

Is it all written in the stars? A methodological commentary on Sachs' astrology monograph and re-analyses of his data on crime statistics

ALEXANDER VON EYE¹ (VIRGO), FRIEDRICH LÖSEL² (LEO), RONI MAYZER³ (CAPRICORN)

Summary

In his monograph “Die Akte Astrologie” [“The Astrology Dossier”], Sachs (1999) claims that statistically significant relationships exist between signs of the Zodiac and behavior. The author presents these relationships in the form of local associations in contingency tables that cross the signs of the Zodiac and numerous behavior categories from statistical registers of Switzerland. As one example, we discuss and re-analyze his data on astrology and crime that, according to Sachs, demonstrate a clear relationship. Although Sachs' methods are largely transparent, his conclusions are not valid. The main reasons for this lack of validity are that the analyses capitalize on chance and fail to take into account the mutual dependency of statistical tests performed on the same data. Our re-analyses of Sachs' data on criminal convictions and the signs of the Zodiac using (1) Configural Frequency Analysis and (2) two-way cluster analysis suggest that the conclusions drawn in the monograph are untenable. Statistical and substantive aspects of our results are discussed.

Key words: Zodiac, astrology, crime, human behavior, Configural Frequency Analysis

¹ Prof. Dr. Alexander von Eye, Michigan State University, Department of Psychology, 119 Snyder Hall, East Lansing, MI 48824-1117; E-mail: voneye@msu.edu

² University of Erlangen-Nürnberg

³ Michigan State University

Is it all written in the stars? A methodological commentary on Sachs' astrology monograph and re-analyses of his data on crime statistics

Astrology not only fascinates large parts of the general population, but has also been of interest to scientists. For example, Johannes Kepler, one of the founders of modern astronomy, created a surprisingly valid horoscope for Albrecht Wallenstein, the Habsburg Monarchy's general in charge during the Thirty-Year-War (Mann, 1979). Some centuries later, Hans Eysenck and colleagues examined relationships between astrological and personality factors (e.g., Gauquelin, Gauquelin, & Eysenck, 1979; Mayo, White, & Eysenck, 1978). Although these and various other studies found significant correlations, many results failed to support the role of astrology in personality (e.g., Carlson, 1985; Hume & Goldstein, 1977; Russell & Wagstaff, 1983; van Rooij, 1994). Kelly (1979) notes that (1) the majority of empirical studies undertaken to test astrological tenets did not confirm astrological claims and (2) "the few studies that are positive need additional clarification" (p. 1231; cf. Kelly, 1998). In addition, authors emphasized methodological weaknesses (e.g., selective samples) and investigated alternative explanations, for instance that individuals who possess astrology knowledge tend to behave according to their respective sign of the Zodiac (e.g., Pawlik & Buse, 1979; van Rooij, 1994, 1999). Such problems are less prevalent in some of the astrological analyses that Gunter Sachs presented in a recent monograph (1999).

With his monograph, Sachs intended to put astrology on scientific footing. He used statistical methods to explore possible associations between the Zodiac and human behavior. Although to many, the author is better known as an object of the rainbow press and as a professional photographer, his effort deserves our interest, for a number of reasons. First, although astrology is widely rejected as unscientific, its use of latent variables and association hypotheses in the effort of explaining behavior is similar in principle to procedures in psychology and other scientific disciplines. Second, science is not a "closed shop" of mainstream research. Rather, it must be open to everybody and unconventional ideas as long as they meet basic methodological criteria such as objectivity, replicability, and accuracy. Third, Sachs' view of astrology is rather neutral. He is neither a protagonist nor involved in the business aspects of astrology. Fourth, Sachs is trained as a mathematician, and he collaborated with statisticians from academic and demographic institutes when performing his analyses and when writing the book manuscript. Fifth, the analyses contain a very large set of unobtrusive data from the Swiss census bureau, from the Swiss criminal justice records, and from the Swiss marriage records. Sixth, the analyses performed by Sachs and his results are presented in a sufficiently clear and detailed manner that leaves the door open for re-analyses.

Considering this background, it is justified to discuss Sachs' monograph in a scientific journal. In the following sections, we first briefly describe the contents of Sachs' book and present, as one example, his results on crime statistics in more detail. Second, we put Sachs' results on astrology and criminal convictions in the scientific framework of personality research. Third, we discuss the statistical methods that Sachs used for analysis. Fourth, we present a re-analysis of the data on criminal convictions in which we employ Configural Frequency Analysis, a method of analysis closely related to the χ^2 -methods used by Sachs. Fifth, we validate our results using a different method of data analysis, two-way cluster analysis. Finally, we discuss our findings and draw conclusions with respect to the validity of Sachs' results.

Contents of Sachs' Book and Results on Criminal Convictions

Sachs used rather complete data records from Switzerland to analyze the relationships between the signs of the Zodiac and (1) who purchases literature on astrology, (2) marriages, (3) divorces, (4) who lives single, (5) choice of university major, (6) profession, (7) cause of death, (8) suicide, (9) criminal convictions, (10) driving record, and (11) who plays soccer (European football). For example, for his analyses of who marries whom, Sachs used the records of weddings in Switzerland from 1987 through 1994. In all 11 behavior domains, Sachs found numerous significant associations between the signs of the Zodiac and behavior.

Results of statistical analyses of the 11 behavior domains are presented in the core chapters of the book. As introductory chapters, the monograph presents a historical chapter on astrology, contributed by Claus Jacobi, and an introduction into the concept of χ^2 -analysis. After the statistical analyses of the 11 behavior domains listed above and a summary of results, the reader finds a chapter on astrology and statistics written by Rita Künstler. A chapter follows that evaluates the scientific expertise in the analyses from a methodological perspective, co-authored by Jürgen Chlumsky and Manfred Ehling. An appendix contains a rich collection of tables in which the signs of the Zodiac are cross-classified with a large number of everyday behaviors and attitudes. This part of the book was prepared by one of the best-known German survey companies (Institut für Demoskopie Allensbach). It includes items on astrology presented in regular consumer interviews of more than 13,000 individuals.

In Chapter 9 of his book Sachs presents his data on the relation between astrological factors and crime. This area of behavior is insofar of particular interest as attitudes to astrology may, in contrast to selections for marriage or other behaviors, have no influence. Sachs analyzed all cases from the Swiss criminal justice statistics that have been sentenced in the years 1986 through 1994 for 25 different crimes (325,866 cases). The 25 crimes were crossed with the 12 signs of Zodiac to form a contingency table with 300 cells. This table is not presented in the book, but analyzed by using χ^2 methods (see below). The overall test showed that independence between the signs of the Zodiac and kinds of crime "could be ruled out with very high probability" (p. 168). Eighteen percent of the 300 cell frequencies could not be explained by chance. Six tests were "highly significant" ($p < .001$), 12 were "significant" ($p < .01$), and 37 were "slightly significant" ($p < .05$).

Because various crimes had relatively low base rates, Sachs selected those 10 offenses that contained more than 12,000 cases during the 9 years. The respective cross-tabulation with the 12 signs of Zodiac is presented on pp. 170/1 of the book. The 10 crimes were: theft, embezzlement, concealment, fraud, forgery, hit-and-run, illegal use of a motor vehicle, driving car without licence, drug dealing, and drug use. When Sachs analyzed this table by using χ^2 , he found an overall probability of $p = .00016$. Of the χ^2 tests for single cells, 1 was "highly significant" ($p < .001$), 4 were "significant" ($p < .01$), and 17 were "slightly significant" ($p < .05$).⁴ Nine observed frequencies were higher than expected ($o_i > e_i$) and 13 lower ($o_i < e_i$). More frequent were, for example, the patterns drug dealing x Capricorn, illegal use of a motor vehicle x Sagittarius, drug dealing x Pisces, driving without licence x Libra, and forgery x Gemini. Less frequent were, for example, drug use x Aries, drug use x Pisces, theft x Taurus, driving without licence x Libra, and drug dealing x Cancer.

⁴ In contrast to the 22 "significant" results reported in the Table, Sachs mentioned 23 (1/6/16) in the text (p. 172). In addition, the overall number of convictions included in the Table on pp. 170/171 is 285,929 instead of 285,947, as one may conclude from adding the relevant crime categories in the table on p. 168. Accordingly, our re-analyses yielded an overall $p = 0.00022$ instead of the reported $p = 0.00016$. For the purposes of our paper, we ignore these differences, because they affect neither our arguments nor our results.

Sachs did not formulate any scientific hypotheses about the relation between astrology and crime. Accordingly, he hesitates to interpret his results on the various offenses. As an example, he only mentions that at least three possibilities may explain the under-representation of "Gemini" (according to the Table, "Taurus" would be correct) among the convictions for theft: The respective group of persons may (a) have a true lower rate of thefts, (b) be more cautious and thus less frequently detected when stealing, (c) be more clever in the criminal trial and therefore less often be sentenced. Probably, he concluded, such different factors work together in explaining the statistical differences.

Personality, Crime and Astrology

Sachs' explanations reflect the issues that arise when interpreting cross-sectional relations between court-known criminality and characteristics of the offender (e.g., Lösel & Schmucker, 2002). However, they do not contain any hypotheses explaining *why* the signs of the Zodiac should be associated with criminal behavior. From a scientific perspective, such a relationship - if it exists - is intriguing. Only a few authors have suggested a direct association, relating the astrological charts of serial killers to life circumstances and the potential for murder (Ball, 1998; Young & Rowland, 1995). These approaches are case-oriented and rather speculative. However, a more indirect relationship can be found in the link between the research on crime and personality on the one hand and astrology and personality on the other hand:

One of the most explicated and best-known psychological theories of crime was formulated by Hans Eysenck (Eysenck, 1977, 1997; Eysenck & Gudjonsson, 1989). Eysenck postulates a multi-level explanation of criminal behavior that is based on his general theory of personality. According to this, criminality results primarily from learning deficits that are due to biological dispositions of cortical underarousal and difficulties in forming conditional reactions. In a multilevel approach he links (1) distal causes (e.g., genetic factors), (2) proximal causes (e.g., low arousal), (3) psychometric traits, (4) proximal consequences (e.g., conditioning) with (5) distal consequences such as criminal behavior. On the trait level, his three basic dimensions of extraversion (E), neuroticism (N), and psychoticism (P) play a central role. Individuals with high E are sociable, lively, venturesome, and assertive; high N are tense, high-strung, anxious, depressed, irrational, and emotionally labile; and high P are solitary, troublesome, cruel, insensitive, aggressive, and egocentric in interpersonal relations. Offenders are expected to have high scores on all three factors, E, N, and P.

Studies that have examined the relationship between Eysenck's personality dimensions and criminal behavior have yielded relatively weak or equivocal findings with regard to extraversion (e.g., Eysenck & Eysenck, 1970, 1977; Lösel & Wüstendörfer, 1976). A meta-analysis of 92 studies revealed a mean effect size of $r = .04$ for E (Fischer & Kretschmer, 1996). The scales for N typically fared better (e.g., Eysenck & Eysenck, 1970, 1977; Saklofske & Eysenck, 1980) as can be seen in a mean effect size of $r = .28$ (Fischer & Kretschmer, 1996). Correlations between P and delinquency are even stronger (Eysenck & Gudjonsson, 1989; Saklofske & Eysenck, 1980). However, the contents of this dimension are largely confounded with the explanandum (e.g., aggressive, egocentric, impulsive, and antisocial behavior).

The relations between Eysenck's personality dimensions and criminal behavior must be differentiated in various aspects. For example, the answers to questionnaires by prisoners may be affected by circumstances of incarceration (Eysenck & Gudjonsson, 1989). With respect to extraversion, the sociability component is less relevant for delinquency than the subfactor of impulsivity (Eysenck, 1997; Lösel & Schmucker, 2002). The N dimension seems to be more

relevant for serious adult and incarcerated offenders than for juvenile delinquency (Eysenck & Gudjonsson, 1989; Fischer & Kretschmer, 1996). For the latter, nervousness and anxiety may even have a protective effect (Lösel & Bender, 2003). In general, personality factors are much more important for the persistent form of antisocial behavior and less for the adolescence-limited pathway (Moffitt, 1993). Eysenck (1997) also suggests specific relationships between high P and violent crime and high N and so-called victimless offenses.

Eysenck's personality theory and related explanations (see Lösel & Schmucker, 2002) are not addressed by Sachs. His astrological analyses also do not refer to crime versus non-crime or theoretically meaningful differentiations of offenses. Violent crimes are even excluded for reasons of sample size. However, Eysenck's personality factors may insofar build a tentative link to Sachs' astrological data as there is some research on their relation to the signs of the Zodiac. For example, Mayo et al. (1978) found higher levels of extraversion for so-called even Zodiac affiliations (Aries, Gemini, Leo, Libra, Sagittarius, Aquarius) as well as elevated neuroticism for the 'water' signs (Cancer, Scorpio, Pisces) and a high E-high N combination for Aries (i.e., a hybrid common among antisocial and histrionic personality disorder). Other results also suggest a relationship between astrology and personality (e.g., Gauquelin et al., 1979; van Rooij, Brak, & Commandeur, 1988). However, most studies fail to support the sun-sign hypothesis (e.g., Jackson & Fiebert, 1980; Russell & Wagstaff, 1983; Saklofske, Kelly, & McKerracher, 1982; van Rooij, 1994; Veno & Pamment, 1979). In addition, studies that have employed more complete astrological charts (Carlson, 1985; Hume & Goldstein, 1977), the influence of other planets (Russell & Wagstaff, 1983), the angular relationship between planets (their 'aspects'; Startup, 1985), and other personality measures (Carlson, 1985; Silverman & Whitmer, 1974; van Rooij, 1999) provided no support for the role of astrology in personality. When small correlations have been found in the literature, these could be explained by knowledge about astrology and self-attribution in questionnaires as a moderator variable (e.g., Pawlik & Buse, 1979; van Rooij, 1994, 1999). Climate and/or biological rhythms may be an alternate explanation (e.g., Smithers & Cooper, 1978).

Perhaps, the relatively high number of 9 out of 22 "significances" that Sachs reports for the area of drug-related offenses may be due to more neurotic, esoteric and self-attributional tendencies in this offender group. However, before embarking on interpretations, one must ask whether Sachs' results are valid. Therefore, we discuss his methods of analysis in the following section, and re-analyze his data using different methods of statistics.

Sachs' Methods of Analysis

The methods employed in Sachs' book to explore the relationships between behavior categories and the signs of the Zodiac are well known from χ^2 -analysis. All analyzed tables in this book present two-way cross-classifications. Pearson's X^2 for two-way tables is known to be

$$X^2 = \sum_i \frac{(o_i - e_i)^2}{e_i}$$

where o_i is the i th observed cell frequency, e_i is the i th expected cell frequency, and i goes over all cells in the table. When the sample, that is, $\sum_i o_i$, is large enough, the statistic X^2 is approximately distributed as χ^2 with $(r-1)(c-1)$ degrees of freedom, where r indexes the number of rows and c indexes the number of columns. If $X^2 > \chi^2_{\alpha, df}$, an association between the variable that constitutes the rows and the variable that constitutes the columns of the cross-classification is said to exist. The expected cell frequencies are estimated under the assumption of row and column independence, that is, under the log-linear main effect model

$\log m = \lambda_0 + \lambda_j + \lambda_k$, where j indicates the parameters for the rows, k indicates the parameters for the columns, and λ_0 is the intercept parameter.

In his analyses, Sachs does not use the overall X^2 in detail. Instead, he uses X^2 -components, specifically, the summands in Equation 1. If the estimated expected cell frequencies are large enough, these components are distributed as χ^2 with $df = 1$. For each cell of the cross-classifications, the question is asked whether the observed frequency deviates significantly from the expected frequency (cf. DuMouchel, 1999).

Sachs uses the X^2 -components, $\frac{(o_i - e_i)^2}{e_i}$, to identify possible relationships between signs of the Zodiac and behavior categories. This idea is very similar to the concepts pursued in Configural Frequency Analysis (CFA; Lienert, 1969; von Eye, 2002). In a first step, classical CFA (Lienert, 1969) specifies a base model for the estimation of expected cell frequencies. This model typically is the main effect model of row and column independence. In a second step, CFA asks for each cell i whether $o_i > e_i$, $o_i = e_i$, or $o_i < e_i$. If $o_i > e_i$, cell i is said to constitute a CFA type. If $o_i < e_i$, cell i is said to constitute a CFA antitype, and if $o_i = e_i$, cell i is said to constitute neither a type nor an antitype.

For the statistical decision as to whether a cell constitutes a type, an antitype, or neither, researchers make two decisions. First, they select a statistical test. The X^2 -component test employed by Sachs is one viable option. Second, researchers select a procedure for the protection of the significance level α . This level needs to be protected against inflation, for two reasons. First, when many tests are performed on one sample, they may no longer be independent. Second, when many tests are performed, a portion of α of the corresponding statistical decisions can be expected to come with Error Type I. This number can be considerable if the number of tests is large.

The most popular, yet conservative Bonferroni procedure of α protection posits that a significance threshold that is protected against both threats possess two characteristics. First the threshold must be the same for each test, and second, the sum of all errors must not be greater than α . The adjusted significance level that possesses both of these characteristics is $\alpha^* = \frac{\alpha}{t}$, where t is the number of tests performed.

Obviously, Sachs' approach and CFA share the selection of the independence model and the selection of the Pearson X^2 -component test in common. However, Sachs does not protect his α . Thus, one can anticipate that a large number of the cell-wise deviations from independence identified in Sachs' analyses may not be labeled as types or antitypes if the significance level is protected.

Configural Frequency Analysis of Sachs' Crime Data

Based on the methodological arguments raised in the last section, we re-analyzed Sachs' Table on crime statistics. This section presents the results of a classical CFA. To make the CFA as parallel as possible to Sachs' analyses, it was performed using Pearson's X^2 -component test which involves exactly the same calculations as performed by Sachs. The significance threshold was adjusted using Bonferroni's procedure as outlined above. The adjusted α was $\alpha^* = 0.0004167$. A summary of the CFA results appears in Table 1.

Table 1:
Configural Frequency Analysis of Sachs' Zodiac and Crime Data

Configuration		o	e	χ^2	p	Type/Antitype?
Aries	x Theft	8761	8724.15	.16	.6932	
Taurus	x Theft	8276	8419.36	2.44	.1182	
Gemini	x Theft	8555	8569.36	.02	.8768	
Cancer	x Theft	8124	8181.69	.41	.5236	
Leo	x Theft	8123	8213.20	.99	.3196	
Virgo	x Theft	8164	8123.82	.20	.6557	
Libra	x Theft	8035	7895.05	2.48	.1153	
Scorpio	x Theft	7626	7499.51	2.13	.1441	
Sagittarius	x Theft	7332	7323.49	.01	.9208	
Capricorn	x Theft	8207	8249.84	.22	.6372	
Aquarius	x Theft	8567	8542.64	.07	.7921	
Pisces	x Theft	8149	8176.90	.10	.7577	
Aries	x Embezzlement	1079	1073.42	.03	.8648	
Taurus	x Embezzlement	1093	1035.92	3.15	.0762	
Gemini	x Embezzlement	1090	1054.38	1.20	.2726	
Cancer	x Embezzlement	1037	1006.68	.91	.3393	
Leo	x Embezzlement	1012	1010.56	.00	.9638	
Virgo	x Embezzlement	968	999.56	1.00	.3182	
Libra	x Embezzlement	994	971.41	.53	.4686	
Scorpio	x Embezzlement	902	922.74	.47	.4947	
Sagittarius	x Embezzlement	885	901.09	.29	.5921	
Capricorn	x Embezzlement	965	1015.06	2.47	.1161	
Aquarius	x Embezzlement	1058	1051.09	.04	.8312	
Pisces	x Embezzlement	965	1006.09	1.68	.1952	
Aries	x Concealment	1126	1132.05	.03	.8573	
Taurus	x Concealment	1091	1092.50	.00	.9638	
Gemini	x Concealment	1119	1111.96	.05	.8328	
Cancer	x Concealment	1103	1061.66	1.61	.2045	
Leo	x Concealment	1112	1065.75	2.01	.1565	
Virgo	x Concealment	1060	1054.15	.03	.8570	
Libra	x Concealment	986	1024.47	1.44	.2295	
Scorpio	x Concealment	965	973.14	.07	.7942	
Sagittarius	x Concealment	931	950.30	.39	.5313	
Capricorn	x Concealment	1089	1070.50	.32	.5718	
Aquarius	x Concealment	1088	1108.50	.38	.5382	
Pisces	x Concealment	1036	1061.04	.59	.4421	
Aries	x Fraud	2054	2010.44	.94	.3313	
Taurus	x Fraud	1922	1940.20	.17	.6794	
Gemini	x Fraud	2051	1974.77	2.94	.0863	
Cancer	x Fraud	1843	1885.44	.96	.3284	
Leo	x Fraud	1855	1892.70	.75	.3862	
Virgo	x Fraud	1863	1872.10	.04	.8335	
Libra	x Fraud	1828	1819.38	.04	.8398	
Scorpio	x Fraud	1720	1728.23	.04	.8431	
Sagittarius	x Fraud	1671	1687.67	.17	.6850	
Capricorn	x Fraud	1896	1901.14	.01	.9062	
Aquarius	x Fraud	2005	1968.61	.67	.4122	
Pisces	x Fraud	1857	1884.33	.40	.5290	
Aries	x Forgery	1201	1155.66	1.78	.1823	
Taurus	x Forgery	1159	1115.28	1.71	.1905	
Gemini	x Forgery	1190	1135.15	2.65	.1036	
Cancer	x Forgery	1031	1083.80	2.57	.1087	
Leo	x Forgery	1082	1087.98	.03	.8563	
Virgo	x Forgery	1109	1076.14	1.00	.3164	
Libra	x Forgery	1016	1045.83	.85	.3563	
Scorpio	x Forgery	917	993.44	5.88	.0153	
Sagittarius	x Forgery	937	970.12	1.13	.2877	
Capricorn	x Forgery	1090	1092.83	.01	.9318	
Aquarius	x Forgery	1164	1131.62	.93	.3357	
Pisces	x Forgery	1075	1083.17	.06	.8040	

Configuration		o	e	χ^2	p	Type/Antitype?
Aries	x Hit and run	2503	2437.21	1.78	.1826	
Taurus	x Hit and run	2417	2352.06	1.79	.1806	
Gemini	x Hit and run	2431	2393.97	.57	.4491	
Cancer	x Hit and run	2313	2285.67	.33	.5675	
Leo	x Hit and run	2312	2294.47	.13	.7144	
Virgo	x Hit and run	2213	2269.50	1.41	.2356	
Libra	x Hit and run	2179	2205.59	.32	.5713	
Scorpio	x Hit and run	2076	2095.09	.17	.6766	
Sagittarius	x Hit and run	1981	2045.92	2.06	.1512	
Capricorn	x Hit and run	2250	2304.71	1.30	.2545	
Aquarius	x Hit and run	2330	2386.50	1.34	.2474	
Pisces	x Hit and run	2350	2284.33	1.89	.1694	
Aries	x Illegal use of vehicle	1743	1789.93	1.23	.2673	
Taurus	x Illegal use of vehicle	1743	1727.40	.14	.7073	
Gemini	x Illegal use of vehicle	1702	1758.17	1.80	.1804	
Cancer	x Illegal use of vehicle	1728	1678.63	1.45	.2282	
Leo	x Illegal use of vehicle	1716	1685.10	.57	.4516	
Virgo	x Illegal use of vehicle	1658	1666.76	.05	.8301	
Libra	x Illegal use of vehicle	1605	1619.83	.14	.7126	
Scorpio	x Illegal use of vehicle	1557	1538.67	.22	.6403	
Sagittarius	x Illegal use of vehicle	1587	1502.56	4.75	.0294	
Capricorn	x Illegal use of vehicle	1681	1692.62	.08	.7777	
Aquarius	x Illegal use of vehicle	1737	1752.69	.14	.7078	
Pisces	x Illegal use of vehicle	1633	1677.65	1.19	.2757	
Aries	x Driving w/o licence	3582	3620.58	.41	.5215	
Taurus	x Driving w/o licence	3520	3494.09	.19	.6611	
Gemini	x Driving w/o licence	3510	3556.34	.60	.4372	
Cancer	x Driving w/o licence	3397	3395.45	.00	.9788	
Leo	x Driving w/o licence	3432	3408.53	.16	.6877	
Virgo	x Driving w/o licence	3388	3371.44	.08	.7754	
Libra	x Driving w/o licence	3165	3276.50	3.79	.0514	
Scorpio	x Driving w/o licence	3081	3112.35	.32	.5742	
Sagittarius	x Driving w/o licence	3041	3039.29	.00	.9753	
Capricorn	x Driving w/o licence	3382	3423.74	.51	.4757	
Aquarius	x Driving w/o licence	3590	3545.25	.57	.4523	
Pisces	x Driving w/o licence	3549	3393.46	7.13	.0076	
Aries	x Drug dealing	1136	1109.95	.61	.4343	
Taurus	x Drug dealing	1072	1071.18	.00	.9799	
Gemini	x Drug dealing	1023	1090.26	4.15	.0417	
Cancer	x Drug dealing	958	1040.94	6.61	.0102	
Leo	x Drug dealing	1060	1044.95	.22	.6414	
Virgo	x Drug dealing	1034	1033.57	.00	.9894	
Libra	x Drug dealing	991	1004.47	.18	.6709	
Scorpio	x Drug dealing	916	954.15	1.53	.2169	
Sagittarius	x Drug dealing	912	931.75	.42	.5176	
Capricorn	x Drug dealing	1193	1049.61	19.59	<.0004	Type
Aquarius	x Drug dealing	1053	1086.86	1.06	.3044	
Pisces	x Drug dealing	1110	1040.33	4.67	.0308	
Aries	x Drug use	2290	2421.62	7.15	.0075	
Taurus	x Drug use	2292	2337.02	.87	.3518	
Gemini	x Drug use	2352	2378.65	.30	.5848	
Cancer	x Drug use	2357	2271.04	3.25	.0713	
Leo	x Drug use	2279	2279.79	.00	.9868	
Virgo	x Drug use	2265	2254.98	.05	.8329	
Libra	x Drug use	2255	2191.48	1.84	.1748	
Scorpio	x Drug use	2139	2081.69	1.58	.2091	
Sagittarius	x Drug use	2108	2032.83	2.78	.0955	
Capricorn	x Drug use	2337	2289.96	.97	.3256	
Aquarius	x Drug use	2353	2371.24	.14	.7080	
Pisces	x Drug use	2153	2269.71	6.00	.0143	

The results of CFA suggest that although the sample is very large, only one configuration constitutes a type. No antitype was found. The type indicates that more Capricorns were found to have been convicted of drug dealing than expected based on chance. In an interpretation of these data, researchers would typically be reluctant to interpret this only type. Finding one type in a table with 120 cells is not necessarily surprising.

In contrast, Sachs interprets 9 type-like deviations ($o_i > e_i$) and 13 antitype-like deviations ($o_i < e_i$) in the same data (see above). There are three reasons for this discrepancy. First, the expected cell frequencies published by Sachs are not identical to the ones calculated using von Eye's (2001) program. However, these differences are mostly small and do not account for large portions of variability. Second, even without adjusting α , we only found 10 cells in which the difference between o_i and e_i was "significant" (at least $p = .05$; two-tailed). We do not know why other cells of Sachs' Table have been marked by asterisks. Third, and most importantly, Sachs did not protect the significance level α . Thus, the results published in Sachs' (1999) book are in great danger of reflecting errors of type I (and some of the errors related to attempts to document Psi-phenomena using methods of statistics; see Ch. 5 in Hergovich, 2001).

There may be a further problem with the analyses of Sachs' data that applies to the CFA analyses presented here as well. As Sachs (1999) repeatedly points out in his text, many methods of statistical significance testing are rooted in the assumption that the sample used for analyses is a random sample of a well-defined population. This is hardly the case for the present data. Sachs used the complete criminal records for a series of years. Similarly, for other analyses he used the complete Swiss marriage records. Thus, he comes close to analyzing entire populations. There may be cases missing, but the number of such cases in the marriage data should be small, and the number of missing cases in the criminal record should be minimal, too. Note that *convictions* are analyzed rather than crimes for which the number of unrecorded cases can be very large. If entire populations are analyzed, statistical significance testing has no longer the same meaning as when samples are analyzed.

One could argue that the data collected and analyzed by Sachs are samples of the population of all marriages and convictions recorded in Switzerland over long time periods. In this case, however, one would have to show that the selected years are a representative sample of this so-defined population. In either case, the status of the analyzed data as a random sample can be questioned.

Two-Way Cluster Analysis of Sachs' Crime Data

To validate the results of our CFA by a statistical method that does carry the problem of multiple significance testing, we applied a two-way cluster analysis. Methods of cluster analysis form groups of cases such that members of groups are, on average, more similar to each other than to members of other groups (Hartigan, 1975). Objects of clustering can be individuals, variables, or both. The third of these options, also called *matrix clustering*, is most useful for displaying the structure in a correlation matrix or two-way frequency table.

Two-way clustering can use mostly the same options as standard clustering. For example, the fusing algorithm can be hierarchical, partitioning, or create additive trees. The measure of similarity can be correlational or reflect distance. The resulting clusters can be overlapping or distinct.

The results of two-way cluster analysis are described in three components. The first component is the cluster structure of the rows, typically individuals. The second component

is the cluster structure of the columns, typically variables. These two components are no different than the results of clustering the rows and the columns separately. The third component is the cross-classification of the row clusters with the column clusters. This cross-classification shows a pattern that indicates the strength of relationship between clusters. This pattern can be displayed in the form of a mosaic. At the row and column margins of this mosaic, the cluster hierarchy appears for the individuals and the variables, respectively. Both rows and columns can be re-ordered such that the cluster hierarchies and the crossing of the clusters are optimized.

Our two-way cluster analysis of Sachs' data on criminal convictions was based on R^2 , a correlational measure, and used the agglomerative Ward method to create clusters. The measure R^2 was selected for two reasons. First, the measure has norm. Therefore, there is no need to standardize the data under study. Second, we are less interested in the raw frequencies than in the covariation patterns of crimes and signs of the Zodiac. The result of the analysis is shown in Figure 1.

2D Cluster Analysis of Zodiac and Crime

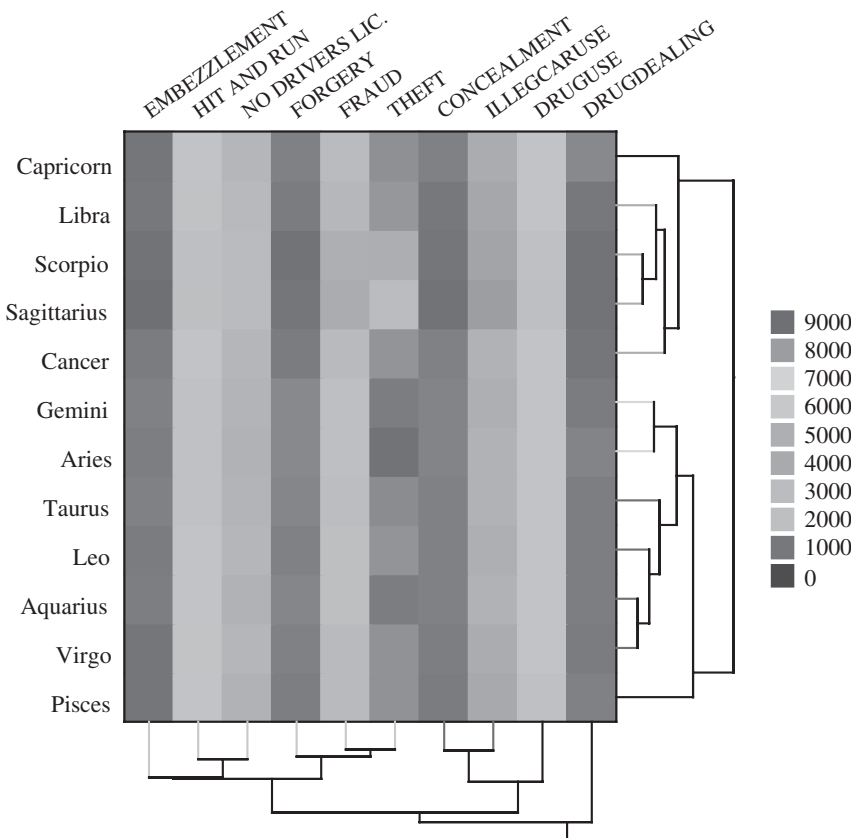


Figure 1:
Two-way cluster analysis of Sachs' criminal conviction data

The figure presents the signs of the Zodiac in the rows and the crimes in the columns. The cluster hierarchy of the signs of the Zodiac appears at the right hand side of the graph, the cluster hierarchy of the crimes appears at the bottom of the graph. There seems to be a two-cluster structure of the signs of the Zodiac and a three-cluster structure of the crimes (with drug dealing as the last crime to join another cluster).

The graph itself shows a very simple pattern. Rather than displaying some sort of a mosaic, the graph reveals a structure that represents the columns. There is almost no variation within the rows. The variation across the columns reflects the relative frequencies of the 10 crimes. The most frequent crime, theft, is shaded in lighter tones. The less frequent crimes are shaded in darker tones. Variations within columns would have indicated that local relationships between crimes and signs exist. The only discernible variation within a column appears for theft. However, our CFA as well as the analyses presented by Sachs suggest that the smaller number of thefts observed for Sagittarii is within expectation.

We thus conclude from the two-way cluster analysis that there may be a cluster structure for the crimes, and a cluster structure for the signs of the Zodiac. In contrast to astrological expectations, there is no non-random relationship between the clusters. Rather, the relationship between the crimes and the signs of the Zodiac seems to be dominated by the main effects that represent the differential crime frequencies.

Discussion and Outlook

Sachs presents an interesting book in which he analyzes large sets of objective data. He intends to link the signs of the Zodiac with human behavior by using scientifically accepted methods of statistics. His analyses revealed many “significant” relationships between both areas. Therefore, and based on the methods used for analysis, the author claims to have put astrology on scientific footing. However, as was shown in the above sections, the methods employed in Sachs’ book are not fully appropriate. His results and conclusions are therefore invalid. Our sample discussion of his data on criminal convictions and the signs of Zodiac revealed both methodological and theoretical problems. Our re-analyses using two different statistical methods suggest that there is no systematic link between the two areas.

It should be emphasized that methodological arguments have already been discussed by Sachs’ statistical experts (Chlumsky & Ehling, 1999; Künstler, 1999). Discussions include Basler’s (1998) criticisms of the tables in the appendices of Sachs’ monograph which include arguments of sampling and independence of information, and Basler’s mentioning of the problems of (1) one-sided versus two-sided testing and (2) multiple testing. However, the authors did not re-analyze the data in a more critical manner but emphasized the overall significance of χ^2 . Although this result is replicated in our CFA, it cannot be taken as a proof of a scientific hypothesis concerning the impact of the signs of the Zodiac on convictions for criminal behavior.

It should also be noted that our re-analysis using CFA was based on the most conservative method of α -protection, the Bonferroni procedure. As well this procedure is known to protect the local-level α . However, there exist other procedures that protect α as well, but are less conservative. Most of these methods are sequential in the sense that they adjust the nominal significance threshold α with respect to (1) the total number of tests performed and (2) the number of tests performed before a particular test. Typically, these methods require to rank order the test statistics. The largest statistic is subjected to the most conservative test. Beginning with the second test, these procedures are less conservative. Hommel, Lehmacher,

and Perli (1985) proposed a method that is less conservative beginning with the first test. Each of these procedures concludes the testing as soon as the first null hypothesis prevails (for an overview, see von Eye, 2002). One wonders whether employing these less conservative procedures would lead to different conclusions in the re-analysis of Sachs' data.

Consider, for example, the least conservative of the procedures of α -protection, that is, the procedure proposed by Hommel et al. (1985; cf. Hommel, 1988) for two-dimensional tables of the kind analyzed here. Table 1 contains 120 cells. Hommel et al.'s procedure performs the first five tests under the adjusted $\alpha_1^* = \alpha_2^* = \dots = \alpha_5^* = \frac{\alpha}{r-4}$, where r is the total number of tests performed. For $r = 120$, one obtains $\alpha_{1.5}^* = 0.05/116 = 0.000431$. This threshold is already less extreme than the Bonferroni threshold of $\alpha^* = 0.05/120 = 0.000417$ used for the analyses in Table 1. Accordingly, the sole type in Table 1 emerges also when this relaxed procedure is used. The second-most extreme discrepancy is found for the pattern Pisces x driving without license. The tail probability for this pattern is $p = 0.0076$. The critical adjusted α is smaller than this value. Therefore, we can not reject the null hypothesis for this pattern, and we conclude the sequence of significance testing after the second test. Obviously, the application of a more liberal procedure of protection of the local-level α does suggest the same statistical decisions as the conservative Bonferroni procedure. For the present data, we can therefore state that the application of the more conservative procedure did not obscure results that, with less conservative procedures, could have been detected.

Another important issue is whether the results presented in our re-analyses are specific to the crime data presented in Sachs' table on pp. 170-171. As mentioned above, we used the crime data for two reasons: First, this kind of behavior seems to be relatively independent of processes of self-attribution that may link the signs of the Zodiac to the answers in personality questionnaires or other reactive data. Second, there are at least some theoretical bases that address correlations between personality, crime, and astrology. Although Sachs did not refer to this area of research, we performed additional re-analyses in two ways: First, we grouped the data presented in Sachs' table on pp. 170-171 in criminologically more coherent groups. Specifically, we formed the groups of property crimes (first five categories in Table 1), traffic-related offenses (next three categories in Table 1), and drug-related crimes (last two categories in Table 1). Second, we analyzed various tables of Sachs' book that addressed other areas of behavior such as marriages or causes of death. In none of these re-analyses, we obtained results that differed clearly from those presented above. In other words, these re-analyses yielded no types nor antitypes. We thus are confident that the conclusions that we drew based on the re-analyses of the crime data are not an artifact but relatively typical for Sachs' analyses.

We do not claim that our methodological, theoretical, and empirical re-analyses are the last word on the large data sets presented by Sachs. For example, as we have mentioned, groupings that refer to persistent and/or violent offenses may be more promising from the perspective of personality research. In addition, more detailed analyses of the signs of Zodiac and their shifts over centuries may reveal different results. However, we aimed at a fair analysis of empirical data and did not intend to prove or disprove astrological thinking. Insofar, our discussion of the relation between personality, crime, and astrology already went beyond the material presented in Sachs' book. Other authors may address more differentiated issues.

From our analyses we conclude that, (1) if there is a scientific basis to astrology, this basis remains to be shown, and (2) if there exists a link between the signs of the Zodiac and human behavior, this link remains to be shown too. Still, Sachs' book is entertaining to read. Its analyses and results are not useable as scientific material. However, it contains a wealth of data that can be used as discussion examples in the classroom and in conference talks or other presentations.

References

1. Ball, P. (1998). *Jack the Ripper, a psychic investigation: The compelling search for the killer's true identity*. London: Arcturus Publishing.
2. Basler, H. (1998). "Die Akte Astrologie" von Gunter Sachs aus Sicht der mathematischen Statistik. *Skeptiker*, 11, 104 - 111.
3. Carlson, S. (1985). A double-blind test of astrology. *Nature*, 318, 419-425.
4. Chlumsky, J., & Ehling, M. (1999). Die Akte Astrologie - Wissenschaftliche Expertise aus statistisch-methodischer Perspektive. [The astrology file - scientific expertise from a statistical-methodical perspective.] In G. Sachs (1999), *Die Akte Astrologie [The astrology file]* (pp. 221-237). München: Goldmann.
5. DuMouchel, W. (1999). Bayesian data mining in large frequency tables, with an application to the FDA spontaneous reporting system. *The American Statistician*, 53, 177 - 190.
6. Eysenck, H.J. (1977). *Crime and personality*. London: Paladin.
7. Eysenck, H.J. (1997). Personality and the biosocial model of anti-social and criminal behavior. In A. Raine, P.A. Brennan, D.P. Farrington, & S.A. Mednick (Eds.), *Biosocial bases of violence* (pp. 21-37). New York: Plenum Press.
8. Eysenck, S. B. G., & Eysenck, H. J. (1970). Crime and personality: An empirical study of the three-factor theory. *British Journal of Criminology*, 10, 225-239.
9. Eysenck, S. B. G., & Eysenck, H. J. (1977). Personality differences between prisoners and controls. *Psychological Reports*, 40, 1023-1028.
10. Eysenck, H. J., & Gudjonsson, G. H. (1989). *The causes and cures of criminality*. New York: Plenum Press.
11. Fischer, T., & Kretschmer, T. (1996). *Persönlichkeit und Delinquenz: Eine Metaanalyse. [Personality and delinquency - a metaanalysis]* Diplomarbeit. Universität Erlangen-Nürnberg: Institut für Psychologie. [Unpublished masters thesis]
12. Gauquelin, M., Gauquelin, F., & Eysenck, S. B. G. (1979). Personality and the position of the planets at birth: An empirical study. *British Journal of Social and Clinical Psychology*, 18, 71-75.
13. Hartigan, J. A. (1975). *Clustering algorithms*. New York: Wiley.
14. Hergovich, A. (2001). *Der Glaube an Psi: Die Psychologie paranormaler Überzeugungen. [The belief in astrology: the psychology of paranormal beliefs]* Bern: Hans Huber.
15. Hommel, G. (1988). A stagewise rejective multiple test procedure based on a modified Bonferroni test. *Biometrika*, 75, 383 - 386.
16. Hommel, G., Lehmacher, W., & Perli, H.-G. (1985). Residuenanalyse des Unabhängigkeitsmodells zweier kategorialer Variablen. [residual analysis of the independence model of two categorical variables] In J. Jesdinsky & J. Trampisch (Eds.), *Prognose- und Entscheidungsfindung in der Medizin [Determining prognosis and decisions in medicine]* (pp. 494 - 503). Berlin: Springer.
17. Hume, N., & Goldstein, G. (1977). Is there an association between astrological data and personality? *Journal of Clinical Psychology*, 33, 711-713.
18. Jackson, M., & Fiebert, M. S. (1980). Introversiön-extroversiön and astrology. *The Journal of Psychology*, 105, 155-156.
19. Kelly, I.W. (1979). Astrology and Science: A critical examination. *Psychological Reports*, 44, 1231 - 1240.
20. Kelly, I.W. (1998). Why astrology doesn't work. *Psychological Reports*, 82, 527 - 546.
21. Künstler, R. (1999). Astrologie und Statistik. [Astrology and statistics] In G. Sachs, *Die Akte Astrologie [The astrology file]* (pp. 217-219). München: Goldmann.
22. Lienert, G. A. (1969). Die "Konfigurationsfrequenzanalyse" als Klassifikationsmethode in der klinischen Psychologie. [Configural Frequency Analysis - a method of classification in clinical

- psychology] In M. Irle (Ed.), Bericht über den 26. Kongress der Deutschen Gesellschaft für Psychologie in Tübingen 1968 [Proceedings of the 26th congress of the German Psychological Association in Tübingen, 1968] (pp. 244-255). Göttingen: Hogrefe.
23. Lösel, F., & Bender, D. (2003). Protective factors and resilience. In D.P. Farrington & J. Coid (Eds.), *Prevention of adult antisocial behavior* (pp. 130-204). Cambridge: Cambridge University Press.
 24. Lösel, F., & Schmucker, M. (2002). Persönlichkeit und Kriminalität. [Personality and criminal behavior] In K. Pawlik (Ed.), *Enzyklopädie der Psychologie: Differentielle Psychologie*. [Encyclopedia of Psychology: Differential Psychology] Göttingen: Hogrefe (in press).
 25. Lösel, F., & Wüstendörfer, W. (1976). Persönlichkeitskorrelate delinquenten Verhaltens oder offizieller Delinquenz? [Correlates of delinquent behavior or of police-known delinquency?] *Zeitschrift für Sozialpsychologie*, 7, 177-191.
 26. Mann, G. (1979). Wallenstein, 7th ed. Frankfurt a.M.: S. Fischer.
 27. Mayo, J., White, O., & Eysenck, H. J. (1978). An empirical study of the relation between astrological factors and personality. *The Journal of Social Psychology*, 105, 229-236.
 28. Moffitt, T.E. (1993). Adolescence-limited and life-course-persistent antisocial behavior: A developmental taxonomy. *Psychological Review*, 100, 674-701.
 29. Russell, J., & Wagstaff, G. F. (1983). Extraversion, neuroticism, and time of birth. *British Journal of Social Psychology*, 22, 27-31.
 30. Pawlik, K., & Buse, L. (1979). Selbst-Attribuierung als differentiell-psychologische Moderatorvariable: Nachprüfung und Erklärung von Eysencks Astrologie-Persönlichkeit-Korrelationen. [Self-attribution as a differential moderator variable in Psychology: A test and an explanation of Eysenck's astrology - personality correlations] *Zeitschrift für Sozialpsychologie*, 10, 54-69.
 31. Sachs, G. (1999). *Die Akte Astrologie*, revised edition. München: Goldmann. [Sachs, G. (1999). *The astrology file*. London: Orion.]
 32. Saklofske, D. H., & Eysenck, S. B. G. (1980). Personality and antisocial behavior in delinquent and non-delinquent boys. *Psychological Reports*, 47, 1255-1261.
 33. Saklofske, D. H., Kelly, I. W., & McKerracher, D. W. (1982). An empirical study of personality and astrological factors. *The Journal of Psychology*, 110, 275-280.
 34. Silverman, B. I., & Whitmer, M. (1974). Astrological indicators of personality. *The Journal of Psychology*, 87, 89-95.
 35. Smithers, A. G., & Cooper, H. J. (1978). Personality and season of birth. *The Journal of Social Psychology*, 105, 237-241.
 36. Startup, M. (1985). The astrological doctrine of 'aspects': A failure to validate with personality measures. *British Journal of Social Psychology*, 24, 307-315.
 37. van Rooij, J. J. F. (1999). Self-concept in terms of astrological sun-sign traits. *Psychological Reports*, 84, 541-546.
 38. van Rooij, J.J.F. (1994). Introversiön-extraversiön: Astrology versus psychology. *Personality and Individual Differences*, 16, 985-988.
 39. van Rooij, J.J.F., Brak, M.A., & Commandeur, J.J.F. (1988). Introversiön-extraversiön and sun-sign. *The Journal of Psychology*, 122, 275-278.
 40. Venó, A., & Pamment, P. (1979). Astrological factors and personality: A southern hemisphere replication. *The Journal of Psychology*, 101, 73-77.
 41. von Eye, A. (2001). *Configural Frequency Analysis - Version 2000 program for 32 bit operating systems*. *Methods for Psychological Research - online*, 6, 1 - 4.
 42. von Eye, A. (2002). *Configural Frequency Analysis: Methods, models, and applications*. Mahwah, NJ: Lawrence Erlbaum.
 43. Young, S. H., & Rowland, E. (1995). *Destined for murder: Profiles of six serial killers with astrological commentary*. St. Paul, MN: Llewellyn Publications.