

Family Relationships

An Evolutionary Perspective

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10 Kin Detection and the Development of Sexual Aversions: Toward an Integration of Theories on Family Sexual Abuse

Ilanit Tal and Debra Lieberman

Sexual abuse is a pressing social problem. In the 1990s alone, there were approximately 336,000–429,000 annual reports of child sexual abuse in the United States (Peddle & Wang 2001) with 90,000–150,000 annual cases substantiated by child-protective agencies (Jones & Finkelhor 2001; Jones, Finkelhor, & Kopiec 2001). In a survey of undergraduate students, Finkelhor (1984) found that almost 50% of students reported an unwanted non-penetrative sexual experience, and 16% reported an unwanted penetrative sexual experience before the age of 16. With respect to sexual abuse within the family, specific rates are difficult to assess given the bias against reporting family abuse to authorities. Nevertheless, in a study surveying adult women from the San Francisco area, Russell (1983) found that 16% reported at least one such experience before the age of 18. Given these statistics, it is not surprising that researchers and social workers alike are concerned with understanding *why* sexual abuse occurs and identifying the factors that put children at risk for both intrafamilial and extrafamilial sexual abuse.

Despite decades of research, however, the field of child sexual abuse still lacks an integrative theoretical framework (Cole & Putnam 1992). Consequently, much of the work to date has been descriptive, focusing on, for example, incidence rates (e.g., Finkelhor 1979, 1980; Russell 1983, 1986), how rates have changed over time (e.g., Dunne, Purdie, Cook, Boyle, & Najman

2003; Jones, Finkelhor, & Kopiec 2001), the negative effects on victims (e.g., the development of clinical and psychiatric disorders, Kendall-Tackett, Williams, & Finkelhor 1993; Molnar, Buka, & Kessler 2001; Weiss, Longhurst, & Mazure 1999), and the characteristics of families, victims, and perpetrators of abuse (e.g., Adler & Schutz 1995; Burkett 1991; Hartley 2001; Laviola 1992; Lung & Huang 2004; Smith & Israel 1987; Trepper, Niedner, Mika, & Barrett 1996; Worling 1995).

Although much is known about the sequelae of sexual abuse and the characteristics of the individuals and families involved, these pieces of information have yet to be arranged to form a clear picture of *why* sexual abuse occurs. In this chapter, we provide an account of how an evolutionary computational framework can help organize what is currently known about sexual abuse and provide a set of answers to the question of why. Specifically, we focus on one component of our evolved psychology hypothesized to play a significant role in explaining why familial sexual abuse occurs: mechanisms governing the development of sexual aversions toward close genetic relatives. We suggest that identifying the cues our evolved psychology uses to detect kin and generate sexual aversions toward them can help illuminate why sexual aversions fail to develop, leading, in some circumstances, to an increased risk of sexual abuse. Other concepts also hypothesized to predict patterns of abuse, but not fully explored in this chapter, include mate value (e.g., men with low mate value might target younger females to sidestep the competition for high mate-value females) and inbreeding conflict (e.g., the costs associated with inbreeding are lower for men compared to for women, leading to asymmetric motivations to commit and avoid these sexual encounters). Together, these concepts provide useful guide-rails for organizing our knowledge regarding sexual abuse and generating new avenues of research.

To start, we very briefly discuss two current models of sexual abuse: the family-systems model and the model developed by David Finkelhor, a leading researcher in the field of child sexual abuse. Next, we discuss an evolutionary-computational model of inbreeding avoidance. This entails a discussion of why inbreeding avoidance mechanisms exist and how evolution might have engineered such a system. We focus on the potential cues evolution might have used to detect different types of family members (e.g., offspring, parents, and siblings). We argue that identifying the cues used to guide kin detection can shed light on those circumstances that compromise kin detection and result in a failure to trigger strong sexual aversions. The last section of our paper integrates the features of sexual abuse identified by previous models into an evolutionary-computational framework of kin detection and inbreeding avoidance. Our goal is to demonstrate how an

evolutionary framework can help generate new lines of inquiry and inform public policy and programs relating to child sexual abuse.

A SELECTION OF CURRENT MODELS OF SEXUAL ABUSE

Family-Systems Model

As the name suggests, this approach views the family as "a system" and describes the factors that compromise the system and prevent its functioning properly (Friedman 1988, Minuchin 1974). With respect to sexual abuse within the family, the family-systems model was first applied to explain father-daughter and stepfather-stepdaughter incest, and focuses primarily on the health of the marital relationship (Furniss 1983, 1985). Father-daughter sexual abuse is said to occur when the marital relationship breaks down and the mother does not fulfill her duties as mother and wife, causing the father to substitute a daughter for his wife both emotionally and sexually, a process called triangulation (e.g., Greenspun 1994).

More recently, a family systems approach has been applied to explain sibling sexual abuse. As with father-daughter sexual abuse, explanations for sibling sexual behavior focus on the marital relationship. Sibling incest has been found to occur in families with marital conflict or where the parents are neglectful or emotionally distant (e.g., Hardy 2001, Laviola 1992, Pierce & Pierce 1990, Smith & Israel 1987). Specifically, families in which sibling incest has occurred have been characterized as having a neglectful mother (e.g., Laviola 1992).

In general, then, the deterioration of familial relationships is seen as the cause of intrafamilial sexual abuse in the family-systems model. Fathers abuse daughters because the relationship with the mother has deteriorated and the daughter is capable of filling the void; brothers abuse sisters, or siblings engage in consensual incest for comfort when parental relations disintegrate. There have been many criticisms of the family-systems model, including its limitations in explaining extrafamilial sexual abuse (e.g., Finkelhor 1984) and its focus on the mother (e.g., by feminist theories of sexual abuse, which emphasize the power of men over women [Herman 1981]).

The family-systems model also raises important questions: Why is it that the mother plays a key role in mitigating the risk of sexual abuse? Why is the quality of the marital relationship important? And are all seeds of marital conflict factors that contribute to sexual abuse, or only some? As we discuss below, integrating what is known from the family-systems approach with an evolutionary-computational framework can help answer these important questions.

Finkelhor's Preconditions of Sexual Abuse

According to David Finkelhor, a leading researcher and theorist within the field of child sexual abuse, there is a need for a more comprehensive theory of sexual abuse (Finkelhor 1984). Specifically, Finkelhor argues the field has mainly relied on two useful yet disjointed models of sexual abuse: the family-systems model (see above) and models that focus primarily on the attributes of the offender (e.g., the existence of psychopathy and the developmental history of abuse). What is missing, Finkelhor claims, is a general model of sexual abuse that incorporates psychological and also sociological factors related to victims, families, and offenders. In an attempt to unify the disparate theoretical frameworks, Finkelhor proposes a model describing several preconditions that contribute to the occurrence of sexual abuse. These include the presence of motivations to sexually abuse and the ability of the abuser to overcome internal and external inhibitors. We briefly discuss each in turn.

Motivations to Sexually Abuse

According to Finkelhor, an individual's motivation to sexually abuse a child can be influenced by a number of factors. These include: (i) the desire to fulfill an emotional need due to, for example, a lack of emotional development or the need to exert power; (ii) the experience of sexual arousal that can result from a biological abnormality or the recollection of a traumatic (or pleasant) childhood sexual experience; and (iii) the unavailability of alternate sexual partners (termed "blockage"), which might be a function of social skills, marital problems, and traumatic adult sexual experiences.

Overcoming Inhibitors

In addition to the presence of motivations to abuse, abusers must overcome internal and external inhibitors before an instance of sexual abuse occurs; even when motivations to abuse exist, if an individual is dissuaded by any inhibitor, no abuse will occur. Identification of these inhibitors is thus an important component for understanding the occurrence and also the prevention of sexual abuse. Internal disinhibitions can occur when judgments and decision-making processes relating to sexual behavior are impaired. This might be a result of drug or alcohol abuse (e.g., see Famularo, Stone, Barnum, & Wharton 1986; Walsh, MacMillan, & Jamieson 2003), impairments due to clinical abnormalities (e.g., psychosis), or age-related cognitive dysfunctions. Finkelhor also includes the failure of incest-avoidance mechanisms as an internal factor influencing the inhibition of sexual behavior, a topic we turn to in the next section.

External inhibitors of sexual abuse focus on the social environment and family dynamics. Using a method similar to that of the family-systems model discussed above, Finkelhor stresses the importance of the mother when he evaluates a child's risk of being sexually abused. Specifically, Finkelhor found that individuals whose mother was absent, often ill, emotionally distant, or in a sexually or physically abusive relationship (either currently or during her childhood) were more likely to have experienced childhood sexual abuse. In addition, children whose mothers introduced boyfriends or new husbands into the family reported more incidents of sexual abuse. Thus, a consistent finding in the literature is that a healthy, emotionally available mother who maintains a stable relationship with the child's biological father serves as an inhibiting force, protecting the child from the risk of being sexually abused. In addition to mothers, other members of the social environment can be a source of external inhibition. The greater the interaction with siblings, friends, and neighbors, the less likely individuals are to have experienced childhood sexual abuse. Indeed, those with few friends and those who lived in social isolation (e.g., on farms or in the woods) reported greater incidents of sexual abuse compared to those with many friends or those who lived close to neighbors (Finkelhor 1984).

In summary, Finkelhor proposes a general framework that can be applied to any form of sexual abuse, intrafamilial or extrafamilial. Accordingly, each instance of sexual abuse requires an understanding of the motivations to target another sexually and the inhibitors that might have been absent or impaired that otherwise would have prevented the sexual behavior from occurring. By and large, this model catalogues a number of important factors contributing to sexual abuse. But is there a theoretical framework that can organize this information and generate predictions regarding, for example, why certain factors play an inhibitory role or what distinguishes those individuals who sexually target children versus those who do not? Finkelhor's model, though it is much more comprehensive than previous formulations, still leaves unanswered the question of why the mother plays such a critical role in child sexual abuse. Furthermore, what is the structure of inbreeding-avoidance mechanisms and why might they fail to deploy in certain situations? In the next section, we outline an evolutionary-computational model of inbreeding avoidance that identifies the ways in which sexual aversions might fail to develop, introducing the possibility of sexual abuse.

AN EVOLUTIONARY-COMPUTATIONAL MODEL: KIN DETECTION AND SEXUAL AVERSIONS

One approach to understanding why sexual abuse sometimes occurs is to first identify the computational mechanisms that govern sexual avoidance.

One category of individuals for whom there are likely to be mechanisms mediating sexual avoidance is close kin. Indeed, there are sound biological reasons why evolution is expected to have selected for mechanisms that function to prevent sexual relations with close genetic relatives. The selection pressures posed by deleterious recessive mutations (Bittles & Neel 1994) and short-generation pathogens (Tooby 1982) would have meant that, on average, individuals who selected less genetically related individuals as mates would have left a greater number of healthy offspring compared to individuals who mated randomly or with individuals who had a high probability of sharing similar genes. Furthermore, the closer the genetic relatedness between two individuals, the more deleterious the reproductive consequences, with the most severe consequences occurring for matings between parents and offspring and between siblings (i.e., individuals for whom degree of relatedness equals 0.5). The negative reproductive consequences of inbreeding have been well established in humans and nonhumans. Offspring of close genetic relatives suffer increased rates of mortality, physical defects, and cognitive impairments (e.g., see Adams & Neel 1967; Carter 1967; Charlesworth & Charlesworth 1999; Crnokrak & Roff 1999; Keller, Arcese, James, & Hochachka 1994; Seemanova 1971).

But *how* do humans avoid inbreeding? What cognitive processes are required to avoid genetic relatives as mates? One method for answering this question is to consider what a well-designed inbreeding-avoidance system might look like. From this perspective, at least two psychological procedures are required: (1) the ability to detect kin (i.e., assess for a given individual the probability they share genes identical through common descent), and (2) the ability to regulate sexual motivations based on the probability that an individual is close kin (see Lieberman, Tooby, & Cosmides 2007). This system can function as an inbreeding-avoidance mechanism by monitoring the environment for information indicating an individual is likely to be a close genetic relative and, if such information is present, down-regulating sexual motivations targeting that individual. In the absence of such information, no sexual aversion will develop, and instead, whether that individual is an attractive mate or not will be left to other procedures that guide mate choice. Thus, a key question is: What information does our mind use to detect probable kin and to develop sexual aversions toward them?

How Do We Detect Close Genetic Relatives?

How did evolution engineer systems for learning who counts as a close genetic relative? Since we cannot "see" another person's genes, the best that evolution could have done is to build a system that uses information, or cues, that, over

our species' evolutionary history, were correlated with relatedness. A likely source of information regarding relatedness comes from the ecologically valid cues that signaled relatedness in ancestral environments. Indeed, nonhuman animals are capable of detecting kin using a variety of mechanisms (e.g., see Fletcher & Michener 1987, Hepper 1991). But what cues do humans use to carve the social world into kin versus non-kin? And are the same cues used for detecting each category of close kin (e.g., mother, father, offspring, and sibling)? To the extent that different environmental, social, or biological cues correlated with an individual's being a particular type of close genetic relative, different detection systems are expected to exist. What follows is a brief discussion of the stable and recurring cues natural selection could have targeted to detect two specific categories of kin: offspring and siblings.

Female Detection of Offspring

One of the recurring features of our ancestral environment was that women gave birth to their own offspring. Since it was an absolute certainty that the baby coming out of a woman's body was indeed her own, selection could have used this regularity to shape an offspring-detection mechanism in women. To be useful, however, a detection mechanism had to solve the problem of initial detection and also the continued identification throughout childhood and sexual maturity. There are many ways such a detection mechanism could have solved these problems. For example, a woman could imprint on visual, auditory, or olfactory cues derived from her newborn. From a theoretical standpoint, however, visual cues such as facial features might not be the most reliable and consistent source of information because the face of a newborn baby changes rapidly throughout development (Pagel 1997; Porter, Cernoch, & Balogh 1984). Similarly, auditory signatures change throughout the life span and would need to be continually updated to maintain positive identification as kin. Nevertheless, researchers have found that mothers are capable of recognizing their own infants' vocalizations from as early as 48 hours after birth when presented with a number of different infants' cries (Formby 1967; Murray, Hollien, & Muller 1975).

Perhaps the most stable cue available to females for identifying their young is olfactory information that does not change throughout the life cycle. One candidate for this kind of cue is the major histocompatibility complex (MHC). The MHC is a group of cell-surface proteins and are responsible for the self- versus non-self discrimination of the immune system (Janeway 1993, Klein 1986, Snell 1981). Because of the number of different alleles coding for the MHC (some loci have as many as 50–60 alleles), and the increased mutation rate in this part of the genome (Beauchamp, Yamazaki, & Boyse 1985), an individual's MHC composition is unique. As has been shown

in mice, MHC can be detected via smell in sweat and urine when it is broken down, making it a potential cue for identifying kin of different types, not just offspring (e.g., see Manning, Wakeland, & Potts 1992; Potts, Manning, & Wakeland 1991; Singer, Beauchamp, & Yamazaki 1997; Singh, Brown, & Roser 1987; Yamazaki, Beauchamp, Curran, Bard, & Boyse 2000). Indeed, a handful of studies have demonstrated that humans are capable of distinguishing between kin and non-kin solely on the basis of smell (Porter, Cernoch, & McLaughlin 1983; Porter & Moore 1981) and might use this information to guide mating preferences (Jacob, McClintock, Zelano, & Ober 2002; Wedekind & Furi 1997; Wedekind, Seebeck, Bettens, & Paepke 1995).

Can women identify their offspring on the basis of smell alone? The answer appears to be yes. Russell, Mendelson, and Peeke (1983) tested whether or not blindfolded mothers could discriminate between their own newborn and two unrelated newborns. They had mothers smell the head of their baby along with those of two unrelated babies and found that mothers could discriminate between their own baby and the others only 6 hours postpartum, having been exposed to the newborn only once for half an hour. Interestingly, the researchers found that fathers could not make the same discrimination, even though they had also been exposed to the newborn for the same amount of time (see *Males Detecting Offspring* below). Other studies have provided converging lines of evidence that mothers are capable of identifying their own child's odor, in some cases after only a short period of time postpartum (Kaitz, Good, Rokem, & Eidelman 1987; Porter, Cernoch, & McLaughlin 1983; Porter & Moore 1981; Russell et al., 1983; Weisfeld, Czilli, & Phillips 2003).

Given the certainty of relatedness between a mother and her newborn, a kin-detection system that immediately registered cues derived from the newborn (e.g., auditory, visual, and/or olfactory cues) would have functioned as an offspring-detection mechanism. As we discuss below, this would not have been the best design for an offspring-detection mechanism in men.

Male Detection of Offspring

Compared to other primates, men invest heavily in their offspring (Boyd & Silk 1997). However, the benefits men would have accrued from their parental efforts depended critically on the ability to assess their probable relatedness to the child a woman gives birth to. Any design feature that caused a man to regulate his investment in a particular child according to the probability that that child was in fact his offspring would have been selected over alternative design features causing, for example, a man to invest indiscriminately in any offspring he encountered, whether his or not. Unlike a woman, who

can be certain that the newborn she bears is her own biological offspring, men cannot be 100% certain as to who their biological offspring are—they lack paternity certainty. Thus, the problem of detecting offspring for men translates into the problem of evaluating paternity certainty.

There are a number of cues that could be used to assess paternity. Children from women a man never had sex with cannot be his. Thus, men should assume the probability of paternity is zero for offspring of women with whom they have not had sex. For women with whom a man has had sex, the frequency of intercourse would have correlated with paternity. That is, the more often a man had sex with a woman during a given period of his life, the greater the likelihood that the children she produced during this period (and during no other) are his.

But frequency of intercourse is insufficient. A woman who is often away from her mate is more likely to have engaged in a sexual liaison with another man than is a woman who is always in the presence of her mate (Baker & Bellis 1993, Buss 2003). Therefore, information as to how much time a man's mate was absent or was known to be with other men might function to estimate the likelihood of paternity. One possible way such a mechanism could be designed is to keep a running total of time a man's mate was absent during the period they maintained a sexual relationship; the greater the total time away, the less certain a man could be of paternity. Or perhaps the mechanism is more targeted and, once cues to pregnancy have been detected, it backtracks to the probable time period of conception and determines the frequency with which the woman was absent back then. Could men have a dedicated memory trace that is activated upon exposure to cues signaling pregnancy? Depending on the evolutionary costs of engineering such a system, this might be one way men solve the problem of assessing paternity.

Another factor that would have provided reliable information about probable paternity is the behavior of a man's mate. Gregarious women with many male friends or a promiscuous sexual history (or reputation) would have posed a greater threat to a man's paternity than would women with few male friends and a reputation for being chaste. Thus, men should be sensitive to the personalities, reputations, and social behaviors of their mates. Indeed, across cultures, chastity is a trait men strongly favor in a mate (Buss 2003). Further, studies by Apicella and Marlowe (2004, 2007) found that male parental investment was a function of a man's perception of mate trustworthiness, fidelity, and clothing style.

Two additional pieces of information that a system designed to assess paternity might take as input are (1) a man's assessment of his own mate value relative to the mate value of other men in his local social environment and, (2) a man's assessment of the mate value of his partner. All else equal, a man

with higher status is more attractive to women and may be more certain of paternity than a man of lower status (Symons 1979). In other words, there is a lower probability that a woman will engage in sexual infidelities when she is in a relationship with a higher status man than when she is in a relationship with a lower status man. Similarly, if a man's partner has a high mate value, especially relative to his own, she has a higher probability of being pursued as a mate by other men, opening the door to an increased risk of sexual infidelities. Furthermore, the quality of a mateship (e.g., close and loving versus distant and hostile) may have been a reliable predictor of infidelity. When a relationship is unstable, the man is away a lot, or the woman seems to act promiscuously, paternity certainty might be low and the resulting offspring categorized as non-kin.

Another possible cue that men might use to assess paternity is phenotypic similarity, such as facial resemblance (Daly & Wilson 1982). It has been shown that mothers and maternal relatives remark at the resemblance between a newborn and the mother's mate, presumably in an attempt to assure paternity and evoke greater levels of paternal investment (Daly & Wilson 1982, Regalski & Gaulin 1993). Despite the possibility that visual cues might not have been the most reliable for detecting offspring, men do appear to use facial resemblance as a cue to relatedness. For example, Platek et al. (2003, 2004) have shown that men preferentially favor children whose faces have been morphed with their own. Apicella and Marlowe (2004) showed that men's reports of levels of offspring investment (e.g., attention paid to offspring and help offered with schoolwork) correlated with their perception of offspring resemblance. Whether an offspring-detection mechanism in men relies on phenotypic resemblance or an assessment of cues signaling mate sexual fidelity is still an open question because no study of which we are aware has teased these two classes of cues apart.

What about olfactory cues? The few studies investigating if parents are capable of discriminating between their offspring and other unrelated children via smell indicate that women can identify their offspring with high reliability, but fathers, despite similar times of exposure, are unable to do so (Russell et al., 1983; Weisfeld, Czilli, & Phillips 2003). This suggests that whatever the cues driving offspring detection in men, they may not be the same ones women use to detect offspring. This makes sense since men and women faced different adaptive problems when it came to identifying offspring. In stark contrast to female detection of offspring, male detection of offspring appears to rely on the behavior of the mate. If men assess who their offspring are via female cues of sexual fidelity, then any female behavior that causes a negative assessment might reduce the certainty of relatedness and prevent sexual aversions from developing, thus opening the door to the possibility of sexual abuse.

Sibling Detection

What cues would have signaled that another individual was a sibling? One plausible cue to siblingship would have been duration of shared parental investment. Throughout our evolutionary history, the nutritional demands of breastfeeding, along with the need for protection, would have meant that children of the same mother were typically reared in close proximity during early childhood. Therefore, childhood coresidence would have served as a stable cue that identified probable siblings. This cue was first suggested by Edward Westermarck, a Finnish social scientist. Westermarck, having noted the injurious effects of inbreeding, proposed a mechanism by which humans naturally came to avoid close genetic relatives as sexual partners. He hypothesized that close physical proximity during early childhood leads to the development of a sexual aversion later, during adulthood (Westermarck 1891). This has come to be known as the Westermarck hypothesis.

Perhaps the most famous studies investigating the Westermarck hypothesis are the natural experiments created by the Israeli kibbutzim (Shepher 1971, 1983; Talmon 1964) and Taiwanese minor marriages (Wolf 1995). In both, cultural institutions created situations in which genetically unrelated individuals were co-reared from early childhood. In Israeli kibbutzim, for example, children were reared collectively in mixed-sex peer groups from right after birth. Shepher (1983) found that individuals who married within their own kibbutz rarely chose an individual from the same peer group. And, of the marriages that occurred between individuals of the same peer group, the partners had not lived together for more than 4 of the first 6 years of life. This led Shepher to reason that uninterrupted coresidence during the first 6 years of life is critical for the development of a sexual aversion later, during adulthood.

In Taiwanese minor marriages, a young bride is adopted into her future husband's family and reared alongside him into adulthood until the day they are married. The anthropologist Arthur Wolf has shown that, as the Westermarck hypothesis predicts, the earlier a girl is adopted, the longer her duration of coresidence with her future husband, and, consequently, the lower the rates of marital fertility and the higher the rates of divorce and extramarital affairs (Wolf 1995, 2005). Specifically, Wolf points to the first 3 years of life as the critical age of coresidence. In his data, he finds much lower fertility rates and higher rates of divorce in couples in which the girl was adopted before her third birthday (Wolf 2005).

Though coresidence would have been a good cue for detecting siblings, a better, more stable cue exists: seeing your biological mother caring for a neonate (e.g., breastfeeding). However, this information is available only to older siblings in the environment. (The arrow of time forbids younger siblings from seeing their older siblings breastfed and cared for during infancy.)

For younger siblings, then, coresidence duration might have been the best cue available. Indeed, when younger and older siblings are considered separately, coresidence duration predicts disgust associated with sibling sexual behaviors for younger siblings, not for older siblings (Lieberman et al., 2007). That is, the longer a younger sibling lived with an older opposite-sex sibling, the more disgusting they found the prospect of engaging in sexual behavior with that sibling. For the older sibling in the pair, disgust was not strongly correlated with the length of coresidence with the younger sibling. So long as the older sibling was exposed to his or her mother caring for their younger sibling as an infant, the older sibling reported intense disgust, a level attained after approximately 14–15 years of coresidence for the younger siblings (Lieberman et al., 2007).

In summary, two cues might play prominent roles in sibling detection: for older siblings, seeing one's mother caring for a newborn, and for younger siblings, coresidence during periods of shared parental investment (see also Fessler & Navarrete 2004; Lieberman, Tooby, & Cosmides 2003; McCabe 1983). Of course, additional cues might be used, including MHC-derived olfactory cues (e.g., Porter & Moore 1981, Wedekind & Furi 1997, Wedekind et al. 1995) and phenotypic resemblance (e.g., DeBruine 2005). To tease apart the contribution of each hypothesized cue, we are currently conducting a study that considers all the known possible cues to siblingship: coresidence duration, seeing a newborn being cared for by one's mother, phenotypic resemblance, MHC detection, and genetic similarity. In this way, we will be able to uncover how the mind integrates the various sources of information used to regulate sibling-directed behavior.

Summary

The identification of the cues our mind uses to assess relatedness has important implications for understanding why sexual abuse sometimes occurs. In situations where cues to kinship are absent, sexual aversions might not develop, leaving open the possibility of sexual abuse. In the next section, we discuss how an integration of an evolutionary-computational model of inbreeding avoidance with extant models of sexual abuse can inform future programs of research seeking to understand the factors that contribute to sexual abuse.

CONCEPTUAL INTEGRATION OF MODELS OF SEXUAL ABUSE

Based on the model of inbreeding avoidance discussed above, two procedures are required for the development of sexual aversions toward kin: procedures

governing kin detection and procedures that take as input kinship information and regulate sexual motivations accordingly. How might this process shed light on sexual abuse? This model suggests there are (at least) two ways sexual aversions might fail to develop between kin and lead to a greater probability of sexual abuse: (i) cues signaling kinship might be absent or compromised; and (ii) programs regulating sexual motivations (e.g., the emotion of disgust) might be impaired. In this section, we discuss each possibility in turn and, along the way, integrate the factors that contribute to the incidence of sexual abuse as discussed by the family-systems model and David Finkelhor. We then briefly touch on how mate value, a variable distinct from kinship that is also hypothesized to be taken as input by systems regulating sexual motivations, can inform research on sexual abuse.

Cues Mediating Kin Detection Might Be Absent or Compromised

Cues Mediating Sibling Detection and Sexual Abuse

From the discussion above, it is apparent that an important cue found to mediate sibling detection and guide the development of a sexual aversion is coresidence duration. If this is indeed the case and the Westermarck hypothesis is correct, then the interruption or lack of coresidence during childhood should lessen the aversion and contribute to the incidence of sexual behavior or abuse (Erickson 2006; Lightcap, Kurland, & Burgess 1982). This seems to be the case. For example, Benc and Silverman (1993, 2000) compared a population of college undergraduates who had engaged in sexual relations with a sibling to those who had not to determine whether or not there were any differences in childhood separation. They found that separation from their sibling during childhood was associated with increased consummatory sexual behavior (i.e., acts involving actual or attempted oral or genital penetration) than non-consummatory sexual behavior (i.e., acts including touching and kissing in a sexual manner and pretend intercourse).

In a much earlier evaluation, Weinberg (1955) discusses six cases of sibling sexual behavior. In each case, the siblings had not been reared together throughout childhood. Rather, the majority of the sibling pairs were reunited during adulthood and found each other to be attractive sexual partners. In the absence of the cues signaling relatedness, the mind is left to evaluate potential sexual partners according to the criteria of mate-choice systems (e.g., health and fertility for women; resources and investment inclinations for men). Since one's genetic relatives can be attractive individuals, it is not

necessarily surprising that in the absence of any sexual aversions they are considered potential sexual partners. For example, Greenberg and Littlewood (1995) report on an apparently common phenomenon of sexual attraction between family members reunited after being separated by adoption. That kin are perceived as *more* attractive mates under these circumstances does not undermine evolutionary models of inbreeding avoidance. Rather, these examples provide evidence of preferences for individuals who share similar positive affordances such as hobbies, intellectual interests, and lifestyle (e.g., see Tooby & Cosmides 1996 for a discussion on "association value" as a route to the formation of deep engagements).

According to the family-systems model of sexual abuse, families in which sibling incest occurs are typified by a poor marital relationship and a neglectful mother. How might this link to kin detection? If an important cue that older siblings use to assess relatedness is whether or not their own mother cares for a newborn, then when mothers neglect their newborns, this could compromise older siblings' certainty of genetic relatedness. Furthermore, if breastfeeding a newborn is the particular cue older siblings evolved to take as input to assess relatedness, then it is possible that newborns who are wet-nursed or often bottle-fed by women other than their mother would not be as certain of relatedness (it is likely that bottle-feeding mimics breastfeeding cues, given that the positioning of the infant and close contact are quite similar in both cases). Of course, families with a history of sexual abuse are often plagued by many conditions, including drug and alcohol abuse and physical abuse or neglect (Black 1981, Finkelhor 1984, Kellogg & Menard 2003, Liles & Child 1986, Walsh, MacMillan, & Jamieson 2003). Nevertheless, understanding how the parental relationship and the behavior of the mother interfere with the natural categorization of other children as siblings can help us not only understand why sibling incest sometimes occurs but also identify those families at risk.

Cues Mediating Offspring Detection and Sexual Abuse

Within the family, abuse is most common between a mother's mate and her offspring (e.g., see Daly & Wilson 1988, Erickson 2005, Finkelhor 1984, Russell 1983). As discussed above, the development of a sexual aversion between a man and the child of a particular woman relies on his assessment of paternity. For those men who lack paternity certainty, young women, for all intents and purposes, represent potential (future) mates. Both the family-systems model and David Finkelhor point to biologically unrelated men introduced into the family (e.g., stepfathers or mother's boyfriends) as posing the greatest threat of sexual abuse (e.g., Finkelhor 1984). These men are

certain that any children in the family cannot be their own, and thus motivations to avoid them sexually will not have developed through the kin-detection system.

In contrast to men introduced into the family after the birth of a woman's children (or when she is pregnant), a man who has been sexually active with a woman for a long period of time *could* have fathered her child and can assess his probability of paternity based on cues relating to his mate's sexual fidelity and her patterns of parental investment. For example, if men use the cue "newborn being cared for by the woman I have been having sex with for a prolonged period of time" to assess paternity, then any interruption in maternal parental investment, especially when it occurs early in a child's life, might reduce a man's certainty of relatedness. When a mother has died (perhaps from complications during childbirth) or is often ill, rendering her incapable of caring for her child, this will reduce the frequency with which a man will see a child in an extended care-giving relationship with the mother and might, subsequently, detract from his certainty of relatedness. Indeed, many of the characteristics Finkelhor has found to be linked to sexual abuse fall into this category (Finkelhor 1984; see also Herman & Hirschman 1981).

Both Finkelhor and the family-systems model of sexual abuse indicate that a common feature of families in which sexual abuse occurs is a poor marital relationship. However, a poor marital relationship might not be the cause of sexual abuse per se. Rather, a poor marital relationship is likely the consequence of conflict, and it is the nature of the conflict that is of importance in predicting sexual abuse. An evolutionary framework predicts that poor marital relationships resulting from conflicts relating to female infidelity and male sexual jealousy are more likely to be associated with sexual abuse than poor marital relationships caused by issues unrelated to female mating behavior (e.g., childrearing). This is because the former types of conflict are more likely to compromise paternity certainty. Importantly, what matters is the man's *perception* of sexual infidelity rather than his mate's actual behavior, though of course these two are usually tightly linked. Thus, if a man, for whatever reason, suffers from morbid sexual jealousy, warranted or not, his assessment of paternity might be compromised, leading to a greater probability of sexual abuse.

In addition to considering the nature of the marital discord, an evolutionary perspective suggests that the timing of the conflict might affect paternity assessment. All else equal, marital problems initiating before the time of conception might have a greater likelihood of compromising a man's certainty of paternity than would problems that arise after the child has been born. We are currently exploring these hypotheses, which could have important implications for identifying families at risk of sexual abuse.

What is clear is that the mother, as suggested by Finkelhor and the family-systems model, plays a key role in mitigating the risk of sexual abuse within the family. If a man bases his certainty of paternity on the actions of his mate (e.g., her sexual fidelity, how many male friends she has, how often she is absent, her investment in offspring) and her qualities (e.g., whether her mate value is actually or merely perceived to be higher than his [see below]), then whether or not a sexual aversion develops toward a particular child depends mostly on her. This does not blame women for father-daughter sexual abuse but rather recognizes that a woman's behavior may be critical in shaping how men will interact with her child. Knowledge of how maternal behaviors can affect male paternity certainty can be used to educate teens and new mothers and might help lessen the risk of sexual abuse.

In this section, we stress that the absence of evolutionarily reliable cues signaling paternity are important for identifying children at risk for sexual abuse. These cues might be different from those signaling siblingship. However, previous applications of an evolutionary framework to investigating father-daughter sexual abuse have relied mainly on the Westermarck hypothesis, that is, early childhood exposure, a cue found to mediate sibling detection (e.g., Parker & Parker 1986, Williams & Finkelhor 1995). For example, Williams and Finkelhor (1995) tested the hypothesis that a father's close physical association with his daughter during her childhood leads to the development of a sexual aversion and, consequently, lower rates of incest. The researchers surveyed incestuous and non-incestuous Navy and civilian fathers to determine if any differences existed between incestuous and non-incestuous populations in the level of physical care fathers directed toward their daughters. Collecting data from civilian and Navy incestuous fathers allowed the researchers to determine if time away from home increased the risk of sexual abuse. Though Williams and Finkelhor did not find any difference between incestuous and non-incestuous fathers with respect to the amount of time spent away from the children as infants, they did find that incestuous fathers had lower caretaking scores than did non-incestuous fathers; compared to incestuous fathers, non-incestuous fathers engaged in more non-physical caretaking behaviors (e.g., reading stories and supervising) and also physical care-taking behaviors (e.g., feeding and changing diapers). They interpret these data to mean that care-taking protects the child from later abuse by enhancing positive parenting, protective feelings, and alternative gratifications, not by suppressing sexual arousal.

Based on the evolutionary-computational model discussed above, we posit a different explanation for Williams's and Finkelhor's data. Prolonged close physical association is not necessarily the best cue signaling paternity in the same way it signals siblingship. That is, the Westermarck hypothesis

might be specific to siblings. Fathers are hypothesized to use a different set of information to assess relatedness to a child: information relating to paternity certainty (e.g., partner sexual fidelity). In a sense, then, it shouldn't be close physical association with the child but rather prolonged contact with the child's mother around the time of conception that predicts sexual abuse across populations. Though their study did not necessarily consider the cues signaling paternity, Williams and Finkelhor found that men who reported being dissatisfied in their marriage were five times more likely to have sexually abused their daughter. We suspect that marital discord is an important red flag since some of the main causes of conflict within a marriage relate directly to sexual jealousy. We predict that upon further inspection of the causes of marital dissatisfaction, men who suspect sexual infidelity, who are often sexually jealous, or who were absent from their mate around the time of conception will be more likely to sexually abuse a daughter.

Importantly, the cues signaling paternity are hypothesized to shape not only sexual motivations but altruistic motivations as well (e.g., see Daly & Wilson 1988; Lieberman et al., 2007). That non-incestuous fathers display greater patterns of investment is a signal that they have assessed the cues to paternity and estimated the probability of relatedness to be high. Thus care-taking per se does not protect the child from later abuse. Rather, we suggest that it is the cues that indicate to the man that he is the likely father that influence motivations to care as well as motivations to avoid sexual contact.

With respect to the negative results regarding time away, we predict that time away does indeed matter. Whereas Williams and Finkelhor asked if the father had been absent for more than 30 days during the first 12 months of the child's life, we predict the critical time period is before the child is even born. For example, whether or not sexual abuse occurs in Navy families is likely to depend on the time period in which the husband is away from his mate. All else equal, men who depart after their child has been born can be more certain of relatedness than men who depart then return to a pregnant wife! Also, a man's kinship network might help protect his paternity. That is, women who are left close to her mate's kin while he is away might be less apt to seek alternate sexual partners than might a woman left alone or away from the man's kin.

As this discussion reveals, more-focused hypothesis testing that takes into account the cues a man is likely to use to assess paternity holds great promise for shedding light on the factors that contribute to father-daughter sexual abuse. It is our hope that our discussion spurs researchers to shift a portion of their focus from the downstream behaviors that result from paternity certainty to the cues that directly regulate the assessment of paternity.

Programs Regulating Sexual Motivations Might Be Impaired

An evolutionary-computational model of inbreeding avoidance suggests that, even with perfect kin detection, if systems regulating sexual motivations are impaired, intrafamilial sexual abuse might still occur. The emotion of disgust is hypothesized to regulate sexual motivations, specifically sexual avoidance (Angyal 1941; Lieberman et al., 2007). Therefore, impairments to disgust might be linked to greater incidents of sexual abuse. Certainly, alcohol and drug use can affect decision-making processes and likely change disgust sensitivities. In addition, acquired or developmental impairments in neural regions associated with disgust, such as the anterior insula (Phillips et al. 1997) might also be associated with greater incidents of sexual abuse. To date, few if any studies have looked at the relationship between impairments in disgust and sexual abuse. Future investigation of disgust sensitivities, in particular sexual disgust sensitivities, can help illuminate why particular individuals might be targeted as sexual partners.

Beyond Kin Detection: Mate Value, Social Isolation, and Inbreeding Conflict

In the absence of cues signaling kinship, an individual will not categorize another as kin and, consequently, no sexual aversion will develop via this route (e.g., Erickson 2006). Instead, mate-choice systems will use information other than degree of relatedness to guide sexual motivations. Information that should be relevant to mate-choice systems include the mate value of a potential sexual partner (e.g., for women, health and reproductive value; for men, financial status and willingness to invest), one's own mate value, and the availability of potential mates. For example, men with low mate value (e.g., low SES, low symmetry, low testosterone-versus-estrogen levels) most likely experience a smaller mating pool, causing them to shift their focus to more-vulnerable sexual targets. That is, if men are motivated to attain the highest mate-value female they can, then for those dealt a less attractive phenotype, women typically not considered as potential mates by other men might be considered the top choice.

In the presence of cues signaling kinship, sexual aversions are likely to develop, but whether or not sexual motivations still target kin depend on a number of other factors, including the availability of alternate mates (e.g., social isolation) and inbreeding conflict. Perceived social isolation might recalibrate sexual motivations causing men to find their sisters, nieces, and other animals (not necessarily in that order) more attractive sexual partners.

However, because of the asymmetric costs of sexual reproduction in general and incest in particular (e.g., see Haig 1999, Tooby 1977, Walter & Buyske 2003), women are likely to strongly object to incestuous matings, even when there are few men to choose from.

SUMMARY AND CONCLUSIONS

An evolutionary-computational model integrates the themes of current models of sexual abuse into a cogent theoretical framework. It incorporates several of Finkelhor's motivations to abuse and internal and external inhibitors, as well as Family Systems' emphasis on the mother and the marital relationship. This model is based on the principles of kin recognition and allows for the generation of specific hypotheses based on the kin recognition cues of each family dyad. For example, mother-offspring recognition is most likely regulated by immediately registered cues because genetic relatedness is assured at birth. Father-offspring recognition, on the other hand, is likely mediated by cues of paternity confidence such as physical resemblance and cues of female fidelity. Finally, sibling recognition is likely regulated by cues of coresidence and witnessing maternal care.

Kin detection plays an important role in how sexual aversions develop. Therefore, understanding how kin detection operates, that is, the cues our mind evolved to use to categorize another as kin, is critical to identifying those situations in which kin detection is likely to fail, leading to a greater probability of sexual abuse. Since procedures for detecting kin influence not only sexual motivations but altruistic motivations as well, understanding how kin detection operates will also shed light on the reasons behind physical abuse and neglect (Daly & Wilson 1988).

In addition to kin detection, the assessment of one's own mate value, one's prospects among potential sexual partners, and the costs associated with different sexual partners are hypothesized to affect sexual motivations. Men with low mate value might be more prone to target more-vulnerable individuals as sexual partners, and once they secure a mate might be less certain of their child's paternity. Social isolation can influence perceptions of potential mating partners, increasing the probability that men but not women (because of the elevated costs women incur from inbreeding) might seek a family member as a sexual partner.

An evolutionary model of all the factors guiding sexual motivations (e.g., kinship and mate value) can help generate predictions of the conditions under which sexual abuse is likely to occur. It is of critical importance that we be able to identify the conditions under which the available kin recognition cues may not inhibit sexual motivation toward morally inappropriate

sexual partners, as might be the case in situations of paternity uncertainty. This is especially important given the fact that a large proportion of familial sexual abuse is perpetrated by men, and could have important implications for policy regarding military deployment, for example, and for programs aimed at educating and counseling new families.

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