Impact of Behavioral Genetic Evidence on the Perceptions and Dispositions of Child Abuse Victims

Raymond Raad · Paul S. Appelbaum

New York State Psychiatric Institute and Department of Psychiatry, Columbia University, New York, N.Y., USA

Key Words

Behavioral genetics · Child abuse · Cycle of violence · Genetic essentialism

Abstract

Background: Behavioral genetic research is beginning to elucidate some of the genetic contributions to human behaviors – including criminal and other problematic behaviors – and their interactions with environmental influences. One of the most studied of these interactions involves low-activity alleles of the monoamine oxidase A (MAOA) gene, which appear to increase the risk of antisocial behavior among males in the wake of childhood maltreatment. Some scholars have suggested that decisions about disposition of child abuse victims should be shaped by these findings, but the extent of public support for such approaches has not been assessed. **Methods:** In this study, a representative sample of the US population (n = 250) was presented with a vignette about a child, physically abused by his mother, who was tested for the presence of an allele that increases the risk of future impulsive violent behavior. Participants were asked about their views regarding the child's disposition, including return to his mother, and medical or psychological treatment. **Results:** Although participants thought that genetic data should be taken into account, the presence of an allele

that increases the risk of impulsive violent behavior did not affect views regarding the child's return to his mother. However, it did increase respondents' willingness to provide the child with medical treatment and their view of the child as dangerous to other children. **Conclusions:** The findings suggest that behavioral genetic evidence has effects on perceptions of dangerousness and tendencies to view problems as medical but that the public is cautious about the use of genetic findings in child abuse adjudications.

© 2014 S. Karger AG, Basel

Introduction

The field of behavioral genetics is expanding our understanding of causal influences on human behavior. For several decades, researchers using twin and family studies have known of the significant heritability of a variety of behavioral traits, ranging from shyness to vocational interests [1]. More recently, with the development of advanced techniques in molecular genetics, a growing number of genes have been associated with adult and child temperament and personality, behavioral traits, and mental disorders [2–4]. Combining genetic techniques with neuroimaging has permitted researchers to begin to illuminate the brain pathways underlying these effects

[5]. These findings have challenged the idea that human beings are blank slates shaped entirely by their environment [6].

In addition to augmenting our understanding of the roots of behavior, advances in behavioral genetics may have implications for governmental policy and attributions of responsibility in everyday life in at least 3 ways. First, by showing that behaviors are partly caused by factors that are outside our conscious awareness and control, behavioral genetics can impact questions of criminal and personal responsibility for past behavior [7, 8]. Second, it can affect decisions regarding prospective interventions when an individual is discovered to have genetic risk factors for problematic behaviors prior to engaging in such behaviors [9]. Lastly, advances in behavioral genetics have heightened policy questions regarding when and how behavioral genetic data should be gathered while appropriately protecting the freedom and privacy of individuals [10].

A particularly pertinent example of the ways in which behavioral genetics can raise these issues is illustrated by studies demonstrating the effect of variant alleles of the gene encoding monoamine oxidase A (MAOA), an enzyme that degrades monoamine neurotransmitters. After a pedigree study demonstrated that the absence of MAOA, coded for by a gene on the X chromosome, was associated with increased rates of impulsive and aggressive criminal behavior among men in an extended family in the Netherlands [11], a similar effect of reduced, but not absent, MAOA levels was found in a longitudinal epidemiologic study of a birth cohort in Dunedin, NZ [12]. Individuals with an allele associated with reduced MAOA activity (often referred to as MAOA-L) were 9.8 times as likely to be convicted of a violent offense as adults, but only if they also had a history of maltreatment as children: a classic gene $\times$ environment interaction [13]. Subsequent studies in males have largely confirmed [14–25], but in some cases failed to confirm [26–31] these findings. Although the studies varied in methods and populations sampled, 3 meta-analyses have supported the association between MAOA and antisocial behavior by maltreated boys [15, 32, 33]. Thus, within the sample of victims of child abuse, a variant of the MAOA gene appears to constitute a significant prospective risk factor for violent behavior, a known consequence of child abuse [34].

Even as potential mechanisms of the effects of low MAOA levels are being sought [35], a variety of potential policy implications of this finding have been discussed. The greater vulnerability of MAOA-L children to abuse has been suggested as justifying a lower threshold for re-

moval from a home where abuse has occurred and a higher threshold for return [36, 37], an approach arguably supported by a small number of studies that suggest the possibility of a dose/response relationship between the amount of abuse and adverse consequences in these children [38, 39]. Commentators have also called for preferential access to treatment services for MAOA-L children on the basis of their heightened vulnerability [36] and in light of data suggesting that strong social supports may buffer the consequences of abuse [40]. It has even been proposed that someone knowingly abusing an MAOA-L child be subject to more severe punishment than other abusers [36].

Since public attitudes towards behavioral genetic findings are likely to have a significant impact on the adoption or rejection of such recommendations, explorations of popular attitudes and beliefs have begun. Several commentators have suggested that a large portion of the public is likely to fall prey to simplistic views of genetics, including the idea that genes, more than other properties of a person, constitute the nature of individuals themselves (genetic essentialism), and that genes determine people's destiny and are the primary cause of their behavior (genetic determinism) [41]. To date, attitudes towards behavioral genetic data have been studied primarily in the context of determinations of responsibility and punishment for criminal behavior, and the impact of such data has been less than many experts have anticipated or, in some cases, advocated [42].

A study of state trial court judges found that after hearing a description of a case of aggravated battery by a psychopathic defendant, those judges who were exposed to genetic and other biological data to support the diagnosis of psychopathy indicated that they would impose less severe sentences on the perpetrator. However, this difference, although significant, was small in absolute magnitude – one less year in prison, on average [43]. In a second study, which surveyed a representative sample of the US adult population, evidence of a genetic predisposition to impulsive behavior did not lead to a significant change in the seriousness of the crime of which subjects would convict the defendant or the length of sentence imposed, although it did make respondents more fearful of the perpetrator [44]. Thus, to this point, the available evidence suggests a relatively limited impact of behavioral genetic data on views of responsibility for behavior.

Given the suggestions that abused children should be treated differently when they carry an MAOA-L allele, we wanted to explore public views on this issue. In this paper, we report the results of a survey of a nationally represen-

tative sample of the US adult population. (The first part of the survey, which focused on public attitudes about the effects of behavioral genetic evidence on criminal responsibility and punishment, has been reported previously [44].) Here, in particular, we explore their views as to the appropriateness of genetic testing in the context of child abuse, and the proper inferences to be drawn from data regarding an abused child's MAOA activity, including whether the child should be returned to the care of a previously abusive parent and whether treatment should be made available. Additionally, these data may offer a perspective on how members of the public reason about genetic information more generally.

Methods

Participants

The participant panel was drawn by Knowledge Networks (KN), based on sampled households from its KnowledgePanel®, a probability-based web panel designed to be representative of the population of the US Members of the KnowledgePanel are recruited through a combination of list-assisted random digit dialing and address-based sampling techniques. Panel members are invited to take about one survey per week, with an average duration of 10–15 min per survey. KN has an incentive system to encourage participation and to provide modest compensation for the time involved. Further details about the panel make-up, recruitment procedures, and incentives for participants have been reported previously [44]. Additional information can be found at: <http://www.knowledgenetworks.com/knpanel/index.html>.

The target population for this study consisted of noninstitutionalized adults aged ≥ 18 residing in the Northeast, Midwest and West of the US, as defined by the US Census. E-mailed invitations were sent to 371 randomly selected KnowledgePanel participants, with the sampling adjusted as described above, over a 1-month period in July and August 2011, with reminders to nonresponders sent on day 3 of the field period. Four additional e-mail reminders were sent to nonresponders on days 12, 15, 22, and 27. Recipients of invitations were asked to click on a link that would take them to the questionnaire on the KN system; the questionnaire took an average of 12 min to complete. In addition to the usual KN incentives, participants were eligible to win an in-kind prize through a monthly KN sweepstakes.

Procedure and Design

KnowledgePanel participants who clicked on a hyperlink that took them to the online survey first saw a screen with a brief description of the study and were asked to indicate their voluntary consent to participate by advancing to the next screen. Procedures for the study were approved by the New York State Psychiatric Institute's Institutional Review Board. The experiments comply with the laws of the United States.

After reading and responding to a series of questions about a vignette on criminal responsibility and punishment [44], participants were asked to consider a different situation. The second vignette, data from which are reported here, described a 7-year-old

boy, Ted, who was a victim of an episode of physical abuse by his mother (see Appendix for the complete text of the vignette and associated questions). Participants were asked to rate their agreement or disagreement on a 4-point Likert scale (strongly disagree, disagree, agree, and strongly agree) with a series of statements regarding whether Ted should be removed from his mother's care and should be tested for a gene that, like MAOA, has a variant that can increase the risk that victims of child abuse will be violent as adults.

Participants were then told that Ted was tested for the gene in question. Half of the sample, selected at random, was informed that Ted was found to have the form of the gene that puts him at risk for impulsivity and violence (hereafter 'high-risk allele'), and half were told that he did not have that form of the gene (hereafter 'low-risk allele'). They were then asked to rate their agreement with statements that addressed potential implications of and responses to the genetic finding and Ted's disposition.

To determine whether participants attended to the key elements of the case, they were asked a question about the nature of the genetic test. Nineteen participants (7.6%) failed to answer this question correctly. Statistical analyses were performed with and without this group, but since results did not differ when this group was removed, data from the entire sample are reported here.

Statistical Analyses

Statistical analyses were based on data subject to a post-stratification adjustment. Prior to drawing a sample for a particular study, KN corrects known sources of deviation from an equal probability of selection (e.g. historical oversampling of particular geographic areas) by base weight sampling. A second adjustment is then made to correct for nonresponse and noncoverage bias in the overall panel membership, based on distribution of demographic variables in the most recent Current Population Survey (April 2011) conducted by the US Bureau of Labor Statistics and Bureau of the Census. Once the sample is selected, the survey fielded, and all study data collected and finalized, a post-stratification process is used to adjust for any survey nonresponse as well as any noncoverage or under- and oversampling resulting from the study-specific sample design. Variables included in this final adjustment are gender, age, race/Hispanic ethnicity, education, census region, metropolitan area, and Internet access.

To simplify the analysis, the 4-point Likert scale used to indicate responses to all items was collapsed into 2 categories (agree/strongly agree, disagree/strongly disagree). Nonresponders for each question were removed from the analysis for that question. Weighted χ^2 tests were used for all analyses, using SPSS software. The study was powered to detect a medium correlation of $r = 0.5$ in each of the 2×2 tables. With 244 subjects, we had 88% power to detect such a correlation at the 5% level of significance (PASS software).

Results

Two hundred fifty participants responded to the invitation to participate, yielding a response rate of 67%. Demographics of the respondents are presented in table 1. The modal participant was white, married, middle-aged,

Table 1. Demographics of participants (n = 250)

	n (%)
Gender	
Female	127 (50.8)
Male	123 (49.2)
Mean age $\pm$ SD, years	48.9 $\pm$ 1.1
Race	
White, non-Hispanic	188 (75.2)
Hispanic	26 (10.4)
Black	22 (8.8)
Other	14 (5.6)
Marital status	
Married/living with partner	160 (64.0)
Never married	49 (19.6)
Divorced/widowed	41 (16.4)
Median household size	2
At least one child $\leq$ 18	73 (29.0)
Median household income, USD	60,000–74,999
Residence (US Census Bureau region)	
Northeast	75 (30.0)
Midwest	90 (36.0)
West	85 (34.0)
Major metropolitan area	204 (81.6)

Table 2. Participant's extent of agreement about whether to obtain genetic testing

Item	n (%)
If I were Ted's grandmother, I would want to have Ted tested for this gene. (n = 243)	173 (71)
If the grandmother won't consent, I think the court or state should require that Ted be tested. (n = 235)	81 (34)

middle-class, and living in a major metropolitan area. There was roughly equal male/female distribution, and a bit under a third of respondents indicated the presence of a child under 18 in their household.

There were no statistically significant differences between the 2 groups with regard to age, race/ethnicity, gender, household size, and the presence or absence of children in the household. The randomized groups were significantly different on measures of education [χ^2 (n = 228, df = 3) = 11.271, p = 0.010] and marital status [χ^2 (n = 229, df = 5) = 15.752, p = 0.008]. Regarding education, those participants told that Ted had the high-risk allele were more likely to have completed high school or college, while those in the low-risk allele group were more likely

to have had some high school or college experience without receiving a diploma or degree. With regard to marital status, those participants told that Ted has the high-risk allele were more likely to be divorced, separated or living with a partner, while those informed that Ted had the low-risk allele were more likely to be married, widowed or never married.

Participants' Views on Removal from the Mother's Home and Genetic Testing

Just over one half (54%, n = 133) of the participants, on the basis of the initial description of the episode of abuse, agreed that Ted should be taken from his mother's house. Those respondents with children in the home were less likely to agree that Ted should be removed from his mother [χ^2 (n = 230, df = 1) = 7.100, p = 0.008]. Table 2 shows the extent of participants' agreement that Ted should be tested to determine if he has the specific form of the gene that would increase his risk of manifesting violent behavior in adulthood. A substantial majority (71%, n = 173) would have wanted Ted to receive the genetic test if the decision had been in their hands. This result was associated with the age of the participants, with older survey takers (i.e. $\geq$ 45 years) more likely to want Ted tested [χ^2 (n = 243, df = 3) = 13.90, p = 0.003]. Despite this preference, the majority chose to allow Ted's grandmother to make the decision and did not think that the courts should order Ted to be tested over her objections. Respondents with children in the home were less likely to agree to have Ted tested over his grandmother's objections [χ^2 (n = 223, df = 1) = 6.200, p = 0.013].

Participants' Views on Use of Genetic Information and Disposition

Table 3 summarizes participants' responses after being told that the genetic test had been performed and what the results were. A majority of respondents (60%, n = 144), regardless of what they had been told about the outcome of the test, wanted the court to consider the genetic evidence in determining whether to return Ted to his mother.

Asked whether Ted should be compelled to undergo psychological treatment or counseling, a substantial majority of the participants (72%, n = 175) agreed that he should, with responses not differing significantly by whether Ted was described as having the high-risk or low-risk allele [χ^2 (n = 244, df = 1) = 2.445, p = 0.118]. Responses to this item differed by participants' ages, with those between 30 and 44 less likely to agree to psychological counseling than those in all other age groups (i.e.

Table 3. Participants' extent of agreement about the implications of the results of genetic testing for Ted's disposition

Item	Ted has the high-risk allele (n = 122)	Ted has the low-risk allele (n = 122)	
	n (%)	n (%)	
The courts should consider [the genetic test] result in determining whether it is in Ted's best interests to return to live with his mother	79 (64)	65 (54)	$\chi^2(n = 244, df = 1) = 2.785, p = 0.095$
The court should compel Ted to undergo some form of psychological treatment or counseling	93 (76)	82 (67)	$\chi^2(n = 244, df = 1) = 2.445, p = 0.118$
Ted should be given medications that have been proven to help with impulsive behavior	60 (50)	21 (17)	$\chi^2(n = 241, df = 1) = 28.8, p < 0.001$
Ted represents a danger to other kids in any potential foster home	44 (36)	16 (14)	$\chi^2(n = 239, df = 1) = 16.5, p < 0.001$
The court should now return Ted to live with his mother	101 (83)	110 (90)	$\chi^2(n = 244, df = 1) = 2.838, p = 0.092$

Sample sizes differ due to nonresponse. Percentages are therefore calculated on the basis of the number of subjects who actually responded, which varies by question.

18–29, 45–59, and ≥ 60) [$\chi^2(n = 244, df = 3) = 9.327, p = 0.025$]. In contrast, only a minority of respondents (34%, $n = 81$) agreed that Ted should be given medications that have been proven to help with impulsive behavior, with those participants who were told that Ted has the high-risk allele 3 times as likely to agree with giving him medications [$\chi^2(n = 241, df = 1) = 28.8, p < 0.001$].

With regard to perceptions of Ted's dangerousness, although overall only a minority thought that Ted represented a danger to other children (25%, $n = 60$), those who were told that Ted has the high-risk allele were significantly more likely to believe that he was dangerous [$\chi^2(n = 239, df = 1) = 16.5, p < 0.001$]. Regardless of the results of the genetic testing, a substantial majority endorsed allowing Ted to return to live with his mother (86%, $n = 211$) after she had undergone 6 months of rehabilitation. Responses to this item were associated with participants' age, with those ≤ 30 less likely to agree with returning Ted [$\chi^2(n = 244, df = 3) = 22.0, p < 0.001$].

Except where noted, responses to all items showed no association with age, gender, race/ethnicity, marital status, level of education, household size, or presence of children ≤ 18 years in the home.

There was no significant association between believing that the court should use the genetic test results in determining whether Ted should be returned to his mother and agreeing that Ted should be returned [$\chi^2(n = 246, df = 1) = 0.900, p = 0.34$]. However, those who believed that Ted would pose a danger to other children in a po-

tential foster home were more likely to agree with giving Ted medications that have been proven to help with impulsive behavior [$\chi^2(n = 223, df = 1) = 53.489, p < 0.001$]. Lastly, there was also a significant association between the 2 'treatment' variables: those respondents who thought Ted should be given medications were significantly more likely to want him to receive psychological treatment [$\chi^2(n = 226, df = 1) = 14.897, p < 0.001$].

Discussion

In this nationally representative sample of the US adult population, a substantial majority thought that an abused child ('Ted') should be tested for a gene variant that would increase the risk of later aggressive behavior, and a smaller majority wanted the result to be considered in deciding whether he should be returned to his mother. This finding suggests a generally positive view among most of our respondents about the relevance of behavioral genetic data to decisions being made in the context of child abuse proceedings. Specifically, it indicates a degree of belief in the value of genetic information in predicting future behavior and – combined with greater endorsement of treatment with medication in the presence of the high-risk form of the gene – in pointing to preventive interventions that may reduce the risk of adverse outcomes.

Other aspects of our data, however, suggest somewhat greater caution among the participants in this study with

regard to how genetic data should be used. Although a majority endorsed obtaining information on whether Ted was at heightened risk for certain adverse consequences of child abuse, there was no significant effect of the genetic test on the ultimate issue at hand: whether Ted should be reunited with his mother. Regardless of the genetic findings, an overwhelming proportion of respondents strongly favored returning Ted to his mother after she had undergone treatment for her abusive behavior.

To the extent that Ted's having the high-risk allele had an impact on the attitudes of our respondents, it made them more likely to regard Ted as a danger to other children. This is consistent with the finding in the first part of this study that genetic attributions of an adult defendant's violent behavior increased participants' apprehension more than did other explanations of the behavior [44]. To the extent that this apprehension is a result of a belief that Ted's genetic endowment constitutes something fundamental about his character, it may represent a form of genetic essentialism [41]. It is also consistent with fears of the stigmatizing effect of behavioral genetic information regarding criminal propensities [45].

Concern about Ted's risk of violence towards other children correlated strongly with the belief that he should be given medications to reduce that risk. In part, increased willingness to resort to medication may represent a general tendency to view genetics as medicalizing, i.e. shifting a problem into the medical sphere [46]. A similar finding was observed in the General Social Survey, a population-based survey of non-institutionalized adults in the US. When given descriptions of a person with schizophrenia, depression or alcohol, those who believed that the person's condition had a neurobiological cause were much more likely to support treatment with medications [47]. On the other hand, half the participants in the group that was told Ted had the high-risk allele continued to oppose use of medication. Their reluctance may be consistent with other results of the General Social Survey, in which only a minority of the US adult population endorsed the use of medications in nonsuicidal children, even when those children were hostile [48]. It is also consistent with studies showing that psychotherapy is preferred to medication by the general public for the first-line treatment of psychiatric problems [49]. In children, the reluctance to resort to medication may be heightened by frequent media reports of inappropriate and excessive psychopharmacological treatment [50]. In contrast, a large majority of respondents in both conditions wanted Ted to receive counseling, even though it would be compelled and despite no mention of whether such treatment was likely to be effective.

From a broad perspective, our results are consistent with other reports of the public's desire for their own and their children's genetic information regarding predispositions to behavioral and medical disorders, even in the absence of available interventions to mitigate risk [51–53]. This optimistic view of the value of behavioral genetic information may represent a more general pro-innovation bias among the American public, or simply a tendency to value genetic data highly [54]. However, the genetic information itself did not affect respondents' views of the proper disposition of the case, suggesting a less-than-complete embrace of the value of such data when applied to actual decisions – a disjunction noted in other studies of attitudes toward genetic testing as well [55].

In this respect, our respondents' views are in keeping with the majority of commentators, who urge caution in relying on behavioral genetic information in making highly consequential decisions. Among their concerns are the mismatch between legal categories and scientific data, and the risks of miscommunication or misinterpretation of complex biological information [56, 57]. As Buckholtz and Meyer-Lindenberg [35] have argued with regard to effects of the MAOA $\times$ child abuse interaction, 'More work is needed to determine the formal sensitivity, specificity, and phenotypic selectivity of the effect; its robustness to variability in the measurement of maltreatment; the impact of maltreatment exposure duration and timing; and effect of ethnic background ...' They also note the conceptual difficulties in applying group data to individual cases. In addition, to our knowledge no data exist regarding whether removal of children from their families and placement in foster care reduces the already acquired risks based on this gene $\times$ environment interaction. The realities of the child welfare system, in which abused children are often at risk of further abuse [58], and a commitment to keeping families together whenever possible [59], may legitimately override genetic risk of undefined dimensions.

With regard to the limitations of this study, using a web-based survey allowed us to obtain a sample statistically representative of the adult population of the US but with the restrictions characteristic of online surveys. These include an inability to ensure that the invited person was the one who completed the survey, or that the respondents took the time and care to respond appropriately. However, research on Internet surveys indicates good internal consistency, high test-retest reliability, and results similar to those obtained by other means [60, 61]. Another limitation of online surveys is nonresponse. Al-

though, as mentioned previously, KN used post-stratification weights to adjust for nonresponse as a technique for maintaining the representativeness of the data, there is always the possibility that nonresponse was affected by variables that were not controlled for and thus affected the results. In addition, since this study was based on a single vignette involving an abused child, we cannot rule out the possibility that changes in the wording, length or complexity of the vignette could have altered the findings. Further, the case, although realistic, does not represent the full range of circumstances encountered in the context of child abuse, alterations in which could change the findings as well.

These data provide some preliminary evidence about public perceptions of the utility and implications of behavioral genetic information, specifically in the setting of child abuse. Future research on larger samples is needed to confirm these data and to explore some of the variables that may have mediated the effects that we found. In addition, as the field of behavioral genetics advances, public responses to genetic predictors of future behavior will need to be studied in other contexts and situations. At present – despite suggestions by some commentators that behavioral genetic information should alter our approach to management of cases of abuse – these findings suggest that the desire for such information was accompanied by caution in relying on the data for dispositional decisions.

Appendix

Vignette Given to Participants

Now we'd like you to consider a different situation:

Ted is a 7-year-old child who lives with his mother. While at school, Ted is noted by a teacher to have multiple bruises on his arms and legs. He is examined by the school nurse, who suspects child abuse and reports the case to the state's Child Protective Services (CPS) agency as mandated by state law. A doctor working for CPS conducts a more thorough physical exam of Ted, and the boy is also interviewed by a psychologist. Both specialists believe that Ted has been physically abused.

When his mother is questioned, she admits to having 'hit him, but only one time'. The abuse happened over the one day when she was on a drinking binge following a break-up with her boyfriend. She insists that she has otherwise been sober for more than ten years. She describes hitting Ted with her open hand. She is very remorseful about this episode, and explains that she loves her son very much. She fully cooperates with the investigators.

The CPS investigation corroborates the mother's confession and her remorse. A court hearing is held to determine whether Ted should be placed for now in the custody of his grandmother. The court must determine whether it is in Ted's best interests to remain with his mother.

[All questions call for response on 4-point Likert scale: strongly disagree – disagree – agree – strongly agree.]

Please indicate your agreement or disagreement with the following statement:

Q1. Ted should be removed from his mother's home for his own good.

At the hearing, Ted is removed from his mother's custody and placed with his grandmother. A staff member at Child Protective Services also begins counseling Ted's grandmother. His grandmother learns that children who are physically abused are far more likely to demonstrate impulsive behavior, including violence and other forms of criminal activity, when they are grown. She also learns that this risk is greater in children who carry a specific form of a gene that affects how chemical signals are sent in the brain. Studies show that up to 85% of children who are abused and have this particular gene display some form of aggressive, violent, or criminal behavior as adults. The grandmother is asked if she wants Ted to have a simple blood test to see if he carries this gene.

Please indicate your agreement or disagreement with the following statements:

Q2. If I were Ted's grandmother, I would want to have Ted tested for this gene.

Q3. If the grandmother won't consent, I think the court or state should require that Ted be tested.

[Randomization: respondents were randomized to receive one of the following two statements:

Condition 1: His grandmother agrees to have him tested. The test comes back: Ted **does carry the form of the gene** that puts him at risk for impulsivity and violence.

Condition 2: His grandmother agrees to have him tested. The test comes back: Ted **does not carry the form of the gene** that puts him at risk for impulsivity and violence.]

Taking into account the new information, please indicate your agreement or disagreement with the following statements:

Q4. The courts should consider this result in determining whether it is in Ted's best interests to return to live with his mother.

Q5. The court should compel Ted to undergo some form of psychological treatment or counseling.

Q6. Ted should be given medications that have been proven to help with impulsive behavior.

Q7. Ted represents a danger to other kids in any potential foster home.

As a condition for the return of her son, Ted's mother is required by the court to attend an alcohol rehabilitation program, an intensive parent-training course, and outpatient therapy. Six months later, after successfully completing these programs and remaining sober, she asks the court for Ted to be returned to her.

Q8. The court should now return Ted to live with his mother.

Acknowledgement

This work was supported in part by grant 1P20HG005535-01 from the National Human Genome Research Institute.

References

- Plomin R, Owen M, McGuffin P: The genetic basis of complex human behaviors. *Science* 1994;264:1733–1739.
- Oliver BR, Plomin R: Twins' Early Development Study (TEDS): a multivariate, longitudinal genetic investigation of language, cognition and behavior problems from childhood through adolescence. *Twin Res Hum Genet* 2007;10:96–105.
- Livesley WJ, Jang KL: The behavioral genetics of personality disorder. *Annu Rev Clin Psychol* 2008;4:247–274.
- de Moor MHM, Costa PT, Terracciano A, Krueger RF, de Geus EJ, Toshiko T, Penninx BW, Esko T, Madden PA, Derringer J, Amin N, Willemsen G, Hottenga JJ, Distel MA, Uda M, Sanna S, Spinhoven P, Hartman CA, Sullivan P, Realo A, Allik J, Heath AC, Pergadia ML, Agrawal A, Lin P, Grucza R, Nutile T, Ciullo M, Rujescu D, Giegling I, Konte B, Widen E, Cousminer DL, Eriksson JG, Palotie A, Peltonen L, Luciano M, Tenesa A, Davies G, Lopez LM, Hansell NK, Medland SE, Ferrucci L, Schlessinger D, Montgomery GW, Wright MJ, Aulchenko YS, Janssens AC, Oostra BA, Metspalu A, Abecasis GR, Deary IJ, Rääkkönen K, Bierut LJ, Martin NG, van Duijn CM, Boomsma DI: Meta-analysis of genome-wide association studies for personality. *Mol Psychiatry* 2012;17:337–349.
- Bigos KL, Weinberger DR: Imaging genetics – days of future past. *Neuroimage* 2010;53:804–809.
- Pinker S: *The Blank Slate: The Modern Denial of Human Nature*. New York, Viking, 2003.
- Farahany N, Bernet N: Behavioural genetics in criminal cases: past, present and future. *Genomics Soc Policy* 2006;2:72–79.
- Appelbaum PS: Behavioral genetics and the punishment of crime. *Psychiatr Serv* 2005;56:25–27.
- Rocque M, Welsh BC, Raine A: Biosocial criminology and modern crime prevention. *J Crim Justice* 2012;40:306–312.
- Hoffmann DE, Rothenberg KH: Science and law. When should judges admit or compel genetic tests? *Science* 2005;310:241–242.
- Brunner HG, Nelen M, Breakefield XO, Ropers HH, van Oost BA: Abnormal behavior associated with a point mutation in the structural gene for monoamine oxidase A. *Science* 1993;262:578–580.
- Caspi A, McClay J, Moffitt TE, Mill J, Martin J, Craig IW, Taylor A, Poulton R: Role of genotype in the cycle of violence in maltreated children. *Science* 2002;297:851–854.
- Hunter DJ: Gene-environment interactions in human diseases. *Nat Rev Genet* 2005;6:287–298.
- Aslund C, Nordquist N, Comasco E, Leppert J, Orelund L, Nilsson KW: Maltreatment, MAOA, and delinquency: sex differences in gene-environment interaction in a large population-based cohort of adolescents. *Behav Genet* 2011;41:262–272.
- Derringer J, Krueger RF, Irons DE, Iacono WG: Harsh discipline, childhood sexual assault, and MAOA genotype: an investigation of main and interactive effects on diverse clinical externalizing outcomes. *Behav Genet* 2010;40:639–648.
- Ducci F, Enoch MA, Hodgkinson C, Xu K, Catena M, Robin RW, Goldman D: Interaction between a functional MAOA locus and childhood sexual abuse predicts alcoholism and antisocial personality disorder in adult women. *Mol Psychiatry* 2008;13:334–347.
- Fergusson DM, Boden JM, Horwood LJ, Miller AL, Kennedy MA: MAOA, abuse exposure and antisocial behaviour: 30-year longitudinal study. *Br J Psychiatry* 2011;198:457–463.
- Foley DL, Eaves LJ, Wormley B, Silberg JL, Maes HH, Kuhn J, Riley B: Childhood adversity, monoamine oxidase A genotype, and risk for conduct disorder. *Arch Gen Psychiatry* 2004;61:738–744.
- Huang YY, Cate SP, Battistuzzi C, Oquendo MA, Brent D, Mann JJ: An association between a functional polymorphism in the monoamine oxidase A gene promoter, impulsive traits and early abuse experiences. *Neuropsychopharmacology* 2004;29:1498–1505.
- Kim-Cohen J, Caspi A, Taylor A, Williams B, Newcombe R, Craig IW, Moffitt TE: MAOA, maltreatment, and gene-environment interaction predicting children's mental health: new evidence and a meta-analysis. *Mol Psychiatry* 2006;11:903–913.
- Nilsson KW, Sjöberg RL, Damberg M, Lepert J, Ohrvik J, Alm PO, Lindström L, Orelund L: Role of monoamine oxidase A genotype and psychosocial factors in male adolescent criminal activity. *Biol Psychiatry* 2006;59:121–127.
- Nilsson KW, Sjöberg RL, Wargelius HL, Lepert J, Lindström L, Orelund L: The monoamine oxidase A (MAO-A) gene, family function and maltreatment as predictors of destructive behaviour during male adolescent alcohol consumption. *Addiction* 2007;102:389–398.
- Reif A, Rösler M, Freitag CM, Schneider M, Eujen A, Kissling C, Wenzler D, Jacob CP, Retz-Junginger P, Thome J, Lesch KP, Retz W: Nature and nurture predispose to violent behavior: serotonergic genes and adverse childhood environment. *Neuropsychopharmacology* 2007;32:2375–2383.
- Widom CS, Brzustowicz LM: MAOA and the 'cycle of violence': childhood abuse and neglect, MAOA genotype, and risk for violent and antisocial behavior. *Biol Psychiatry* 2006;60:684–689.
- Fergusson DM, Boden JM, Horwood LJ, Miller A, Kennedy MA: Moderating role of the MAOA genotype in antisocial behaviour. *Br J Psychiatry* 2012;200:116–123.
- Haberstick BC, Lessem JM, Hopfer CJ, Smolen A, Ehringer MA, Timberlake D, Hewitt JK: Monoamine oxidase A (MAOA) and antisocial behaviors in the presence of childhood and adolescent maltreatment. *Am J Med Genet B Neuropsychiatr Genet* 2005;135B:59–64.
- Huizinga D, Haberstick BC, Smolen A, Menard S, Young SE, Corley RP, Stallings MC, Grotper J, Hewitt JK: Childhood maltreatment, subsequent antisocial behavior, and the role of monoamine oxidase A genotype. *Biol Psychiatry* 2006;60:677–683.
- Prichard Z, Mackinnon A, Jorm AF, Easteal S: No evidence for interaction between MAOA and childhood adversity for antisocial behavior. *Am J Med Genet B Neuropsychiatr Genet* 2008;147B:228–232.
- Reti IM, Xu JZ, Yanofski J, McKibben J, Uhart M, Cheng YJ, Zandi P, Bienvenu OJ, Samuels J, Willour V, Kasch-Semenza L, Costa P, Bandeen-Roche K, Eaton WW, Nestadt G: Monoamine oxidase A regulates antisocial personality in whites with no history of physical abuse. *Compr Psychiatry* 2011;52:188–194.
- Vanyukov MM, Maher BS, Devlin B, Kirillova GP, Kirisci L, Yu LM, Ferrell RE: The MAOA promoter polymorphism, disruptive behavior disorders, and early onset substance use disorder: gene-environment interaction. *Psychiatr Genet* 2007;17:323–332.
- Young SE, Smolen A, Hewitt JK, Haberstick BC, Stallings MC, Corley RP, Crowley TJ: Interaction between MAO-A genotype and maltreatment in the risk for conduct disorder: failure to confirm in adolescent patients. *Am J Psychiatry* 2006;163:1019–1025.
- Taylor A, Kim-Cohen J: Meta-analysis of gene-environment interactions in developmental psychopathology. *Dev Psychopathol* 2007;19:1029–1037.
- Byrd AL, Manuck SB: MAOA, childhood maltreatment, and antisocial behavior: meta-analysis of a gene-environment interaction. *Biol Psychiatry* 2014;75:9–17.
- Widom CS, Maxfield MG: An update on the cycle of violence. *Natl Inst Justice Res Br* 2001:1–8.
- Buckholtz JW, Meyer-Lindenberg A: MAOA and the bioprediction of antisocial behavior: science fact and science fiction; in Singh I, Sinnott-Armstrong WP, Savulescu J (eds): *Bioprediction, Biomarkers, and Bad Behavior: Scientific, Legal, and Ethical Challenges*. New York, Oxford University Press, 2014, pp 131–152.
- Baum M, Savulescu J: Behavioral biomarkers: what are they good for? Toward the ethical use of biomarkers; in Singh I, Sinnott-Armstrong WP, Savulescu J (eds): *Bioprediction, Biomarkers, and Bad Behavior: Scientific, Legal, and Ethical Challenges*. New York, Oxford University Press, 2014, pp 12–41.
- Stone RD: The cloudy crystal ball: genetics, child abuse, and the perils of predicting behavior. *Vanderbilt Law Rev* 2003;56:1557–1590.

- 38 Weder N, Yang BZ, Douglas-Palumberi H, Massey J, Krystal JH, Gelernter J, Kaufman J: MAOA genotype, maltreatment, and aggressive behavior: the changing impact of genotype at varying levels of trauma. *Biol Psychiatry* 2009;65:417–424.
- 39 Tremblay RE, Szyf M: Developmental origins of chronic physical aggression and epigenetics. *Epigenomics* 2010;2:495–499.
- 40 Kaufman J, Perepletchikova F: Promoting resilience in maltreated children; in Dodge KA, Rutter M (eds): *Gene-Environment Interactions in Developmental Psychopathology*. New York, Guilford Press, 2011, pp 159–188.
- 41 Dar-Nimrod I, Heine S: Genetic essentialism: on the deceptive determinism of DNA. *Psychol Bull* 2011;137:800–818.
- 42 Greene J, Cohen J: For the law, neuroscience changes nothing and everything. *Philos Trans R Soc Lond B Biol Sci* 2004;359:1775–1785.
- 43 Aspinwall LG, Brown TR, Tabery J: The double-edged sword: does biomechanism increase or decrease judges' sentencing of psychopaths? *Science* 2012;337:846–849.
- 44 Appelbaum PS, Scurich N: Impact of behavioral genetic evidence on the adjudication of criminal behavior. *J Am Acad Psychiatry Law* 2014;42:91–100.
- 45 Rothenberg KH, Wang A: The scarlet gene: behavioral genetics, criminal law, and racial and ethnic stigma; in Farahany N (ed): *The Impact of Behavioral Sciences on Criminal Law*. New York, Oxford University Press, 2009, pp 439–463.
- 46 Allen GE: Genetics, eugenics and the medicalization of social behavior: lessons from the past. *Endeavour* 1999;23:10–19.
- 47 Pescosolido BA, Martin JK, Long JS, Medina TR, Phelan JC, Link BG: 'A disease like any other'? A decade of change in public reactions to schizophrenia, depression, and alcohol dependence. *Am J Psychiatry* 2010;167:1321–1330.
- 48 McLeod JD, Pescosolido BA, Takeuchi DT, White TF: Public attitudes toward the use of psychiatric medications for children. *J Health Soc Behav* 2004;45:53–67.
- 49 Riedel-Heller SG, Matschinger H, Angermeyer MC: Mental disorders – who and what might help? Help-seeking and treatment preferences of the lay public. *Soc Psychiatry Psychiatr Epidemiol* 2005;40:167–174.
- 50 Schwarz A: The Selling of Attention Deficit Disorder. *New York Times*, December 15, 2013. http://www.nytimes.com/2013/12/15/health/the-selling-of-attention-deficit-disorder.html?_r=0.
- 51 Bollinger JM, Scott J, Dvoskin R, Kaufman D: Public preferences regarding the return of individual genetic research results: findings from a qualitative focus group study. *Genet Med* 2012;14:451–457.
- 52 Murphy J, Scott J, Kaufman D, Geller G, LeRoy L, Hudson K: Public expectations for return of results from large-cohort genetic research. *Am J Bioeth* 2008;8:36–43.
- 53 Lawrence RE, Appelbaum PS: Genetic testing in psychiatry: a review of attitudes and beliefs. *Psychiatry* 2011;74:315–331.
- 54 Rogers EM: *Diffusion of Innovations*, ed 5. New York, Free Press, 2003.
- 55 Elger BS: Attitudes of future lawyers and psychologists to the use of genetic testing for criminal behavior. *Camb Q Healthc Ethics* 2005;14:329–345.
- 56 Campbell C, Eastman N: The limits of legal use of neuroscience; in Singh I, Sinnott-Armstrong WP, Savulescu J (eds): *Bioprediction, Biomarkers, and Bad Behavior: Scientific, Legal, and Ethical Challenges*, New York, Oxford University Press, 2014, pp 91–117.
- 57 Morse SJ: Gene-environment interactions, criminal responsibility and sentencing; in Dodge KA, Rutter M (eds): *Gene-Environment Interactions in Developmental Psychopathology*. New York, Guilford Press, 2011, pp 207–234.
- 58 Benedict MI, Zuravin S, Brandt D, Abbey H: Types and frequency of child maltreatment by family foster care providers in an urban population. *Child Abuse Negl* 1994;18:577–585.
- 59 Compitello M: Parental rights and family integrity: forgotten victims in the battle against child abuse. *Pace Law Rev* 1997;18:135–198.
- 60 Gosling SD, Vazire S, Srivastava S, John OP: Should we trust web-based studies? A comparative analysis of six preconceptions about internet questionnaires. *Am Psychol* 2004;59:93–104.
- 61 Buhrmester M, Kwang T, Gosling SD: Amazon's mechanical turk: a new source of inexpensive, yet high-quality, data? *Perspect Psychol Sci* 2011;6:3–5.