, but the current research provided no evidence to support the claim.

Does Self-Reported Relatedness Certainty Mediate the Effects of Kinship Cues on Altruism and Sexual Motivation?

Much prior work on candidate cues to paternity has documented associations between the cues and their relevant behavioral and motivational outputs, without determining whether such associations are mediated by consciously accessible beliefs about relatedness. Across two samples, we explicitly tested this possibility. Of particular note are results related to partner fidelity, the factor which was most strongly supported as a possible cue to paternity. The results, however, were decidedly mixed. Path analyses using the Study 1 sample indicated that relatedness certainty mediated—indeed, fully mediated—the effect of partner fidelity on all three pertinent outcomes: altruism, sexual arousal, and sexual disgust. In stark contrast, for the Study 2 sample relatedness certainty

did not mediate the effect of partner fidelity at all, on either altruism or sexual appeal. Additionally, Study 2 showed that relatedness certainty did not mediate the effect of facial resemblance on altruism, the only statistically significant direct effect that we found for resemblance. Thus, all evidence of mediation derived from Study 1 alone, suggesting the possibility of relevant methodological or sample differences across studies, though we know of no reason why this should be the case. Apart from this observation, the causes of these strikingly mixed results remain unclear, and await further research.

Limitations

The two studies reported above suffer from a number of limitations, most notably a reliance solely upon self-report methods, which may produce inaccurate results for multiple reasons, including social desirability effects. Such concerns may be particularly pertinent to the two outcomes of interest here—altruism and sexual motivation. Reported willingness to act altruistically may be strategically overstated, delivered in the interest of self-enhancement (Sznycer, et al., 2016). Relatedly, the threat of social disapproval may make participants reluctant to reveal their sexual motivations, especially toward daughters and other relatives. Despite these well-taken caveats, significant relationships in both the altruistic and sexual domains were detected despite any noise associated with self-report measures. And it is unlikely that the particular pattern of effects predicted for partner fidelity would emerge solely as a result of systematically upward bias in reported altruistic motivation and systematic downward bias in reported sexual motivation (Sznycer, et al., 2016).

The above limitation is exacerbated by the lack of well-validated measures for both altruism and sexual motivation, a limitation not unique to this study. Evolutionary researchers have long bemoaned the lack of a standard, validated instrument for assessing target-specific altruism—Lewis's (2011) complaint in his study of sibling detection is typical. Like Lewis, we have followed other researchers in compiling a composite of various items based on questions used in prior studies—e.g. Lieberman et al., 2007; Stewart-Williams, 2007; Lewis, 2011; Sznycer et al., 2016—but that have not been rigorously validated. As Lewis observed five years ago, kin detection researchers, along with other investigators of altruism in humans, would greatly benefit from one or more standardized measures, as well as the use of behavioral methods (e.g. the pain endurance paradigm used by Madsen et al., 2007). Much the same is true with regard to self-report measures of sexual motivation. We note with interest recent work on kin detection that introduced facial electromyography in the context of imagined sibling incest scenarios as a method for measuring the strength of sexual disgust responses (De Smet, van Speybroeck, & Verplaetse, 2014). We hope that the use of facial electromyography as a measure of sexual disgust will be further validated and extended, and perhaps be used to investigate the reliability of self-report measures of sexual motivation.

Conclusion

The two studies reported above extend prior research on the psychology of paternity assessment. These studies tested whether two previously researched candidate cues to paternity—perceived partner fidelity and offspring resemblance—predicted altruistic and sexual motivation simultaneously, in accord with the most stringent criteria available for proposed kinship cues. Results indicated that perceived partner fidelity met

these criteria, thus providing the strongest evidence to date that partner fidelity serves as a cue to paternity. The studies provided only partial support for offspring resemblance, which did not predict any measure of sexual motivation (taken one at a time). If robust to replication, the finding that offspring resemblance did not predict sexual motivation in our samples may cast doubt on the commonly held view that offspring resemblance is a cue to paternity. The findings emphasize the need to consider sexual as well as altruistic outcomes whenever possible in conducting kin detection research. Additionally, no support emerged for the novel proposition that partner fidelity and maternal perinatal association interact to influence kinship estimates. Finally, both studies investigated whether relatedness certainty might mediate the effects of kinship cues upon altruistic and sexual motivation, but furnished conflicting results.

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Appendix: Are effects of candidate cues robust to outlier removal?

Using candidate cues to predict categorization of cases based on multivariate outlier status replicated the pattern of results obtained from the linear regression analyses typical of prior kin detection research. Because outliers exert considerable influence upon regression analyses, however, a further question arises: does a candidate cue predict altruism and sexual motivation once these multivariate outliers are excluded?

To answer this post hoc question, the multivariate outliers identified in each sample were excluded, and multiple linear regression analyses repeated for each study. In Study 1, cases were removed if they were a multivariate outlier on either the combination of altruism and sexual disgust or on the combination of altruism and sexual appeal. This resulted in the removal of 24 cases. Using this reduced dataset, altruism was regressed on the control variables of father age and daughter age, then perceived partner infidelity and facial resemblance were entered into the model simultaneously. Adding the two candidate cues failed to improve the model significantly, $F_{change}(2, 361) = .82$, $p = .441$, $R^2_{change} = .005$. In Study 1, after removing multivariate outliers, neither perceived partner fidelity nor physical resemblance predicted altruism (fidelity: $b = .013$ [-.02, .05], se = .02, $p = .506$; resemblance: $b = -.02$ [-.06, .01], se = .02, $p = .220$. Again using the reduced Study 1 dataset, sexual disgust was then regressed on the control variables of father age and daughter age, after which perceived partner infidelity and facial resemblance were entered into the model simultaneously. Inclusion of the two candidate cues failed to improve the model, $F_{change}(2, 361) = 1.16$, $p = .316$, $R^2_{change} = .006$. Thus, with multivariate outliers removed, neither partner fidelity nor physical resemblance predicted sexual disgust (fidelity: $b < .001$ [-.007, .006], se = .003, $p = .975$; resemblance: $b = .008$

[-.001, .02], se = .01, p = .123). In a final test of the Study 1 sample with multivariate outliers removed, sexual arousal was regressed on father age and daughter age, with perceived partner fidelity and physical resemblance then added to the model. Inclusion of the two candidate cues again failed to improve the model, $F_{change}(2, 361) = .284$, $p = .753$, $R^2_{change} = .002$. With multivariate outliers excluded from the sample, neither partner fidelity nor physical resemblance predicted sexual arousal, controlling for father age, daughter age, and the other candidate cue (fidelity: b = -.002 [-.01, .004], se = .003, p = .472; resemblance: b = -.005 [-.02, .01], se = .01, p = .474). Study 1 therefore produced no evidence that candidate kinship cues exert significant effects on individuals who are not outliers on the combination of altruism and sexual motivation.

In Study 2, by contrast, candidate cues proved robust to outlier removal. After removing the 50 multivariate outliers identified in the Study 2 sample, altruism was first regressed on the control variables of father age, daughter age, father household income range, and daughter attractiveness. Then perceived partner infidelity and facial resemblance were entered simultaneously, resulting in a statistically significant improvement to the model, $F_{change}(2, 571) = 12.30$, $p < .001$, $R^2_{change} = .04$. Controlling for the four other variables, even after removing multivariate outliers, both perceived partner infidelity and facial resemblance continued to predict altruism (infidelity: b = -.06 [-.10, -.03], se = .02, $p < .001$; facial resemblance: b = .09 [.04, .14], se = .03, p = .001). Examined next were the effects of perceived partner infidelity and facial resemblance on sexual appeal, after excluding multivariate outliers. Sexual appeal was first regressed on the four control variables, then perceived partner fidelity and facial resemblance were simultaneously introduced into the model. The model was significantly improved,

$F_{change}(2, 571) = 4.67$, $p = .010$, $R^2_{change} = .02$. Consistent with results obtained using the full Study 2 sample, perceived partner infidelity predicted sexual appeal, ($b = .314$ [.09, .54], se = .13, $p = .019$), but facial resemblance did not ($b = -.24$ [-.59, .09], se = .17, $p = .150$. Contrary to Study 1, Study 2 thus provided evidence that candidate cues may exert effects even upon men who are not outliers on the combination of daughter-directed altruism and sexual motivation.

Figure 1.

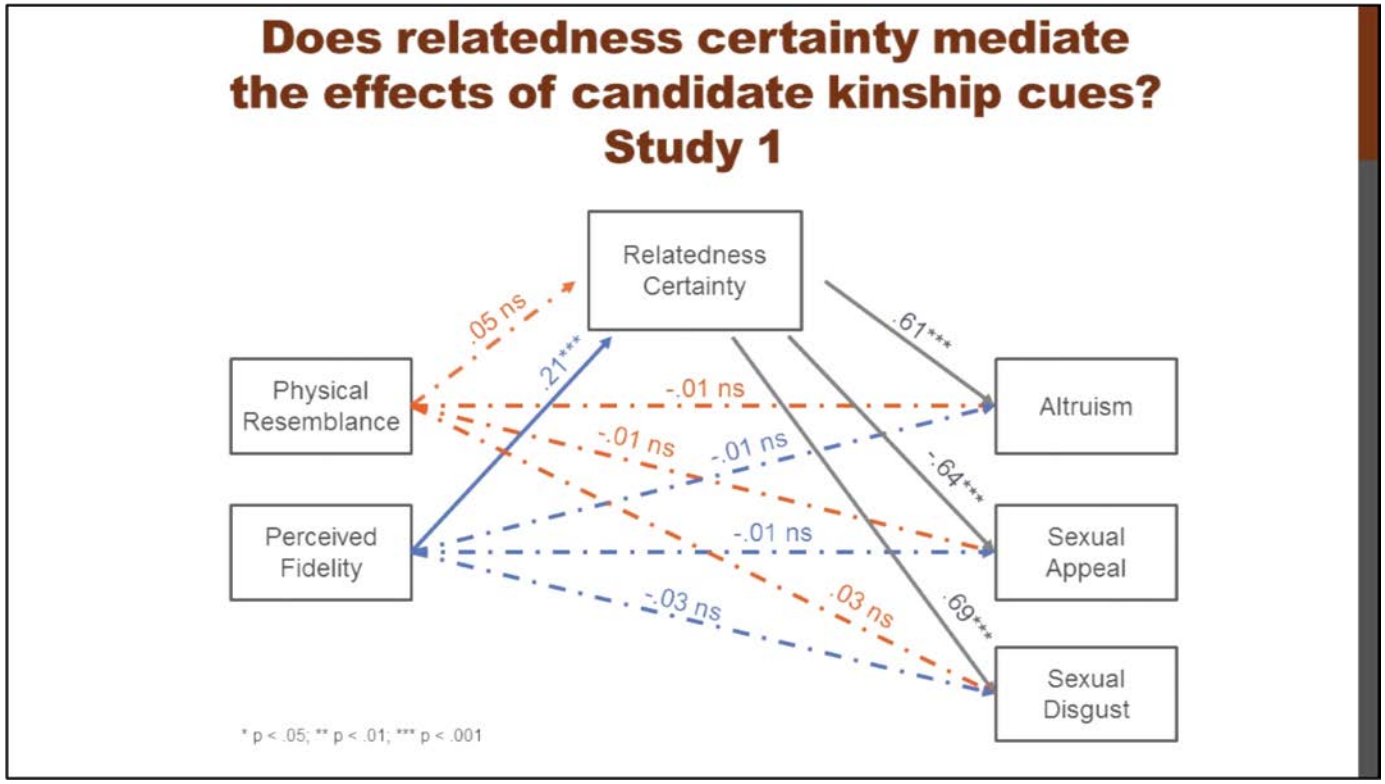
Does relatedness certainty mediate the effects of candidate kinship cues? Study 1
Relatedness Certainty
Physical Resemblance
Perceived Fidelity
Altruism
Sexual Appeal
Sexual Disgust
.05 ns
.21***
-.01 ns
-.01 ns
-.01 ns
-.01 ns
-.03 ns
.03 ns
.61***
-.64***
.69***
* p < .05; ** p < .01; *** p < .001

Figure 2.

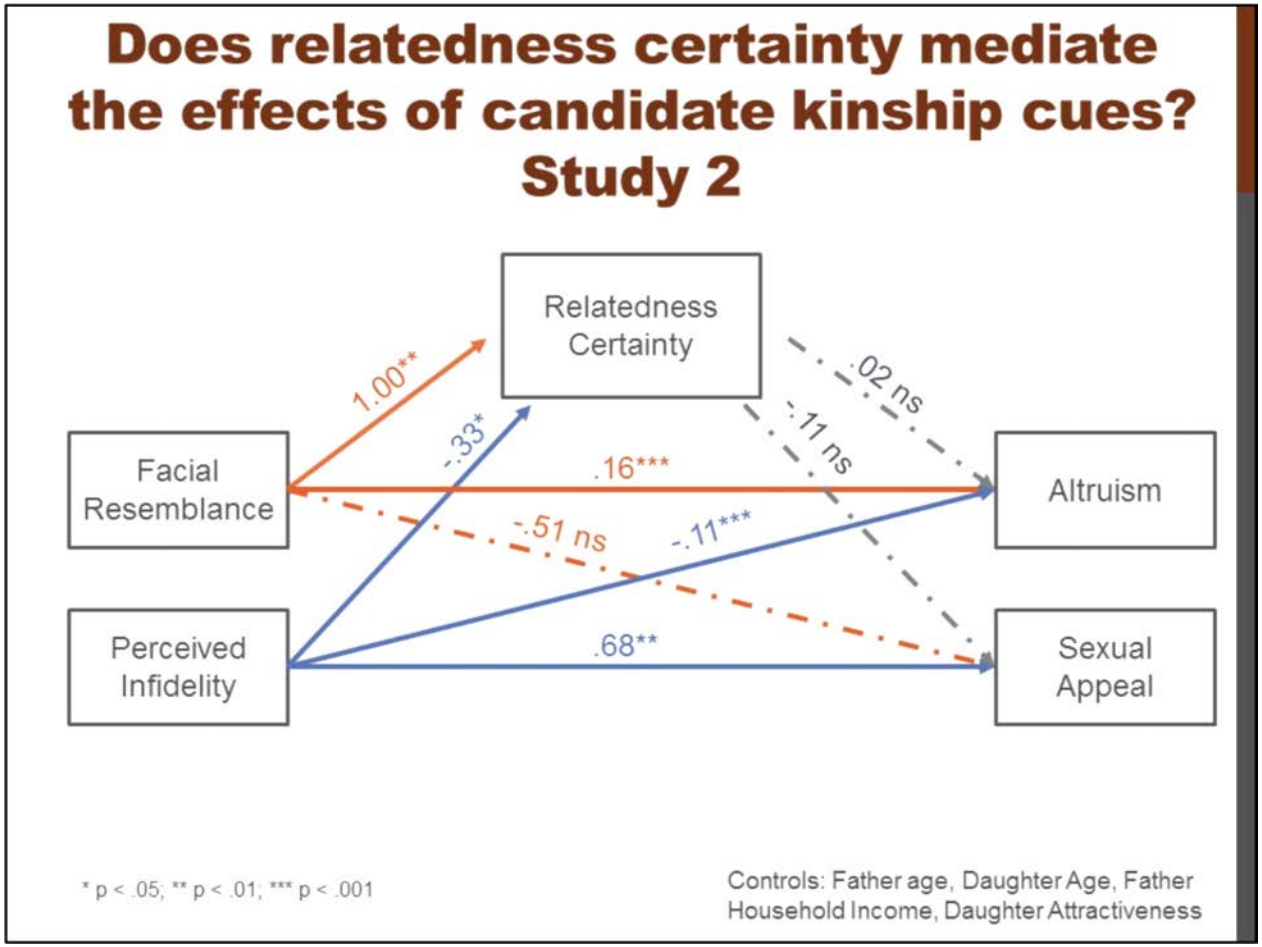
Does relatedness certainty mediate the effects of candidate kinship cues? Study 2
Relatedness Certainty
Facial Resemblance
Perceived Infidelity
Altruism
Sexual Appeal
1.00**
-.33*
.16***
-.51 ns
-.11***
.68**
.02 ns
-.11 ns
* p < .05; ** p < .01; *** p < .001
Controls: Father age, Daughter Age, Father Household Income, Daughter Attractiveness

Table 1: Fit Statistics for Latent Class Analysis, Study 2

Number of Latent Classes	Loglikelihood	Akaike Information Criteria	Bayesian Information Criteria	Adjusted Bayesian Information Criteria	Vuong-Lo-Mendell-Rubin Likelihood Ratio Test	Lo-Mendell-Rubin Adjusted Likelihood Ratio Test	Parametric Boostrapped Likelihood Ratio Test	Entropy
2	12515.564	25255.13	25764.85	25409.23	$p = .018$	$p = .019$	$p < .001$	.998
3	11594.029	23520.06	24275.54	23748.45	$p = .761$	$p = .761$	$p < .001$	.948

Table 2: Latent Class Analysis, Two-Class Solution, Study 2

Item	Comparative Statistic	Class 1 (N = 647)	Class 2 (N = 53)
Tongue-kissing daughter	Mean	-4.58	2.25
Seeing daughter naked	Mean	-3.11	2.56
Daughter making sexual advance	Mean	-4.69	2.36
Dream of sex with daughter	Mean	-4.72	2.63
Having sex with daughter	Mean	-4.92	2.74
Donate kidney	Odds Ratio Category > 4 Class 1 vs. 2	4.05	
Do jail time	Odds Ratio Category > 4 Class 1 vs. 2	1.46	
Give 1/2 year's salary	Odds Ratio Category > 4 Class 1 vs. 2	2.68	
Loan $1000	Odds Ratio Category > 4 Class 1 vs. 2	2.93	
Give $1000	Odds Ratio Category > 4 Class 1 vs. 2	2.46	
Work 1 year for education	Odds Ratio Category > 4 Class 1 vs. 2	2.43	
Dedicate 6 months to accident recuperation	Odds Ratio Category > 4 Class 1 vs. 2	6.02	
Stay with in hospital to aid illness recovery	Odds Ratio Category > 4 Class 1 vs. 2	4.25	

Table 3: Latent Class Analysis, Three-Class Solution, Study 2

Item	Comparative Statistic	Class 1 (N = 440)	Class 2 (N = 207)	Class 3 (N = 53)
Tongue-kissing daughter	Mean	-4.68	-4.38	2.26
Seeing daughter naked	Mean	-3.02	-3.31	2.57
Daughter making sexual advance	Mean	-4.71	-4.63	2.37
Dream of sex with daughter	Mean	-4.75	-4.64	2.63
Having sex with daughter	Mean	-4.93	-4.88	2.75
Item	**Comparative Statistic**	**Class 1 vs. 2**	**Class 1 vs. 3**	**Class 2 vs. 3**
Donate kidney	Odds Ratio, Category > 4	30.79	37.92	1.23
Do jail time	Odds Ratio, Category > 4	7.96	3.87	0.49
Give 1/2 year's salary	Odds Ratio, Category > 4	12.06	9.61	0.8
Loan $1000	Odds Ratio, Category > 4	11.41	11.25	0.99
Give $1000	Odds Ratio, Category > 4	9.79	7.91	0.81
Work 1 year for education	Odds Ratio, Category > 4	16.83	11.48	0.68
Dedicate 6 months to accident recuperation	Odds Ratio, Category > 4	111.36	190.38	1.71
Stay with in hospital to aid illness recovery	Odds Ratio, Category > 4	98.26	118.13	1.2

Table 4. Multiple Regression Analyses for Study 1: Previously Researched Cues of Paternity

	Outcome: Altruism		***Outcome: Sexual Arousal***		***Outcome: Sexual Disgust***	
Variable	**B 95% [BCa CI]**	***se***	**B 95% [BCa CI]**	***se***	**B 95% [BCa CI]**	***se***
Constant	**93.67*** [81.62, 104.80]**	**5.90**	**-1.50 [-10.97, 8.53]**	**.74**	**97.67*** [85.66, 107.76]**	**.69**
Perceived Partner Fidelity	**.12* [.01, .24]**	**.06**	**-.14* [-.27, -.04]**	**.06**	**.11† [.01, .22]**	**.05**
Physical Resemblance	**.02 [-.07, .12]**	**.05**	**-.05 [-.13, .03]**	**.04**	**.06 [-.01, .13]**	**.04**
Father Age	**.09 [-.26, .45]**	**.18**	**.14 [-.15, .43]**	**.15**	**.01 [-.30, .36]**	**.17**
Daughter Age	**-.42† [-.87, .03]**	**.23**	**-.03 [-.31, .31]**	**.16**	**-.06 [-.39, .24]**	**.16**
R^2	**.058**		**.064**		**.059**	
F	**5.92**		**6.58**		**6.02**	
p	**< .001**		**< .001**		**< .001**	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

Table 5. Multiple Regression Analyses for Study 2: Previously Researched Cues of Paternity

	Outcome: Altruism		***Outcome: Sexual Appeal***	
Variable	**B 95% [BCa CI]**	***se***	**B 95% [BCa CI]**	***se***
Constant	**4.42*** [3.83, 5.02]**	**.04**	**-25.47*** [-31.01, -20.13]**	**.40**
Perceived Partner Infidelity	**-.11*** [-.15, -.07]**	**.02**	**.68** [.19, 1.21]**	**.26**
Facial Resemblance	**.16*** [.10, .23]**	**.04**	**-.51 [-1.23, .17]**	**.36**
Father Age	**.01 [-.003, .02]**	**.01**	**.05 [-.09, .18]**	**.07**
Daughter Age	**.00 [-.03, .02]**	**.01**	**-.09 [-.28, .11]**	**.10**
Father Household Income	**.03* [.01, .06]**	**.01**	**-.08 [-.39, .25]**	**.16**
Daughter Physical Attractiveness	**.27*** [.18, .35]**	**.04**	**1.35** [.63, 2.11]**	**.37**
R^2	**.22**		**.04**	
F	**29.92**		**3.93**	
p	**< .001**		**.001**	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

Table 6. Logistic Regressions of Multivariate Outlier Status: Previously Researched Cues of Paternity

	Study 1: Multivariate Outlier for Altruism & Sexual Disgust? Yes or No		***Study 1: Multivariate Outlier for Altruism & Sexual Arousal? Yes or No***		***Study 2: Multivariate Outlier for Altruism & Sexual Appeal? Yes or No***	
Variable	**B [95% BCa CI]**	***Odds Ratio* [95% CI]**	**B [95% BCa CI]**	***Odds Ratio* [95% CI]**	**B [95% BCa CI]**	***Odds Ratio* [95% CI]**
Constant	**-3.94 [-9.15, .07]**	**-**	**-4.35* [-8.12, -1.18]**	**-**	**-2.46 [-5.35, .06]**	**-**
Perceived Partner Fidelity‡	**-.022* [-.04, -.003]**	**.978 [.96, .996]**	**-.023** [-.04, -.01]**	**.977 [.96, .993]**	**.23** [.09, .40]**	**1.26 [1.10, 1.45]**
Resemblance	**-.013 [-.03, .009]**	**.987 [.97, 1.01]**	**-.01 [-.03, .01]**	**.99 [.97, 1.01]**	**-.30* [-.52, -.07]**	**.74 [.60, .92]**
Father Age	**-.03 [-.22, .15]**	**.97 [.84, 1.12]**	**.01 [-.13, .13]**	**.92 [.89, 1.14]**	**-.02 [-.09, .04]**	**.98 [.93, 1.04]**
Daughter Age	**.14* [.003, .32]**	**1.15 [1.01, 1.30]**	**.08 [-.03, .23]**	**1.09 [.98, 1.21]**	**.04 [-.06, .13]**	**1.04 [.96, 1.12]**
Father Household Income	**-**	**-**	**-**	**-**	**-.08 [-.21, .03]**	**.92 [.82, 1.04]**
Daughter Attractiveness	**-**	**-**	**-**	**-**	**.11 [-.27, .55]**	**1.12 [.84, 1.47]**
R^2 Cox & Snell	**.051**		**.046**		**.032**	
R^2 Nagelkerke	**.163**		**.130**		**.075**	
X^2	**20.40**		**18.20**		**20.45**	
Df	**4**		**4**		**6**	
p	**< .001**		**.001**		**.002**	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

‡Note that in Study 2, this variable is *infidelity*—thus the change in sign across studies.

Table 7. Logistic Regression Analysis for Study 2: Previously Researched Cues of Paternity

	Outcome: ***Latent Class 1 vs. Latent Class 2***	
Variable	**B** **95% [BCa CI]**	**Odd Ratio** **95% [BCa CI]**
Constant	**-3.69**** **[-6.58, -.92]**	**-**
Perceived Partner Infidelity	**.22**** **[.08, .35]**	**1.24** **[1.08, 1.42]**
Facial Resemblance	**-.13** **[-.35, .07]**	**.88** **[.71, 1.09]**
Father Age	**.00** **[-.05, .05]**	**1.00** **[.95, 1.06]**
Daughter Age	**-.02** **[-.12, .05]**	**.98** **[.90, 1.06]**
Father Household Income	**-.11†** **[-.24, .004]**	**.89** **[.79, 1.01]**
Daughter Physical Attractiveness	**.42**** **[.13, .79]**	**1.52** **[1.12, 2.06]**
R^2 Cox & Snell	**.029**	
R^2 Nagelkerke	**.070**	
X^2	**20.17**	
p	**.003**	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

Table 8. Does the Interaction of Maternal Perinatal Association with Partner Infidelity Influence Daughter-Directed Motivation? Regression Analyses from Study 2

	Outcome: Altruism						**Outcome: Sexual Appeal**					
	Model 1		*Model 2*		*Model 3*		*Model 4*		*Model 5*		*Model 6*	
Variable	B 95% [BCa CI]	*se*	B 95% [BCa CI]	*se*	B 95% [BCa CI]	*se*	B 95% [BCa CI]	*se*	B 95% [BCa CI]	*se*	B 95% [BCa CI]	*se*
Constant	6.18*** [6.11, 6.25]	.04	5.93*** [5.58, 6.28]	.18	5.93*** [5.53, 6.28]	.19	-19.48*** [-20.25, 18.69]	.39	-22.00*** [-23.52, -20.29]	.86	-22.03*** [-23.42, -20.46]	.75
Perceived Partner Infidelity	-.12*** [-.17, -.07]	.03	-.12*** [-.17, -.07]	.03	-.11 [-.30, .05]	.09	.56* [.11, 1.04]	.24	.60** [.14, 1.10]	.24	.64† [-.07, 1.40]	.39
MPA	-	-	.27 [-.08, .63]	.18	.27 [-.09, .63]	.18	_	_	2.71** [.80, 4.48]	.97	2.74** [1.02, 4.37]	.86
MPA x Perceived Partner Infidelity	-	-	-	-	-.004 [-.17, .19]	.09	_	_	_	_	-.05 [-1.01, .88]	.48
R^2	.047		.052		.052		.009		.014		.014	
F	32.25		17.80		11.85		6.30		4.67		3.11	
p	< .001		< .001		< .001		.012		.010		.026	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

Table 9. Logistic Regression Analysis for Study 2: MPA and the Interaction of MPA with Perceived Infidelity

	Model A		***Model B***		***Model C***	
	Outcome: Multivariate Outlier for Altruism & Sexual Appeal? Yes or No		***Outcome: Multivariate Outlier for Altruism & Sexual Appeal? Yes or No***		***Outcome: Multivariate Outlier for Altruism & Sexual Appeal? Yes or No***	
Variable	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**
Constant	**-2.52*** [-6.88, -.62]**	**-**	**-2.55*** [-3.96, -1.83]**	**-**	**-2.44*** [-3.83, -1.88]**	**-**
Perceived Partner Infidelity	**.22*** [.09, .34]**	**1.24 [1.09, 1.42]**	**.22** [.09, .34]**	**1.24 [1.09, 1.42]**	**.14 [-.64, 1.82]**	**1.15 [.71, 1.86]**
MPA	**-**	**-**	**.03 [-1.10, 19.00]**	**1.03 [.35, 3.06]**	**-.08 [-1.47, 19.00]**	**.90 [.27, 3.17]**
Interaction of MPA/Infidelity	**-**	**-**	**-**	**-**	**.08 [-.47, .60]**	**1.09 [.66, 1.79]**
R^2 Cox & Snell	**.014**		**.014**		**.014**	
R^2 Nagelkerke	**.033**		**.033**		**.034**	
X^2	**9.00**		**9.01**		**9.11**	
Df	**1**		**2**		**3**	
p	**.003**		**.011**		**.028**	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

Table 10. Logistic Regression Analysis for Latent Classification: Interaction of MPA with Perceived Partner Infidelity, Study 2

	Model D Outcome: Latent Class 1 vs. Latent Class 2		***Model E Outcome: Latent Class 1 vs. Latent Class 2***		***Model F Outcome: Latent Class 1 vs. Latent Class 2***		***Model G Outcome: Latent Class 1 vs. Latent Class 2***	
Variable	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**	**B 95% [BCa CI]**	**Odd Ratio 95% [BCa CI]**
Constant	**-2.58** [-2.88, -2.32]**	-	**-2.63*** [-4.01, -1.98]**	-	**-3.47*** [-21.2, -2.56]**	-	**-4.13** [-11.06, -1.79]**	-
Perceived Partner Infidelity	**.18** [.05, .29]**	**1.20 [1.05, 1.37]**	**.18** [.06, .29]**	**1.20 [1.05, 1.37]**	**.56** [.00, 28.58]**	**1.78 [.99, 3.22]**	**.61** [.05, 30.63]**	**1.85 [1.04, 3.29]**
MPA	-	-	**.05 [-.88, 18.76]**	**1.06 [.36, 3.10]**	**.91 [-.51, 138.31]**	**2.48 [.35, 17.67]**	**.86 [-.57, 147.26]**	**2.37 [.35, 16.00]**
MPA*Partner Infidelity	-	-	-	-	**-.43† [-9.82, .04]**	**.65 [.36, 1.20]**	**-.45* [-1.33, -.11]**	**.64 [.35, 1.16]**
Father Age	-	-	-	-	-	-	**.00 [-.06, .05]**	**1.00 [.95, 1.06]**
Daughter Age	-	-	-	-	-	-	**-.02 [-.13, .06]**	**.98 [.90, 1.07]**
Father Household Income	-	-	-	-	-	-	**-.13* [-.26, -.01]**	**.88 [.78, .99]**

Daughter Physical Attractiveness	-	-	-	-	-	-	**.36* [.04, .77]**	**1.43 [1.07, 1.93]**
R^2 Cox & Snell	**.01**		**.01**		**.01**		**.03**	
R^2 Nagelkerke	**.02**		**.02**		**.03**		**.07**	
X^2	**6.27**		**6.28**		**8.54**		**20.40**	
Df	**1**		**2**		**3**		**7**	
p	**.012**		**.043**		**.036**		**.005**	

*** $p < .001$; ** $p < .01$; * $p < .05$; † $p < .10$.

Table 11. Does Relatedness Certainty Mediate the Effects of Kinship Cues, Study 1

Indirect Effects Via Relatedness Certainty	Point Estimate	95% CI Lower Bound	95% CI Upper Bound	se	p
Perceived Partner Fidelity on Altruism	0.13	0.01	0.24	0.06	0.035
Perceived Partner Fidelity on Sexual Appeal	-0.13	-0.25	-0.01	0.06	0.028
Perceived Partner Fidelity on Sexual Disgust	0.14	0.02	0.27	0.06	0.024
Physical Resemblance on Altruism	0.03	-0.02	0.07	0.02	0.213
Physical Resemblance on Sexual Appeal	-0.03	-0.08	0.02	0.02	0.203
Physical Resemblance on Sexual Disgust	0.03	-0.02	0.08	0.03	0.198

Table 12. Does Relatedness Certainty Mediate the Effects of Kinship Cues, Study 2

Indirect Effects Via Relatedness Certainty	Point Estimate	95% CI Lower Bound	95% CI Upper Bound	se	p
Facial Resemblance on Altruism	0.02	-0.003	0.04	0.01	0.090
Facial Resemblance on Sexual Appeal	-0.11	-0.24	0.02	0.07	0.100
Perceived Partner Infidelity on Altruism	-0.01	-0.02	0.01	0.01	0.338
Perceived Partner Infidelity on Sexual Appeal	0.04	-0.03	0.1	0.03	0.287

Table 13. Summary Table: Which Outcomes Did Candidate Cues to Paternity Successfully Predict?

		Candidate Cues			
Study	**Outcome of Interest**	**Perceived Partner Fidelity**	**Resemblance**	**Maternal Perinatal Association (MPA)**	**Interaction of MPA With Fidelity**
Study 1	Altruism	Yes	No	N/A	N/A
Study 1	Sexual Disgust	Yes	No	N/A	N/A
Study 1	Sexual Arousal	Yes	No	N/A	N/A
Study 1	Multivariate Outlier for Altruism & Sexual Disgust	Yes	No	N/A	N/A
Study 1	Multivariate Outlier for Altruism & Sexual Arousal	Yes	No	N/A	N/A
Study 2	Altruism	Yes	Yes	No	No
Study 2	Sexual Appeal	Yes	No	No	No
Study 2	Multivariate Outlier for Altruism & Sexual Appeal	Yes	Yes	No	No
Study 2	Latent Class 1 vs Latent Class 2	Yes	No	No	No