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Second Sight and Family History: Pedigree and Segregation Analyses

SHARI A. COHN

School of Scottish Studies, University of Edinburgh
27 George Square, Edinburgh, EH8 9LD, United Kingdom
Email address: S.Cohn@ed.ac.uk

Abstract — Little is known about the inheritance of mental and artistic talents. However, given the growing body of evidence for genetic factors in cognitive ability and complex behavior, investigation of this issue seems merited. This study concerns *second sight*, a *psychic* ability that has for centuries been believed, in Scotland and other traditions, to be hereditary. The ability manifests itself through the person having spontaneous vivid imagery through different senses which apparently gives information about a spatially or temporally distant event. A total of 130 family histories were constructed and examined using segregation analysis. Second sight seems to be consistent with an autosomal dominant mode of inheritance, particularly for small family sizes. People with the trait were also evenly distributed with respect to their birth order position, in line with the expectations of a genetic model. It is argued that if other studies find a similar mode of inheritance in other cultures, then second sight could be a creative mental ability where the hereditary aspect lies in the sensitivity of the sensory systems which convey the experiences.

Keywords: family studies — second sight — mental talent — segregation analysis — genetics

Introduction

Several well-known neurological diseases such as Huntington's Chorea, Tay-Sachs syndrome and Lesch-Nyhan syndrome follow a single gene Mendelian inheritance pattern. In contrast, there is no consensus as to whether affective disorders follow a single gene or a polygenic inheritance pattern. Several early researchers argued that bipolar manic-depressive illness followed an X-linked dominant inheritance pattern on the basis of linkage between the disorder and the Xg blood group (Winokur & Tanna, 1969; Mendlewicz *et al.*, 1972; Fieve *et al.*, 1973), color blindness or glucose-6-phosphate-dehydrogenase (G6PD) deficiency (Reich *et al.*, 1969; Baron *et al.*, 1987). Subsequent work contradicted the finding of linkage with the Xg blood group (Risch & Baron, 1982) and furthermore demonstrated that the linkage with color blindness or G6PD was weaker than originally claimed (Baron *et al.*, 1994). In addition other studies have found evidence contrary to this mode of inheritance such as incidences of a father–son transmission (Goetzl *et al.*, 1974; Angst *et al.*, 1980).

Also in a study of families in an Amish community in Pennsylvania, USA, an autosomal dominant mode of inheritance was observed with linkage to chromosome 11 (Egeland *et al.*, 1987), though the robustness of this finding has also been questioned (Kelsoe *et al.*, 1989).

In light of these somewhat contradictory findings, others have argued that bipolar manic-depressive illness involves more than one gene and that environmental factors play a significant role in bringing on the illness. For instance, stress, alcohol, and/or interpersonal conflict may trigger a manic-depressive episode in someone who has a history of this illness in their family. Other siblings exposed to the same stresses might not develop the same illness. There may be a threshold of liability for the onset of manic-depressive illness, making it difficult to pinpoint a single gene or polygenic mode of inheritance (McGuffin, 1988; McGuffin & Katz, 1989). The search for susceptibility genes for bipolar manic-depressive illness is already underway (Straub *et al.*, 1994; Berrettini *et al.*, 1994). There is also strong evidence that very creative and gifted people, especially writers and poets, tend to suffer more than others from affective disorders such as manic-depressive illness (Ellis, 1927; Juda, 1949; Andreasen, 1987; Andreasen & Glick, 1988; Akiskal & Akiskal, 1988; Richards *et al.*, 1988; Jamison, 1989, 1993; Ludwig, 1992; Post, 1994). Furthermore, there is a tendency for both manic-depressive illness and creativity to run in families (McNeil, 1971; Andreasen, 1987; Jamison, 1993; Ludwig, 1994). These findings raise intriguing issues about the relationship between disorders and abilities.

Many studies using twin, adoption and family methods have found that cognitive ability has both genetic and environmental factors (*e.g.* Bouchard & McGue, 1981; Plomin & McClearn, 1993; Plomin *et al.*, 1994a). Techniques in molecular genetics are now being applied to locating genes that contribute to particular abilities (Plomin *et al.*, 1994b; McInnes & Freimer, 1995; Plomin *et al.*, 1997). As there are genetic predispositions for neurological, mental and affective disorders and cognitive abilities, can there not be genetic predispositions for mental talents like artistic or musical ability? For example, there is much anecdotal evidence that musical ability may be hereditary, though there is as yet no firm evidence to substantiate this. However, a recent study has shown that the gift of perfect pitch is associated with a characteristic cortical morphology (Schlaug *et al.*, 1995). In people who are not musicians, there is a leftward hemispheric asymmetry of the planum temporale, an area in the cortex associated with processing of sound. Through magnetic resonance imaging, Schlaug *et al.* (1995) found that this leftward asymmetry was accentuated in musicians, particularly so for those who have perfect pitch. Musicians with perfect pitch start their training younger than musicians without perfect pitch, thus suggesting the possibility of an interaction between hereditary and environmental factors in fostering musical talent. For a discussion of this work, see Nowak (1995) and Sacks (1995).

In the Gaelic speaking communities of Scotland, many artistic abilities, for instance being a good piper, or singer, were regarded as being hereditary. This was also believed to be the case for having second sight (MacInnes, 1989; Cohn, 1996). Second sight is traditionally believed to be a "psychic" ability, that of having spontaneous *awake visions*, which apparently gives information about a spatially or temporally distant event. It is usually associated with people living in Scotland, especially in the Western Isles and Highlands though it is known to be reported by people living in different countries such as Germany (Schmëing, 1937, 1950, 1954; see Grober-Glück (1973) for an article in English about Schmëing's work). People in other countries also report experiences with the same psychological phenomenology as second sight, *e.g.* vivid precognitive visions, though the specific term *second sight* might not be used to describe them. In the current study, such experiences are also regarded as second sight.

A recent questionnaire study (Cohn, 1999) found that second sight is reported by people of diverse ages, occupations, and religious and cultural traditions. Women tend to report more experiences than men. Extensive interviews were also conducted with 70 people who lived in different parts of Scotland and over 500 accounts were collected and analyzed (Cohn, 1996). Some classical second sight experiences which reflect local customs of death and burial, such as visions of a funeral procession or a death shroud, feature prominently in the historical literature but are rarely reported today (Cohn, 1999). More contemporary experiences can occur either in a literal or symbolic form. For instance, one informant had a vision of a man hanging in an arched window shortly before he found out that a relative of his had hanged himself in a church fifteen miles away. Other visions can occur in a symbolic form, such as one informant seeing a huge wave engulf a fisherman before he and his crew were drowned. The phenomenology of second sight experiences, which often concern emotionally charged events, suggests that the "imagery," whether visual, auditory, and/or kinaesthetic, is often perceived as external, real and vivid. These and other distinctive features of second sight experiences helped in distinguishing those people with the trait from those without it, thereby facilitating the task of preparing family histories.

Most of the investigators from the 17th century until the present day have observed that second sight ran in the family. Some observed there was a father–son transmission, though most found that both men and women had second sight. For a review of the historical accounts and investigators, see Cohn (in press). No family histories were ever presented in the historical accounts, so it is impossible to assess from them alone whether the capacity to have second sight experiences could be hereditary. In a small scale South African study, Neppe (1980) observed an association between the symptomatology of temporal lobe dysfunction and people reporting psychic experiences. Hurst and Neppe (1981) subsequently examined two pedigrees from people who had spontaneous psychic experiences and temporal lobe dysfunction and reported that both features followed an autosomal dominant inheritance

pattern. In a recent survey using random sampling methods, it was found that second sight does seem often to run in families in the Western Isles, Highlands, Grampian and Lowland regions in Scotland (Cohn, 1994). Clearly second sight could run in families as a social and cultural phenomenon where the interpretation of experiences as being "psychic" is orally passed down in families from one generation to another. Alternatively, second sight could be a genuine mental talent that is in part hereditary. To attempt to discriminate between these two possibilities, a total of 130 pedigrees were prepared from people with a history of second sight and they were studied using segregation analysis.

Subjects and Methods

Selection and Construction of Pedigrees

A 65-item questionnaire consisting of questions on personal background, range of second sight experiences and family history information was constructed. Questions on different types of second sight experiences were drawn up in light of the historical literature on second sight from the 17th century onwards and the more recent accounts from the archives of the School of Scottish Studies at the University of Edinburgh (1950 to present), for more details see Cohn (1996, 1999).

The questionnaire was sent to people living primarily in Scotland but also to people living elsewhere in Britain and other parts of the world, who had contacted the author about having had such experiences and others through contacts made during the survey study and fieldwork. From a total of 208 questionnaire respondents, 70 of whom were also interviewed, there was sufficiently complete family history information to construct pedigrees for 139 of them. From this total, nine pedigrees were excluded from the study: six from people who professed to being mediums or had some other involvement with the occult, and three from people who provided information about having serious medical or clinical problems likely to impair their judgement. Therefore a total of 130 family histories were studied. They were analyzed with the aim of eliminating known inheritance patterns incompatible with the data to see if a particular inheritance pattern would be reached. The full set of pedigrees is given in (Cohn, 1996). In addition to the analyses of this large number of pedigrees, a parallel set of analyses were undertaken on a subset of these pedigrees, henceforth called the *Scottish Interview Group*, consisting of 41 pedigrees which satisfied the condition that the person who provided the pedigree information was interviewed, and was primarily from the Scottish Highlands and Islands or Lowlands. The Scottish Interview Group was analyzed separately to see if the family histories of second sight would be different from the wider group which included people from throughout Britain and other countries who had second sight and other types of psychic experiences. The pedigrees were prepared using a software program called INHERIT (Jones, 1993) and they were analyzed in consultation with Professor Elof Carlson, a geneticist at Stony Brook University, USA.

Criterion for Identifying Individuals with Trait

In the current study the trait in question was whether or not someone had second sight experiences. As there is no repeatable experimental test yet to measure second sight, the assessment was based upon questionnaire and interview material. Specifically, a person was labeled as having second sight if they reported any experiences falling into certain categories, such as having visions of a funeral procession or death shroud; having visions of a person shortly before, at the moment of, or after death; having visions of a person not recognized but later met or precognitive visions which involve sound, light, scent or physical sensation. For a complete list of categories, see Cohn (1996, 1999).

Following the convention in human genetics, an individual who provided information was identified as the propositus or proband and indicated by an arrow in the pedigrees (*e.g.* McKusick, 1964; Bodmer & Cavalli-Sforza, 1976; Carlson, 1984). In some families there was more than one propositus, which helped to corroborate the information. In the families in which interviews were conducted, further consistency checks were possible through follow-up interviews. Relatives were identified as having second sight if they told the propositus that they had such experiences or if they were well-known in the family to have had second sight. The convention used in the pedigrees to indicate that a man reported having second sight was a darkened in square and for a woman, a darkened in circle. Roman numerals are used to label each generation in the pedigree diagrams. The remaining relatives were classed either as not having second sight or as "unsures." Men and women who were reported as not having had second sight were represented in the pedigrees by open squares and circles, respectively. Individuals about whom there was insufficient information to decide whether they had second sight or not were classed as "unsures" and represented by grey symbols. Individuals could be classed as "unsures" for several reasons: first, if the relative was well-known to the propositus but never mentioned having second sight; second, if the relative had died before the propositus knew him and no other relatives could verify whether the relative had second sight experiences or not; third, if the relative lived elsewhere and there was little communication between the propositus and his or her family; lastly, if the relative was reserved and did not wish to admit to having such experiences.

Results

Incidence of Second Sight

Table 1 summarizes data from the complete set of family histories and the Scottish Interview Group. Analyses were made only for those relatives for whom there was information about whether they had second sight or not. The

alternative approach of including everyone in the analyses was not adopted, as it would require treating the "Nos" and "Unsures" as equivalent and thereby underestimate the incidence of second sight in the pedigrees.

The incidence of reported second sight (v) in the set of 130 family histories in Table 1, is: 667/(667+1375) = .33 or 33%. The incidence of reported second sight among the 41 families in the Scottish interview group is similar to that in the wider group: v= 254/(254+668) = .275 or 28%.These observed frequencies of second sight are higher than the frequencies observed in a recent random survey (Cohn, 1994). We would expect this finding as the pedigrees constitute a pre-selected group in which the propositus usually reported having second sight.

Sex Ratio

From the aforementioned survey study, it was observed that there was no significant difference between the proportions of men and women reporting second sight for the Western Isles, Highlands, and Grampian areas, though more women reported second sight than men in the Lowlands. However when we look at the family histories, we observe that women tend to report second sight more than men. The proportion of males with second sight in all the family histories is: 236/992 = .24. The equivalent proportion of females is: 417/1036 = .40. A χ^2 test confirmed that this difference was highly significant: $\chi^2 = 62.9$, $df = 1$, $p < .001$.

It could be that this difference was due to a strong effect in a small number of pedigrees, rather than being a general one. To check this, each pedigree was examined to see whether the number of women reporting second sight exceeded the equivalent number of men. In the complete set of 130 pedigrees, this

TABLE 1
Summary Figures of Pedigree Data

	All Pedigrees	Interview Group
Number of Pedigrees	130	41
Number of Family Members Interviewed	61	51
Number of People with Second Sight	667	254
Number of Males with Second Sight	236	104
Number of Females with Second Sight	417	145
Number of Unspecified Sex with Second Sight	14	5
Number without Second Sight	1375	668
Number of Males without Second Sight	756	361
Number of Females without Second Sight	619	307
Number Not Sure About Second Sight	1602	545
Number of Males Not Sure About Second Sight	606	227
Number of Females Not Sure About Second Sight	484	197
Number of Unspecified Sex without Second Sight	511	121
Number of Married Couples with Second Sight	69	26
Number of Married Couples	500	218

was indeed the case for 89 pedigrees (the men outnumbering the women in another 25, the remaining 16 being tied). A similar trend was found in the Scottish interview group pedigrees (the equivalent figures being 23, 12 and 6 pedigrees, respectively). Thus the sex difference is a general feature of the data.

Assortative Mating Preference

Do people with second sight tend to marry a partner with second sight? One way to examine whether this is so is to compare the observed proportion of marriages in which both partners have second sight to the proportion of such marriages that would be expected to occur by chance, assuming that second sight played no role in partner selection. From Table 1, the observed proportion is 69/500 = .138.

The proportion expected by chance is the probability that a man and woman selected at random in the family histories would both have second sight. The probability that the man would have second sight is $v_{male} = 236/992 = .24$, the probability for a woman is $v_{female} = 417/1036 = .40$. Therefore the probability that both partners in a marriage picked at random would have second sight is $v_{male} \times v_{female} = .096$. Multiplying this by the total number of marriages gives $500 \times .096 = 48$. Thus, if second sight played no role in the selection of a marriage partner we would expect to see around 48 couples in which both partners had second sight. In fact, there are 69 such marriages in the pedigrees, with a test based on normal distribution statistics confirming that the difference is highly significant (*two-tailed*, $p < .01$, $Z = 3.4$.). So we observe an assortative mating preference, that is a tendency for people with second sight to marry partners with second sight more often than would be expected by chance.

The Scottish interview data gives a similar finding. The value of v_{male} = 104/465 = .22. The value of $v_{female} = 145/452 = .32$. Therefore $v_{male}\, v_{female} = .07$. If we multiply this by the total number of marriages we get $218 \times .07 = 17.9$. Again this is lower than the observed number of these marriages, 26. So an assortative mating preference is also found in the Scottish interview group.

Excluding Modes of Inheritance

To assess whether second sight is a cultural phenomenon orally transmitted through the family and/or whether it is hereditary, family histories were analyzed looking for the known Mendelian inheritance patterns (Carlson, 1984). Although there is no *a priori* reason why inheritance should be due to a single gene rather than multiple genes, as single gene transmission patterns are easier to detect, these were searched for first.

The mode of Mendelian inheritance differs according to which type of chromosome the gene in question is on — either on a sex chromosome (X or Y) or on one of the 22 autosomes from each parent — and whether expression of the trait requires just one copy of the gene (dominant) or requires two copies (recessive).

X-linked Recessive Inheritance

Of the 130 pedigrees, none showed an X-linked recessive inheritance pattern. In fact, many pedigrees showed transmission patterns which would clearly go against this. An example is shown in Figure 1 of a father–son transmission from I-1 to II-1 and then to III-5.

Y-linked Inheritance

The instance of father–son transmission just discussed seems to support the folk tradition that second sight follows this mode of inheritance. If this transmission pattern had a genetic basis, it would imply that some gene was necessary for mental processes conducive to having second sight and it would be transmitted on the Y chromosome. We would observe from the family histories that *only* males would have second sight. None of the 130 family histories showed a purely father-to-son transmission pattern in each generation. In fact, the majority of the pedigrees (113 out of 130) showed both women and men having second sight, and 11 additional pedigrees showed just women. Therefore Y-linked inheritance can be excluded.

Autosomal Recessive Inheritance

Traits which follow an autosomal recessive inheritance pattern tend rarely to be seen in the population. Such traits would usually show in one individual in generation III but none in generations I and II. Since autosomal recessive inheritance is not sex-linked, we should expect equal numbers of men and women with the trait. There were eight pedigrees which showed this inheritance pattern (three with a single affected male, three with a single affected female and two with identical female twins affected) from which three probands were interviewed. Figure 2 shows one of these pedigrees.

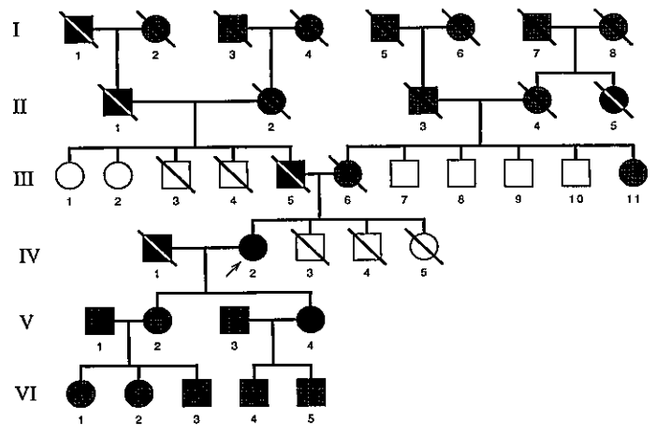

Fig. 1. The pedigree of a woman living in South Uist, Scotland (IV-2), who reports having second sight and can trace it in five generations of her family. This pedigree is consistent with autosomal dominant inheritance with full penetrance.

The possibility also arises that these cases are not autosomal recessive but sporadic, in that only one person in the family has the trait. After several generations, if another person had the trait, it would suggest that these were not sporadic occurrences. Three pedigrees could be considered of the sporadic type since the person who had second sight was either in the first generation (two of the pedigrees) or in the second generation (the third pedigree) and no one else in the family in the other generations had second sight.

Based upon the Mendelian expectation of 1 in 4, in an autosomal recessive inheritance pattern there may occasionally be more than one individual with the trait in generation III. This is illustrated in Figure 3. Despite these examples, the majority of the pedigrees showed individuals with second sight in more than one generation, therefore a purely autosomal recessive mode of inheritance can be excluded.

Autosomal Dominant Inheritance

The pedigrees were then examined for an autosomal dominant inheritance pattern. In such an inheritance pattern, a person with the trait would have both

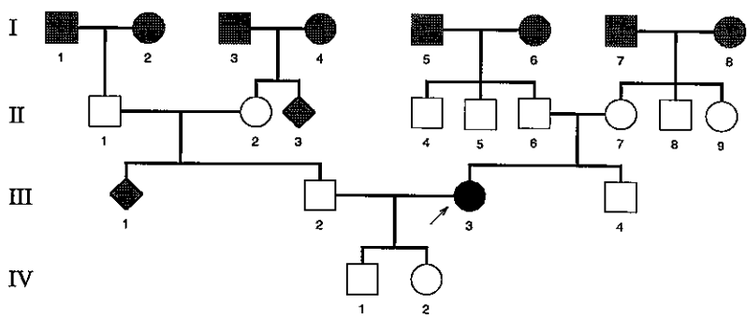

Fig. 2. The pedigree of a woman living in Durham, England (III-3), who is the only person so far in her family to report having second sight. This pedigree is consistent with autosomal recessive inheritance.

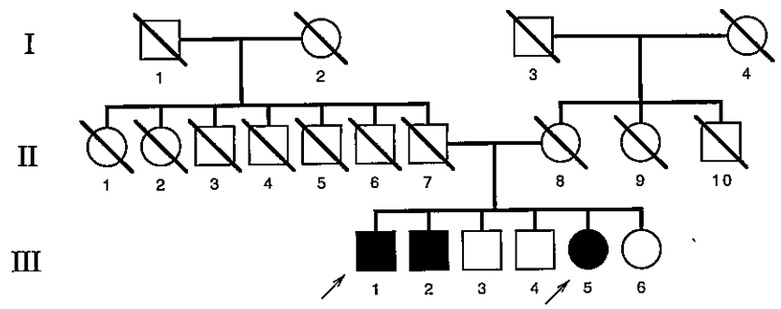

Fig. 3. The pedigree of a brother (III-1) and sister (III-5) who both live in South Uist, Scotland, and report having second sight. One of their brothers (III-2) also had second sight. This pedigree is consistent with autosomal recessive inheritance.

ancestors and descendants showing the trait in several generations. Every affected person will have at least one parent affected with the trait and their sons and daughters would be affected equally.

One hundred and ten pedigrees were judged to be consistent with an autosomal dominant mode of inheritance. Some of these pedigrees were consistent with full penetrance of the trait, for example, Figures 1 and 4. Others were consistent with reduced penetrance, illustrated by Figures 5 and 6.

Sometimes, a pedigree which is consistent with autosomal dominant inheritance can also be consistent with an X-dominant inheritance pattern, as shown by Figure 7. An X-dominant model would predict that when the mother has second sight and the father does not, as with II-2 and II-4, on average 50% of the daughters and sons would have second sight. In actuality, the percentages of children were less than those that would be expected. However, when both parents have second sight (III-8, III-9) we should expect to see all daughters with second sight (IV-2) and 50% of sons having second sight (IV-4). When the father has second sight (IV-4) and the mother does not (IV-5), all daughters will have second sight (V-3) and none of the sons (V-2).

In summary, of the 130 pedigrees, eight contained insufficient information to assess the mode of transmission. None indicated either Y-linked inheritance or X-linked recessive inheritance, nine pedigrees were consistent with an autosomal recessive inheritance pattern, and three were sporadic. One hundred and ten pedigrees were consistent with an autosomal dominant inheritance pattern, of which 23 provided insufficient information to distinguish between autoso-

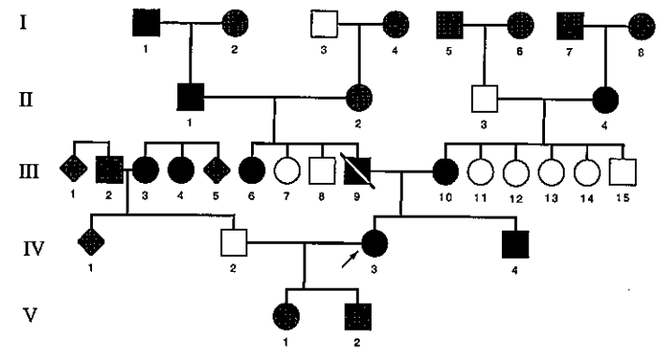

Fig. 4. The pedigree of a woman from Benbecula, Scotland, who reports having second sight (IV-3) and can trace it in three generations on her paternal side and two generations on her maternal side. Her children (V-1 and V-2) are very young and it cannot yet be determined whether they have second sight. This pedigree is consistent with autosomal dominant inheritance with full penetrance.

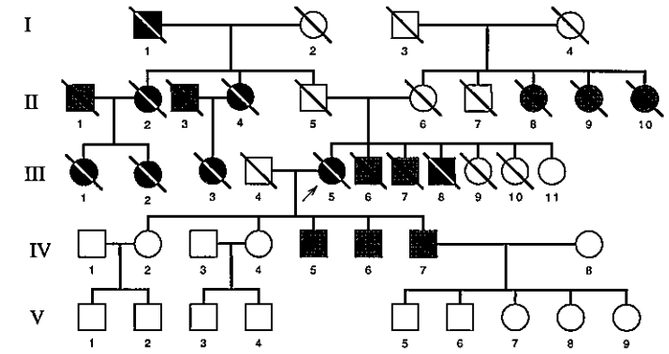

Fig. 5. The pedigree of a woman from South Uist, Scotland (III-5), who reports having second sight. One of her brothers (III-8), two of her paternal aunts (II-2 and II-4) and paternal grandfather (I-1) had second sight. She was very hesitant about discussing whether any of her children and grandchildren had second sight, as evident from generations IV and V. This pedigree is consistent with autosomal dominant inheritance with reduced penetrance.

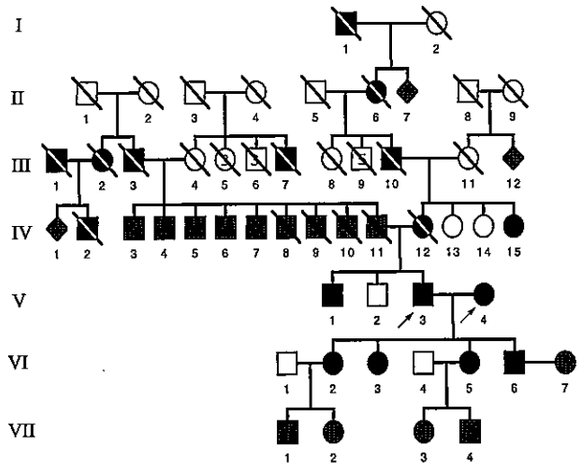

Fig. 6. The pedigree of a man from the Isle of Skye, Scotland, who reports having second sight (V-3) and can trace it in both sides of his family. On his maternal line, he knows of it in four generations and on his paternal line, in two generations. His wife has also had experiences (V-4) as have their three daughters (VI-2, VI-3, VI-5) and one son (VI-6). Their young grandchildren have not had any experiences so far. This pedigree is consistent with autosomal dominant inheritance with reduced penetrance.

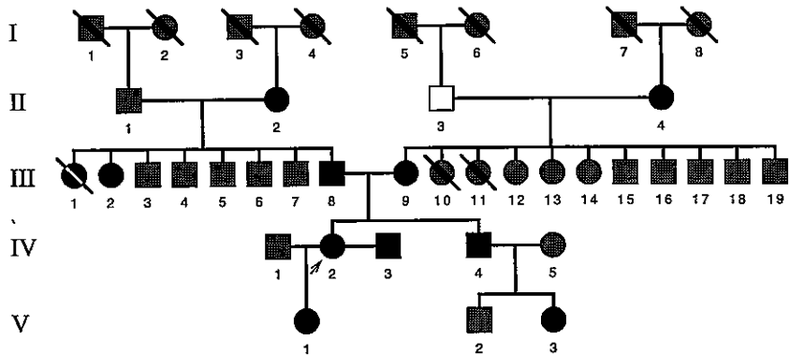

Fig. 7. The pedigree of a woman from Dundee, Scotland (IV-2), who reports having second sight. This pedigree is consistent with autosomal dominant inheritance or X-dominant inheritance.

of which 23 provided insufficient information to distinguish between autosomal dominant and X-dominant inheritance.

Segregation Analysis

To examine more closely whether second sight follows an autosomal dominant mode of inheritance, a quantitative method called segregation analysis was used (Sutton, 1980). Given the genotypes of the parents, the Mendelian laws of inheritance predict the probabilities of the offspring having certain genotypes and their associated phenotypes. Segregation analysis involves comparing these theoretical probabilities with the actual frequency of the offspring with and without the trait. The genotype for an autosomal dominant trait can either be (AA) or (Aa). In the absence of any genotypic information, as (AA) is rarer than (Aa), the latter genotype was chosen to represent a person having second sight and (aa) as a person without second sight. If second sight follows an autosomal dominant mode of inheritance, and if one parent has second sight and their partner does not, each child has a 50% chance of having second sight. If both parents have second sight, each child has a 75% chance of having second sight. A segregation analysis was done to see if the number of children having second sight, for different family sizes, is consistent with these expectations.

Ascertainment Bias

It is important to take into consideration how the pedigrees are sampled as this can lead to an ascertainment bias which favors the trait (McKusick, 1964). Since this study involved a pre-selected group in which the proband usually reported to have second sight, if the proband enters the analysis as a child of parents with second sight, then this biases the sample toward a higher proportion of children having second sight. One simple way to avoid such a bias is to remove any sibships *(i.e.* brothers and sisters) involving the proband from each pedigree (Sutton, 1980). Therefore sibships which included the proband were not counted in the segregation analysis.

Results of the Segregation Analysis

The following four tables contain data from the segregation analyses for all the pedigrees and for the Scottish Interview Group. The tables show, for each family size, the total number of children with second sight out of the total number of children, the resulting proportion, and a p value indicating how consistent this proportion is with the range of sample proportions one would expect, assuming an autosomal dominant inheritance model. Under this model, in the case in which one parent has second sight, the sample proportions should lie near 0.5 and in the case in which both parents have second sight, near .75. The observed proportion will generally deviate from the expected value: the p value is the probability that the model would generate a sample

proportion with the observed (or greater) deviation, computed using binomial statistics. Thus very small p values indicate inconsistency between the data and the model of autosomal dominance, whereas larger p values indicate consistency with the model. The convention used was: p values > .05 indicated that the proportions were consistent with the model and an asterisk was placed next to those values in all the tables.

The segregation analyses were done excluding those that were "unsure" about having second sight. Referring to Table 2, the segregation analysis for families in which one parent has second sight, aggregating over all the pedigrees, showed that the model is consistent for a wide range of family sizes, the observed proportions being .57, .39, .37 and .40, for families of one, three, four or five children respectively. This is also the case when restricting this analysis to only the Scottish Interview Group, see Table 3. The proportions of children with second sight for families of one child, three, four, five, or six, are consistent with the model, being .46, .33, .50, .40, and .16, respectively.

A similar trend is also observed for families in which both parents have second sight. Referring to Table 4, when aggregating over all the pedigrees, the proportions of children with second sight for families of one child, two, three or four, are consistent with the model expectation of 0.75, being .81, .50, .77, and .58, respectively. When restricting the analysis to the Scottish Interview Group, see Table 5, the proportions of children with second sight for families of one child, two, three or four, are consistent with the model, being .80, 1.0, .83, and 1.0, respectively.

In summary, for families in which one or both parents have second sight, the model of autosomal dominant inheritance seems to be in accord with the data especially for small family sizes, see Table 6. For the larger families, the proportions of children with second sight tended to decrease as the family size increased in each of the four tables. (Note that this trend is not due to an ascertainment bias, as sibships involving the propositus were excluded from the segregation analyses, as stated earlier). This may explain why the overall proportions of children with second sight (shown at the foot of the tables), for either one parent or both parents with second sight, are below those predicted by the model. The model for autosomal dominant inheritance predicts a similar proportion of children with second sight in both small and large families. Therefore the finding that the proportions decrease as family size increase clearly runs counter to the model. One social explanation, raised by discussions with the informants in extensive interviews (Cohn, 1996), is that second sight was generally a taboo subject and not openly discussed in the family, making it difficult to know about all relatives with second sight. This was especially relevant for the older generations since they tended to have larger

TABLE 2
Segregation Analysis for Families in Which One Parent Has Second Sight, Aggregating Over All the Pedigrees[1]

Family Size	Number with Trait	Proportion	p value
1	19 out of 33	0.576	0.4869*
2	21 out of 60	0.350	0.0273
3	14 out of 36	0.389	0.2430*
4	6 out of 16	0.375	0.4545*
5	6 out of 15	0.400	0.6072*
6	1 out of 12	0.083	0.0063
7	2 out of 14	0.143	0.0129
8–11	No data		
12	0 out of 12	0.000	0.0005
1 or more	69 out of 198	0.348	0.0000

[1]This includes only those with second sight and those without it.
*Indicates a p value > .05.

TABLE 3
Segregation Analysis for Families in Which One Parent Has Second Sight, Aggregating Only the Pedigrees in the Scottish Interview Group[1]

Family Size	Number with Trait	Proportion	p value
1	6 out of 13	0.461	1.0000*
2	6 out of 22	0.273	0.0525
3	7 out of 21	0.333	0.1892*
4	2 out of 4	0.500	1.0000*
5	4 out of 10	0.400	0.7539*
6	1 out of 6	0.167	0.2188*
7	2 out of 14	0.143	0.0129
8–11	No data		
12	0 out of 12	0.000	0.0005
1 or more	28 out of 102	0.274	0.0000

[1]This includes only those with second sight and those without it.
*Indicates a p value > .05.

TABLE 4
Segregation Analysis for Families in Which Both Parents Have Second Sight, Aggregating Over All the Pedigrees[1]

Family Size	Number with Trait	Proportion	p value
1	9 out of 11	0.818	0.7419*
2	4 out of 6	0.667	1.0000*
3	14 out of 18	0.778	1.0000*
4	7 out of 8	0.875	0.6885*
5	No data		
6	1 out of 6	0.167	0.0046
7–11	No data		
12	1 out of 12	0.083	0.0000
13	No data		
14	4 out of 14	0.286	0.0003
1 or more	40 out of 75	0.533	0.0000

[1]This includes only those with second sight and those without it.
*Indicates a p value > .05.

TABLE 5
Segregation Analysis for Families in Which Both Parents Have Second Sight, Aggregating Only the Pedigrees in the Interview Group[1]

Family Size	Number with Trait	Proportion	*p* value
1	4 out of 5	0.800	1.0000*
2	4 out of 4	1.000	0.5781*
3	5 out of 6	0.833	1.0000*
4	4 out of 4	1.000	0.5781*
5	No data		
6	1 out of 6	0.167	0.0046
7–11	No data		
12	1 out of 12	0.083	0.0000
13	No data		
14	4 out of 14	0.286	0.0003
1 or more	23 out of 51	0.451	0.0000

[1]This includes only those with second sight and those without it.
*Indicates a p value > .05.

TABLE 6
Segregation Analyses for Families in Which One Parent or Both Parents Have Second Sight, Aggregating Over All the Pedigrees or JustThose in the Scottish Interview Group for Family Sizes 1–4[1]

Condition	Number with Trait	Proportion	*p* value
One Parent			
All	60 out of 145	0.414	0.046
Interview	21 out of 60	0.350	0.027
Both Parents			
All	34 out of 43	0.791	0.602*
Interview	17 out of 19	0.895	0.189*

[1]This includes only those with second sight and those without it.
*Indicates a p value > .05.

families. Thus this would lead to an under-reporting of relatives with second sight, especially for the larger families.

If this explanation is true, then it leaves open at least two possibilities. Firstly that second sight could be hereditary, following an autosomal dominant inheritance pattern, with the deviation from classical expectations for larger family sizes being essentially due to social and cultural factors influencing the reporting of second sight as discussed above. Alternatively, it could be argued that second sight is not hereditary, but is purely a social and cultural phenomenon that is orally transmitted from one generation to another in families, with the fact that for small families the inheritance was consistent with autosomal dominant inheritance pattern being put down to coincidence.

Utilizing Birth-Order Data of Siblings

Before attempting to discriminate between these two models we shall first present some quantitative evidence supporting the above explanation for the decrease in the proportions of children with second sight in larger families. Consider a family in which the propositus reports that he and some of his siblings have second sight. If the propositus has only limited knowledge of who has second sight in his family, then one might expect that the siblings reported to have second sight would show a tendency to be nearer the propositus in the family birth order. This can be quantified by comparing the size of the difference between the birth positions of the propositus and the sibling with second sight with the expected average size of this difference if the sibling had no tendency to be near the propositus. In other words, if the ratio of these sizes is less than unity then this indicates that there is a clustering effect, consistent with the idea that the propositus tends to know more about those siblings closer in birth position. Aggregating over those 22 families for which birth-order data was available and in which a clustering effect might be seen (*i.e.* those in which the propositus has two or more siblings), we find the average ratio value to be 0.91. More strikingly, if we consider only the larger families then the average ratio value drops dramatically, indicating a strong clustering effect, as shown pictorially in Figure 8.

Birth-Position and Family Size

If second sight is hereditary and follows an autosomal dominant mode of

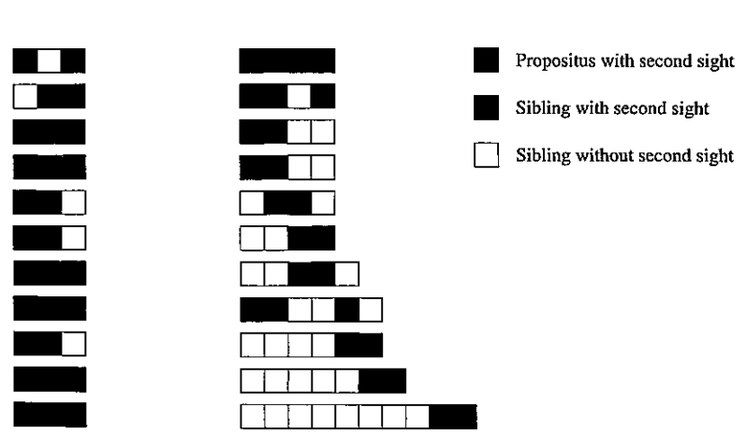

Fig. 8. Schematic diagrams of the birth positions of the propositus and siblings with second sight in 22 families ranging in size from 3 to 10. For example, the top left diagram represents a family of three. The propositus is the third born and the sibling with second sight is the first born.

inheritance, a person's position in the birth order should have no bearing on whether he or she has second sight or not. To assess whether this was so, the available information about the birth position of those relatives with second sight was analyzed for all the pedigrees. Of the 667 people with second sight (see Table 1) there was information of the birth position of 249 of them.

Table 7 shows that the birth positions are generally uniform, especially for family sizes up to five. For example, the 73 people with second sight in families of size three are evenly spread across the three birth positions (24 being the first born, 26 being the second born, and 23 being the third born). There is very little information for larger families but examining the data available, there is no discernible trend.

Discussion

Is second sight a social and cultural phenomenon orally passed down in families from one generation to another, or a mental talent that is inborn and expressed within different cultural traditions? Extensive recent interviews with informants living in the Highlands and Western Isles of Scotland (Cohn, 1996) showed that there is an acceptance of the existence of second sight within the community at large. In some families, though, it was taboo to discuss it. Even so, it still ran in these families. This runs counter to the view that second sight runs in families as purely a sociological belief. Is it hereditary?

The results of both the pedigree and segregation analyses demonstrate that second sight seems to be consistent with an autosomal dominant inheritance pattern, especially for small family sizes. This finding, obtained from pedigrees of people from different cultural traditions, also holds when the analysis is restricted to people of a Scottish background. Further evidence comes from

TABLE 7
Frequencies of Birth Positions of People with Second Sight in Family Sizes 1 to 15

Family Size	Birth Position														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	26														
2	35	40													
3	24	26	23												
4	8	10	8	11											
5	3	4	3	2	0										
6	1	1	1	0	3	2									
7	0	0	1	0	0	1	4								
8	0	1	0	1	0	0	2	1							
9	0	0	0	0	0	0	1	0	0						
10	0	1	0	0	0	0	0	0	1	1					
11	0	0	0	0	0	0	0	0	0	0	0				
12	0	0	0	0	0	0	1	0	0	0	0	0			
13	0	0	0	0	0	1	0	0	0	0	0	0	0		
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
15	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

data on birth positions. If second sight followed this mode of inheritance, then people with second sight would be equally distributed across the birth positions of the family, regardless of family size. The data were consistent with such a view. In support of this finding, Palmer (1979) found no clear relationship between birth order and having psychic experiences.

Nevertheless, there are aspects of the data which *prima facie* go against a genetic model of autosomal dominant inheritance. Clearly, these might be taken to be an indication that second sight is a social and cultural phenomenon. However, it was argued that this data could also reflect the combination of an underlying genetic component with a reporting bias due to social factors. One finding is the decrease in the proportion of children with second sight in larger family groups. Data were presented which showed that siblings with second sight tended to be closer to the propositus in their birth position. It was argued that these data reflect a tendency for the propositus to know more about those siblings closest to him or her in age. A similar tendency at an inter-generational level might lead to an under-reporting of relatives with second sight in other generations, especially those in larger families.

Traits following this mode of inheritance ought to be expressed with equal frequency in males and females, as the transmission is not sex-linked. However, in the current study, significantly more women reported second sight than men. A plausible social and cultural interpretation is that men and women may have second sight equally but women tend to be more open to discussing it.

Usually an autosomal dominant inheritance pattern shows only one side of the family affected. However, in the current study, of the 110 pedigrees compatible with autosomal dominant inheritance, 50 showed relatives from both sides of the family who had second sight. What can account for this? The incidence of second sight suggests that it is not a rare phenomenon, as one might have expected, but is experienced by a sizable number of people in Scotland. In a survey using random sampling, the incidence ranged from 10% to 33% over the regions sampled (Cohn, 1994) and in the current study it is 23% for the interview group and 32% for all the pedigrees. Therefore on statistical grounds, it would not be uncommon to see both sides of the family having second sight and one also would expect to see marriages in which both partners have second sight. In fact, an assortative mating preference was found. This raises the question whether people are attracted to a partner — either consciously or unconsciously — with shared values or experiences.

Previous studies have shown the importance of examining the interaction of genetic and environmental factors of mental abilities and the difficulty of getting a consensus about their mode of inheritance (*e.g.* Muller, 1925; Lander & Schork, 1994; Rose, 1995). With that cautionary note in mind, other studies need to be done to confirm whether second sight and possibly other types of psychic ability follow an autosomal dominant inheritance. One way to test this would be to compare the results from this study on Scottish Second Sight with studies examining pedigrees of second sight from other cultural traditions

across different belief systems. If we observed dissimilar inheritance patterns in the pedigrees in different cultural traditions, then this would strengthen the claim that second sight is not hereditary but a social and cultural phenomenon. Alternatively, if an autosomal dominant inheritance pattern was consistently observed in pedigrees from different cultural traditions, then this would build a stronger case for second sight being partly due to hereditary factors. To decisively demonstrate that having the sensitivity for second sight is due to a single genetic locus would require the identification of the particular chromosomal region through linkage analysis. If this was found to be the case, it would raise the question whether the hereditary aspect of the ability lies in the sensitivity of the normal sensory systems which convey the experiences. There are, however, potential objections to a single gene model. If, as is widely supposed, cognitive ability is determined by an interaction of polygenic and environmental factors, would the same be true for specific mental and artistic abilities? There may be genes for the susceptibility to have specific mental and artistic abilities, including second sight. Research is currently being conducted to examine the inheritance of musical, artistic and other exceptional abilities in themselves and to see whether there is a relationship between second sight and these abilities. If such a relationship were to be found then this would suggest that second sight is a creative inborn talent of the mind expressed by people of different cultural traditions.

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