What Should Chance Look Like? Base Rates of Planetary Aspects, 1900–2100, and False Positives in Aspect Studies

Vít Hnilica
Twelvera, Czech Republic
vit.hnilica@twelvera.com
ORCID: 0009-0000-9993-9648

Preprint · Version 1.0 · November 2026 · DOI: 10.5281/zenodo.24633982

Statistical studies of astrological aspects compare how often an aspect occurs in a sample with how often it should occur by chance, and the result depends on that expectation. We computed how often each aspect between ten bodies actually occurred from 1900 to 2100, using the JPL DE442s ephemeris, and compared it with the common assumption that the angle between two bodies is uniformly distributed. With traditional moiety orbs, 57 of 225 pair-and-aspect combinations (25%) differed from the uniform expectation by more than 10%, and 13 never occurred. We then simulated 40,000 studies in which births were drawn at random from a window of years, so that no astrological effect was present, and tested all 225 combinations in each. With 300 births from a window of 10 to 20 years, 26–33% of tests were significant at the 5% level against the uniform expectation and 15–22% against the long-term empirical rate. Against the rate in the same window of years the share was 3.7–3.8%, and against a control made by shuffling the components of the sample's own birth dates it was 2.3–2.6%. Correction for multiple testing did not repair the first two baselines. We provide reference tables and recommendations for control groups. The study concerns the measurement of chance and does not test the validity of astrology.

Keywords: astrological aspects; base rates; control groups; false positives; ephemeris; simulation; research methods

1 Introduction

An aspect is a particular angle between two bodies as seen from the Earth, measured along the ecliptic: a conjunction (0°), sextile (60°), square (90°), trine (120°) or opposition (180°), and in some traditions several minor angles. The aspect is taken to hold when the angle lies within a tolerance called the orb. A typical quantitative study counts how many members of a group, for example people with a given profession or events of a given kind, have a certain aspect and asks whether the count is higher than chance would give.

Everything in such a study rests on what chance would give. The simplest answer assumes that the angle between two bodies is equally likely to take any value, so that an aspect with an orb of 8° on either side of 90° should hold for 16/180, or 8.9%, of births. This is not how the planets move. Mercury and Venus never go far from the Sun. A planet outside the Earth's orbit moves backwards against the stars around the time it stands opposite the Sun, so the angle between the two changes quickly at opposition and slowly at conjunction. Slow pairs such as Neptune and Pluto take centuries to run through all their mutual angles, so people born within a few decades of one another share the same aspect.

These methodological concerns have been recognised in earlier research. Startup (1985), in a test of aspects against personality measures, noted that studies based on aspect frequencies are hard to evaluate because expected frequencies are difficult to calculate when the geocentric motions of the planets are not uniform; his doctoral thesis treats the angular separation between planets at length (Startup, 1984). The long dispute over Gauquelin's planetary findings concerned in large part how expected frequencies should be obtained (Ertel & Irving, 1996). Ruis (2008) described demographic and astronomical artefacts explicitly and compared three

kinds of control group in one study: an independent sample of people born in about the same years and countries, and two sets of artificial births made by shuffling the years, dates, times and places of the experimental group, together with a procedure that shifts the birth dates forwards and backwards in time.

Aspect studies continue to appear. A recent issue of *Correlation* contains a test of conjunctions and oppositions of Mars with the Sun, Moon, Mercury and Venus in two samples of violent offenders (Daigno, 2026) and an analysis of planetary alignments at the outbreak of about 1,000 wars between 1816 and 2007, which reports Mars–Pluto squares and Mars–Uranus sextiles at about 1.5 times the expected frequency (Martín & Stedall, 2026). We read only the published abstracts of these two studies, which do not say how the expected frequencies were obtained, and we make no claim about either. They show the kind of design to which the present paper applies.

This study addresses two quantitative questions that we did not find answered in the literature: how far the real frequency of each aspect lies from the uniform expectation, and how often a study with an inadequate baseline will report a significant aspect when nothing is there. Our search found the works cited above but no published table of empirical aspect frequencies for a stated period and no simulation of false-positive rates under different baselines. The scope of the literature search is described in section 5.

This study has three research questions, with hypotheses written in the study plan after a pilot computation and before the full run. They were not preregistered.

1. How far do empirical aspect frequencies differ from the uniform model? H1: more than 5% of pair-and-aspect combinations have a ratio of observed to expected frequency outside 0.9–1.1.
2. How large is the false-positive rate when a sample comes from a limited range of birth years and is compared with the uniform or the long-term expectation? H2: for windows shorter than 40 years, more than 5% of tests are significant at the 5% level under both.
3. Which baseline removes the error? H3: a baseline from the same window of years, and a control made by shuffling the components of the birth dates, keep the false-positive rate between 4% and 6%.

The study does not ask whether aspects mean anything. It asks how chance should be computed.

2 Method

2.1 Positions

Positions were computed with the chart engine of the Twelvera application from the JPL planetary ephemeris DE442s, the short-span file (1850–2150) of DE442, a 2024 update of the DE440 ephemeris described by Park et al. (2021): apparent geocentric ecliptic longitude referred to the equinox of date, for the Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto, which gives 45 pairs. The lunar nodes and the chart angles were left out; the angles depend on the place of birth.

Three datasets were produced. The daily set has one instant on each day from 1 January 1900 to 31 December 2100 at a random hour, 73,414 instants in all. The hourly set has every full hour of Coordinated Universal Time in the same period, 1,761,936 instants, with longitude and speed for each body. The episode set lists every stay of a pair within the orb of a major aspect, found in the hourly set and refined by bisection to within 30 seconds. Times are treated as Universal Time throughout; for future dates the difference between the two time scales is not known.

The engine was checked in two ways. For 100 random instants of the daily set we compared all ten longitudes with the JPL Horizons service, set to apparent geocentric ecliptic longitude of date; the largest difference was 0.00012° (0.44 arcseconds), for the Moon (Supplementary Table S4). We also recomputed all positions of the daily set with two public libraries, Skyfield with the DE440s ephemeris (Rhodes, 2019) and the Swiss

Ephemeris, version 2.10 (Koch & Treindl, n.d.), and repeated the frequency tables with separate code. Positions differed from the engine by at most 0.008° and 0.004° respectively, the largest differences being lunar and arising from different conversions between time scales for the early twentieth century and the future. The counts in Table 1 were reproduced exactly with the Swiss Ephemeris and, with Skyfield, in all but one combination that lies on the boundary of the 0.9–1.1 band (Mercury–Jupiter sextile at an 8° orb, ratio 1.1001 against 1.09996).

2.2 Aspects and orbs

The angle between two bodies is the shorter arc, from 0° to 180°. Five major aspects (0°, 60°, 90°, 120°, 180°) and four minor ones (30°, 45°, 135°, 150°) were examined. So that the results do not depend on one convention, each analysis was run with three sets of orbs.

- **Moiety orbs.** Each body has a half-orb, or moiety, and the orb for a pair is the sum of the two moieties. For the seven traditional bodies the moieties are half the orbs given by Lilly (1647, p. 107): Sun 8.5°, Moon 6.25°, Mercury 3.5°, Venus 4°, Mars 3.75°, Jupiter 6°, Saturn 5°. Uranus, Neptune and Pluto have no traditional orb. We used the convention of the engine, a moiety of 2.5° and an upper limit of 6° for any pair that includes one of them; this is a parameter of the study, not a historical value. The same orb was used for minor aspects.
- **Uniform orb** of 8° for major and 2° for minor aspects.
- **Narrow orb** of 3° for major and 1° for minor aspects.

We do not claim that any particular school uses exactly the second or third set. Where the windows of two aspects overlap, which happens only with moiety orbs when minor aspects are included, the angle was assigned to the aspect whose exact angle is nearest.

2.3 Observed and expected frequency

For each pair, aspect and set of orbs, the observed frequency O is the share of the 73,414 daily instants at which the aspect held. The uniform expectation E is the share of the half-circle covered by the aspect's window, that is, the orb divided by 180° for the conjunction and opposition and twice the orb divided by 180° for the others. E was computed numerically, by applying the same assignment rule to 1.8 million evenly spaced angles, and agreed exactly with the formula wherever windows do not overlap. The ratio O/E is the effect a study would appear to find if it used the uniform expectation on a sample with no effect.

Daily samples are not independent, because slow planets hold an aspect for months or years. Intervals for O were therefore obtained with a block bootstrap that resamples whole calendar years (1,000 replicates). For pairs whose cycle is long compared with a year the blocks are still dependent and the intervals are too narrow; for those pairs the tables describe the years 1900–2100 and are not estimates of a long-run rate.

We also computed, for every pair and aspect, the share of days in orb in each decade from the 1900s to the 2090s.

2.4 Simulated studies with no effect

Each simulated study imitates a common design: a group of N people is collected, and for each of the 225 combinations of pair and major aspect the number of people with the aspect is compared with a baseline.

A window of W years was chosen, with W of 10, 20, 40, 80 or 200 years and a starting year drawn uniformly so that the window lay within 1900–2100. N instants, with N of 100, 300, 1,000 or 3,000, were drawn uniformly from the window, and positions at those instants were obtained from the hourly set by cubic Hermite interpolation of longitude and speed. Births are thus spread evenly over the window and unrelated to the sky, so every significant result is a false positive.

Each of the 225 counts was tested against four baselines.

- **K1, uniform expectation:** the value E of section 2.3, with an exact two-sided binomial test.
- **K2, long-term empirical rate:** the share of time the aspect held in 1900–2100, with the same test.
- **K3, same-window empirical rate:** the share of time the aspect held within the study's own window of years, with the same test.
- **K4, shuffled components:** a control group ten times the size of the sample, made from the sample itself by independently permuting the years, the days of the year and the times of day ten times (a day 366 that falls in a year without one is moved to day 365); the sample and the control were compared with Fisher's exact test. This follows the shuffling procedures used for control groups in this field (Ruis, 2008).

There were 2,000 simulated studies for each of the 20 combinations of W and N, 40,000 in all, each with 225 tests under moiety orbs and 225 under the uniform 8° orb. Both tests use the usual definition of the two-sided p value, the sum of the probabilities of all outcomes no more likely than the one observed; our implementation was checked against SciPy (Virtanen et al., 2020) on random inputs with no difference. For each baseline we recorded the share of tests with $p < .05$, the share of studies with at least one such test among the 225, the same after the Benjamini–Hochberg procedure at a false discovery rate of 5% (Benjamini & Hochberg, 1995), and the size of the false effects as the ratio of observed to expected count and as Cohen's h (Cohen, 1988).

An exact test of a discrete count cannot reach the nominal level exactly, and a combination that never occurs in a given window cannot be rejected at all. Because K4 turned out to be conservative, a follow-up simulation of 1,000 studies for each window length, with N of 100 and 300 and moiety orbs, compared three variants: the original K4; the same test with the shuffled control built from a second, independent sample of the same size and window (K4i); and a Monte Carlo test in which 199 shuffled copies of the sample itself, each of size N, supply the reference distribution of the count, (K4p). Its p value is $(b + 1)/(199 + 1)$, where b is the number of copies whose count lies at least as far as the observed count from the mean of all 200 counts, the observed one included. The sample is thus treated in the same way as its copies (Hemerik & Goeman, 2018), and the p value is never zero (Phipson & Smyth, 2010).

To check the simulation itself we also computed, for 40 random windows of each length, the exact probability of $p < .05$ under the same-window rate, averaged over the 225 tests. The simulated rate under K3 should agree with this reference value.

3 Results

3.1 Observed against uniform frequency

With moiety orbs and the five major aspects, 57 of the 225 combinations (25.3%) had a ratio O/E outside 0.9–1.1; for 33 of them the whole 95% interval lay outside that band, and 13 never occurred in the 201 years (Table 1). The uniform 8° orb gave 56 combinations (24.9%) and the narrow 3° orb 63 (28.0%). With the minor aspects included, the share was 25.4% to 31.6% of 405 combinations. H1 is supported under every convention. Figure 1 shows the ratio for all pairs and aspects, Table 2 lists the twenty largest departures, and Supplementary Table S5 gives all 225.

The departures have three causes (Figure 2).

Limits of elongation. Seen from the Earth, Mercury and Venus stay close to the Sun. The largest angles in the daily set were 27.8° between the Sun and Mercury, 47.3° between the Sun and Venus and 73.8° between Mercury and Venus. Sextiles, squares, trines and oppositions of the Sun with either planet therefore do not exist, nor do squares, trines and oppositions between Mercury and Venus; these account for 11 of the 13 combinations

that never occurred. The other side of the same fact is that conjunctions are common: the Sun and Mercury were within the 12° moiety orb on 36.4% of days against a uniform expectation of 6.7% (O/E = 5.46), Mercury and Venus on 12.6% against 4.2% (3.02), and the Sun and Venus on 19.3% against 6.9% (2.78).

Retrograde motion. When Mars is near conjunction with the Sun it moves in the same direction as the Sun and only a little more slowly, so the angle between them changes slowly. Near opposition Mars is retrograde and the angle changes quickly. The Sun and Mars were within 10° of conjunction on 9.27% of days and within 10° of opposition on 1.90%, where the uniform model gives 5.56% for each (Figure 3). With the moiety orb of 12.25° the ratio was 1.67 (95% interval 1.46–1.89) for the conjunction and 0.34 (0.30–0.39) for the opposition; the sextile was above expectation (1.39) and the trine below (0.60). The effect weakens with the distance of the planet: 6.62% against 4.50% for Jupiter, 6.14% against 4.97% for Saturn, 5.69% against 5.41% for Pluto. Mercury and Venus, which accompany the Sun, inherit it: the Venus–Mars opposition had a ratio of 0.35 and the Mercury–Mars opposition 0.36.

Long cycles. Neptune and Pluto need roughly 490 years to return to the same mutual angle, so 201 years contain less than half a cycle. In 1900–2100 they were never in conjunction or opposition and were within 5° of a sextile on 33.4% of days, six times the uniform expectation. Uranus–Neptune and Uranus–Pluto complete only one or two cycles in the period, and their ratios range from 0.68 to 1.88.

A few departures fit none of these classes cleanly, for example the Jupiter–Uranus conjunction (1.38) and the Mars–Jupiter opposition (1.24) and trine (0.83). We did not analyse their causes.

Pairs that include the Moon were close to the uniform expectation for every major aspect (ratios from 0.98 to 1.02).

3.2 Decades

For slow pairs the long-term rate hides large differences between generations (Figure 4). The Neptune–Pluto sextile held on 33.4% of days over the whole period but on 100%, 90%, 99% and 99% of days in the 1950s, 1960s, 1970s and 1980s. Almost everyone born in those four decades has it, whatever else they have in common. The Uranus–Pluto conjunction occurred only in the 1960s, on 38% of days, and the Uranus–Neptune conjunction only in the 1990s, on 52%. Jupiter–Saturn sextiles, squares and trines, by contrast, are spread fairly evenly, at 9–17% of days in every decade.

3.3 False positives in simulated studies

Table 3 and Figure 5 give the share of significant tests when no effect exists. Against the uniform expectation (K1) the share ranged from 11.7% to 53.0% and was above the nominal 5% in every combination of window and sample size. Against the long-term empirical rate (K2) it ranged from 3.7% to 40.2%: it was above 5% for every window of 80 years or less and fell to 3.7–4.6% only when the sample spanned the whole 200 years, where the long-term rate and the same-window rate nearly coincide (the window covers 200 of the 201 years). H2, which concerned windows shorter than 40 years, is supported, and the problem extends to longer windows.

Two patterns in these numbers matter for practice. The error grows as the window shortens, because a short window catches slow pairs in one phase of their cycle. It also grows with sample size: with a window of 10 years, K1 gave 20.7% at N = 100 and 53.0% at N = 3,000. The discrepancy between baseline and reality is fixed, and a larger sample detects it more reliably. At N = 300, which is a common size for such studies, a window of 10 to 20 years gave 26–33% under K1 and 15–22% under K2.

With the uniform 8° orb the results were nearly the same (Supplementary Table S1).

Against the same-window rate (K3) the share was 3.4–4.5%, and with shuffled components (K4) 1.9–3.4%. Neither produced excess false positives. H3 as worded, a rate between 4% and 6%, was met in only 11 of 20 combinations for K3 and in none for K4, because both fell below the band, not above it. For K3 the reason is

the one given in section 2.4: the simulated share agreed with the exact reference value to within 0.05 percentage points in all 20 combinations (for example 3.37% against 3.37% at W = 10 and N = 100, and 4.50% against 4.51% at W = 200 and N = 3,000). In a 10-year window 14.7% of the 225 combinations did not occur at all, and in the 200-year window 5.8%. The shortfall from 5% is a property of the exact test, not an error of the baseline. K4 was more conservative still, and the follow-up simulation shows why (Supplementary Table S6). The shuffled control is built from the sample's own dates, so the two groups are not independent as Fisher's test assumes. When the control was shuffled from a second, independent sample of the same window, the share of significant tests rose from 1.9–3.1% to 4.6–5.4%, close to the nominal level and slightly above it at N = 300 (5.1–5.4%). An independent second sample does not by itself make Fisher's test valid here: ten shufflings of one sample are not ten independent samples, so the control carries less information than its size suggests, and this may be why the share exceeded 5% at N = 300. The Monte Carlo test on shuffled copies of the sample itself gave 2.9–3.6%, less conservative than Fisher's test and close to the 3.4–4.1% of the same-window rate at these sample sizes. Under exchangeability, the probability of rejection is at most 9/200 (4.5%) with the strict criterion $p < .05$. Ties can reduce it further.

Multiple testing. With 225 tests, almost every simulated study had at least one result with $p < .05$ under every baseline: 100% under K1 and K2, 99.9–100% under K3 and 98.1–100% under K4 (Supplementary Table S2), with on average 7.6–10.1 such results per study under K3. After the Benjamini–Hochberg procedure the share of studies with at least one discovery fell to 1.9–4.9% under K3 and 0.7–2.8% under K4. Under K1 it stayed at 100% in every combination. Under K2 it stayed at 100% for windows of 10 and 20 years, was 86–100% at 40 years and 63–100% at 80 years, and fell to 2.2–5.3% only for the 200-year window (Supplementary Table S3). Correction for multiple testing controls the errors of a valid baseline and does not repair an invalid one.

Size of the false effects. The false positives were not marginal. With a 20-year window and N = 300 the median absolute Cohen's h among false positives was 0.33 under K1 and 0.22 under K2, and the median ratio of observed to expected count among false excesses was 1.80 and 1.74. False deficits typically had a ratio of zero: the aspect did not occur in the window at all.

Which combinations are most at risk. Table 4 lists the five combinations with the highest sum of the rejection rates under the uniform and the long-term baseline. All involve Uranus, Neptune or Pluto. Combinations that never occur do not appear in it, although the uniform expectation rejects them most often of all: the Sun–Mercury sextile, expected on 13.3% of days and never observed, was significant under K1 in every simulated study, but it cannot be significant under K2, whose expected rate for it is zero. The Neptune–Pluto sextile was significant in 98% of simulated studies under the uniform expectation and in 76% under the long-term rate, against 3.6% under the same-window rate.

3.4 Length of stay within orb

The same orb corresponds to very different lengths of time (Table 5). A Sun–Moon conjunction within the moiety orb lasted a median of 2.4 days and a Moon–Saturn square 1.7 days. A Sun–Saturn conjunction lasted about a month and a Sun–Mars conjunction 84 days. For slow pairs a single passage is broken by retrograde loops into several entries and exits; when these are merged, a Jupiter–Saturn square lasted a median of 701 days and included three or more exact passes in 80% of cases. Births within such a period share the aspect, which is the mechanism behind the false positives of section 3.3.

4 Discussion

The uniform expectation is wrong for about a quarter of the combinations of pair and major aspect, by more than 10% and in some cases by a factor of three to six or by the whole of the expected frequency. The errors are systematic and known in advance: conjunctions of the Sun, Mercury and Venus with one another and with the

outer planets are more frequent than the uniform model says, oppositions of the Sun, Mercury and Venus with Mars are about a third as frequent, and the aspects of the slowest planets belong to particular decades.

Replacing the uniform expectation with a carefully computed long-term frequency helps less than might be expected. It removes the errors that come from the limits of elongation and from retrograde motion, which are the same in every period, but not the errors that come from when the sample was born. A sample drawn from two or three decades meets the slow pairs in one phase of their cycle, and a table for two centuries does not describe that phase. In our simulations the long-term rate still gave 15–22% significant tests where 5% were due, for a sample of 300 births within 10 to 20 years.

Baselines tied to the birth years of the sample did not show this error. The empirical rate in the same window is simple to compute from an ephemeris if the births are spread fairly evenly over the window. The shuffled control needs no assumption about how the births are spread, because it reuses the sample's own years, days and times. It preserves the distribution of each of these three components separately, so a seasonal or daily pattern in the sample is carried into the control, but not any dependence between the components. Ruis (2008) pointed out its main cost: it reproduces part of the sample's own structure and may hide a real effect. Our result agrees with this: with Fisher's exact test the shuffled control was conservative, at 1.9–3.4% significant tests, because the control is not independent of the sample. The Monte Carlo test on shuffled copies of the sample was less conservative, with false-positive rates of 2.9–3.6%. We did not measure power, so this does not show which test detects a real effect more often. An independent control group of real people born in the same years and places, as Ruis also used, avoids both problems where it can be had.

These findings have direct implications for the interpretation of existing studies. A reported excess or deficit of an aspect cannot be interpreted without knowing the baseline and the range of birth years. A design that tests conjunctions and oppositions of Mars with the Sun, Mercury and Venus, or aspects among Uranus, Neptune and Pluto, in a sample from a few decades, is the kind in which our simulation found most false positives, and the false effects it produced were of a size that would ordinarily be taken seriously. Whether any particular published result is affected depends on the baseline its authors used, which we have not examined.

For authors of aspect studies we suggest five rules.

1. Compare with a baseline that has the same distribution of birth years as the sample: an independent control group, a shuffled control, or empirical frequencies computed for the same years.
2. State the range of birth years, and for slow pairs show the frequency of the aspect by decade.
3. State the orb for each pair and how overlapping aspects are assigned.
4. Report the observed and the expected count, their ratio and an effect size, not only the p value.
5. Correct for the number of aspects tested, and do not expect that correction to make up for an unsuitable baseline.

5 Limitations

Period. All frequencies are for 1900–2100. For Uranus, Neptune and Pluto this is one or two cycles or less, and the figures describe these years, not a long-run rate.

Uniform births. Simulated births were spread evenly over the window. Real births vary by year, season, weekday and hour, and real samples are rarely spread evenly over their range of years. We did not model this; it would add further differences between a sample and any baseline that ignores them.

Orbs. The orbs for Uranus, Neptune and Pluto under the moiety convention are those of one software engine. The uniform and narrow orbs are round numbers chosen for the study. The engine itself assigns an angle that falls within two overlapping windows to the first matching aspect in a fixed order, not to the nearest; this affects only moiety orbs with minor aspects, where it changes the count in Table 1 from 103 to 105.

Bodies. The lunar nodes, the chart angles, asteroids and other points were not included. The simulation covered major aspects only.

Intervals. The bootstrap intervals are too narrow for slow pairs, as noted in section 2.3.

Episodes. The rule for merging episodes is a heuristic, and stays shorter than one hour that begin and end between two hourly samples were not detected.

Shuffled control. The follow-up comparison of K4 variants was run after the main simulation, with fewer studies (1,000 per combination), two sample sizes and moiety orbs only. A test on shuffled copies is exact only if the sample and its copies are exchangeable under the null hypothesis (Hemerik & Goeman, 2018). Here this holds only approximately: shuffling assumes that year, day of the year and time of day are independent, and moving day 366 to day 365 in a year without a leap day treats the copies differently from the sample. We did not measure the power of any baseline to detect a real effect.

Hypotheses. The hypotheses were written after a pilot on the same ephemeris and were not preregistered. H3 was only partly met as worded, and the follow-up simulation of K4 variants was not part of the plan.

Literature. On 28 November 2026 we searched Google Scholar with five queries combining astrology, aspects, expected frequencies, control groups and artefacts, and searched the abstracts on the website of the journal *Correlation*. Scopus and Web of Science were not searched, and much of the older literature in this field is not indexed, so earlier work of this kind may exist.

Tests. The simulation used exact binomial and Fisher tests. Other tests, such as the chi-squared test often used in this field, were not simulated.

6 Conclusion

Chance does not look uniform. Between 1900 and 2100, a quarter of the combinations of planet pair and major aspect occurred at a frequency more than 10% away from the uniform expectation, and thirteen did not occur at all. In simulated studies with no effect, a sample of 300 births from one or two decades gave a significant result in 26–33% of tests against the uniform expectation and in 15–22% against a long-term empirical rate, and correction for multiple testing did not remove these errors. Baselines tied to the sample's own birth years kept the rate below 5%.

The results support a practical and computationally inexpensive remedy: a control with the same distribution of birth years as the sample. The tables provided here show which aspects are most affected and by how much.

Statements

Conflict of interest. The author develops Twelvera, a commercial astrology application, and the positions were computed by its engine. They were checked against JPL Horizons and recomputed with Skyfield and the Swiss Ephemeris.

Use of AI tools. The author defined the research questions and the design, directed the computational analysis, and reviewed the results and the manuscript. An AI assistant (Claude, Anthropic) wrote the analysis code, ran the computations, assisted with the literature search, and drafted and edited the text. The author takes full responsibility for the content.

Data and materials. Frequency tables for all pairs, aspects and orb conventions, decade tables, simulation summaries, episode statistics, the comparison with JPL Horizons, the independent recomputation and the analysis scripts are available at https://github.com/etruhla/twelvera-research (folder `aspect-base-rates`). The chart engine is proprietary; the positions it produced can be reproduced with the public libraries named in section 2.1.

Ethics and consent. The study uses no data about people.

Funding. No external funding.

Author contributions. The author is the sole author.

References

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society: Series B (Methodological), 57*(1), 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203771587

Daigno, S. (2026). Physical violence and Mars aspects to the fastest moving planets. *Correlation, 38*(2), 13–28. https://correlationjournal.com/physical-violence-and-mars-aspects-to-the-fastest-moving-planets/

Ertel, S., & Irving, K. (1996). *The tenacious Mars effect*. Urania Trust.

Hemerik, J., & Goeman, J. (2018). Exact testing with random permutations. *TEST, 27*(4), 811–825. https://doi.org/10.1007/s11749-017-0571-1

Koch, D., & Treindl, A. (n.d.). *Swiss Ephemeris* [Computer software]. Astrodienst. https://www.astro.com/swisseph/

Lilly, W. (1647). *Christian astrology*. London.

Martín, C., & Stedall, T. (2026). The gods of war: An extended statistical analysis of planetary alignments and the outbreak of war. *Correlation, 38*(2), 67–87. https://correlationjournal.com/the-gods-of-war-an-extended-statistical-analysis-of-planetary-alignments-and-the-outbreak-of-war/

Park, R. S., Folkner, W. M., Williams, J. G., & Boggs, D. H. (2021). The JPL planetary and lunar ephemerides DE440 and DE441. *The Astronomical Journal, 161*(3), Article 105. https://doi.org/10.3847/1538-3881/abd414

Phipson, B., & Smyth, G. K. (2010). Permutation P-values should never be zero: Calculating exact P-values when permutations are randomly drawn. *Statistical Applications in Genetics and Molecular Biology, 9*(1), Article 39. https://doi.org/10.2202/1544-6115.1585

Rhodes, B. (2019). *Skyfield: High precision research-grade positions for planets and Earth satellites generator* [Computer software]. Astrophysics Source Code Library, ascl:1907.024. https://ascl.net/1907.024

Ruis, J. (2008). Statistical analysis of the birth charts of serial killers. *Correlation, 25*(2), 7–44. https://www.nvwoa.nl/txt/ruisen.pdf

Startup, M. J. (1984). *The validity of astrological theory as applied to personality, with special reference to the angular separation between planets* [Doctoral thesis, Goldsmiths, University of London]. https://doi.org/10.25602/GOLD.00028954

Startup, M. (1985). The astrological doctrine of 'aspects': A failure to validate with personality measures. *British Journal of Social Psychology, 24*(4), 307–315. https://doi.org/10.1111/j.2044-8309.1985.tb00693.x

Virtanen, P., Gommers, R., Oliphant, T. E., Haberland, M., Reddy, T., Cournapeau, D., Burovski, E., Peterson, P., Weckesser, W., Bright, J., van der Walt, S. J., Brett, M., Wilson, J., Millman, K. J., Mayorov, N., Nelson, A. R. J., Jones, E., Kern, R., Larson, E., … SciPy 1.0 Contributors. (2020). SciPy 1.0: Fundamental algorithms for scientific computing in Python. *Nature Methods, 17*(3), 261–272. https://doi.org/10.1038/s41592-019-0686-2

Tables

Table 1

Pair-and-aspect combinations whose observed share of time in orb differs from the uniform expectation, 1900–2100

Orb convention	Aspect set	Combinations	O/E outside 0.9–1.1	Whole 95% interval outside 0.9–1.1	Never observed (O = 0)
Moiety orbs	Five major	225	57 (25.3%)	33	13
Moiety orbs	All nine	405	103 (25.4%)	64	21
Uniform 8° (2° minor)	Five major	225	56 (24.9%)	33	13
Uniform 8° (2° minor)	All nine	405	112 (27.7%)	63	22
Narrow 3° (1° minor)	Five major	225	63 (28.0%)	32	13
Narrow 3° (1° minor)	All nine	405	128 (31.6%)	62	22

Note. O = observed share of 73,414 daily samples in orb; E = share expected if the angular separation were uniformly distributed; intervals from a block bootstrap over calendar years.

Table 2

The twenty largest departures from the uniform expectation, moiety orbs, major aspects

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E (95% interval)	Cause
Sun–Venus	Sextile	12.5	0.00	13.89	0.00 –	Elongation limit
Sun–Venus	Square	12.5	0.00	13.89	0.00 –	Elongation limit
Sun–Venus	Trine	12.5	0.00	13.89	0.00 –	Elongation limit
Sun–Mercury	Sextile	12	0.00	13.33	0.00 –	Elongation limit
Sun–Mercury	Square	12	0.00	13.33	0.00 –	Elongation limit
Sun–Mercury	Trine	12	0.00	13.33	0.00 –	Elongation limit
Mercury–Venus	Square	7.5	0.00	8.33	0.00 –	Elongation limit
Mercury–Venus	Trine	7.5	0.00	8.33	0.00 –	Elongation limit
Sun–Venus	Opposition	12.5	0.00	6.94	0.00 –	Elongation limit
Sun–Mercury	Opposition	12	0.00	6.67	0.00 –	Elongation limit
Mercury–Venus	Opposition	7.5	0.00	4.17	0.00 –	Elongation limit
Neptune–Pluto	Conjunction	5	0.00	2.78	0.00 –	Long cycle
Neptune–Pluto	Opposition	5	0.00	2.78	0.00 –	Long cycle
Neptune–Pluto	Sextile	5	33.44	5.56	6.02 (5.00–7.12)	Long cycle
Sun–Mercury	Conjunction	12	36.41	6.67	5.46 (5.41–5.51)	Elongation limit
Mercury–Venus	Conjunction	7.5	12.59	4.17	3.02 (2.78–3.25)	Elongation limit

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E (95% interval)	Cause
Sun–Mars	Opposition	12.25	2.34	6.81	0.34 (0.30–0.39)	Retrograde motion
Venus–Mars	Opposition	7.75	1.51	4.31	0.35 (0.30–0.41)	Retrograde motion, inner planet near the Sun
Sun–Venus	Conjunction	12.5	19.29	6.94	2.78 (2.60–2.97)	Elongation limit
Mercury–Mars	Opposition	7.25	1.47	4.03	0.36 (0.29–0.45)	Retrograde motion, inner planet near the Sun

Note. Ranked by the absolute logarithm of O/E; combinations that never occurred come first. Intervals for the Neptune–Pluto pair understate the uncertainty because the period covers less than one cycle of the pair.

Table 3

Share of tests with p < .05 in simulated studies with no effect (per cent), moiety orbs

Baseline	Window (years)	N = 100	N = 300	N = 1,000	N = 3,000
K1 uniform expectation	10	20.7	33.0	42.9	53.0
K1 uniform expectation	20	16.6	26.2	34.8	44.0
K1 uniform expectation	40	14.6	21.7	28.2	36.8
K1 uniform expectation	80	13.1	19.0	24.6	32.4
K1 uniform expectation	200	11.7	16.1	20.9	26.8
K2 long-term empirical rate	10	13.9	22.4	30.5	40.2
K2 long-term empirical rate	20	9.7	15.4	21.4	28.9
K2 long-term empirical rate	40	7.7	10.5	14.1	20.0
K2 long-term empirical rate	80	6.0	8.0	10.4	15.1
K2 long-term empirical rate	200	3.7	4.1	4.4	4.6
K3 same-window empirical rate	10	3.4	3.7	4.0	4.0
K3 same-window empirical rate	20	3.5	3.8	4.1	4.2
K3 same-window empirical rate	40	3.6	3.9	4.2	4.3
K3 same-window empirical rate	80	3.6	4.0	4.3	4.4
K3 same-window empirical rate	200	3.7	4.1	4.3	4.5
K4 shuffled components	10	1.9	2.3	2.4	2.5
K4 shuffled components	20	2.2	2.6	2.9	3.0
K4 shuffled components	40	2.5	2.8	3.1	3.2
K4 shuffled components	80	2.6	3.0	3.2	3.4
K4 shuffled components	200	2.6	3.1	3.3	3.4

Note. Each cell is based on 2,000 simulated studies with 225 tests each. N = number of births per study; window = length of the range of birth years. The nominal level is 5%.

Table 4

The five combinations with the highest combined rejection rate under the uniform and long-term baselines

Pair and aspect	Expected, uniform (% of days)	Long-term rate, 1900–2100 (% of days)	K1	K2	K3	K4
Neptune–Pluto sextile	5.56	33.45	98.3	75.9	3.6	0.2
Neptune–Pluto trine	5.56	4.19	86.5	79.6	1.2	0.0
Neptune–Pluto square	5.56	4.71	82.0	78.8	1.7	0.1
Uranus–Neptune opposition	2.78	5.22	75.9	76.1	1.6	0.1
Uranus–Pluto sextile	5.56	6.58	74.4	66.8	2.9	0.1

Note. Combinations are ranked by the sum of columns K1 and K2. Columns K1–K4 give the share of simulated studies in which the test of this combination had p < .05 (per cent), averaged over the 20 combinations of window length and sample size; moiety orbs.

Table 5

Length of stay within orb for selected pairs, moiety orbs, 1900–2100

Pair and aspect	Orb (degrees)	Episodes	Median length (days)	90th percentile (days)	Merged episodes: median / 90th percentile (days)	Merged episodes with three or more exact passes
Sun–Moon conjunction	14.75	2485	2.4	2.7	–	0%
Moon–Saturn square	11.25	5360	1.7	1.9	–	0%
Sun–Saturn conjunction	13.5	194	31.2	32.6	–	0%
Sun–Mars conjunction	12.25	94	83.8	109.6	–	0%
Jupiter–Saturn conjunction	11	12	420.8	467.9	422.5 / 680.9 (n = 10)	20%
Jupiter–Saturn square	11	51	134.8	397.8	701.0 / 977.3 (n = 20)	80%
Saturn–Pluto square	6	32	123.3	220.1	662.8 / 682.3 (n = 12)	58%
Uranus–Neptune square	5	11	195.3	822.9	2301.7 / 2425.4 (n = 2)	100%

Note. An episode runs from entry into the orb to exit. For pairs without the Sun or Moon, consecutive episodes on the same side of the exact angle separated by less than one year or half the mean synodic period are also reported merged; the merging threshold is a heuristic.

Figures

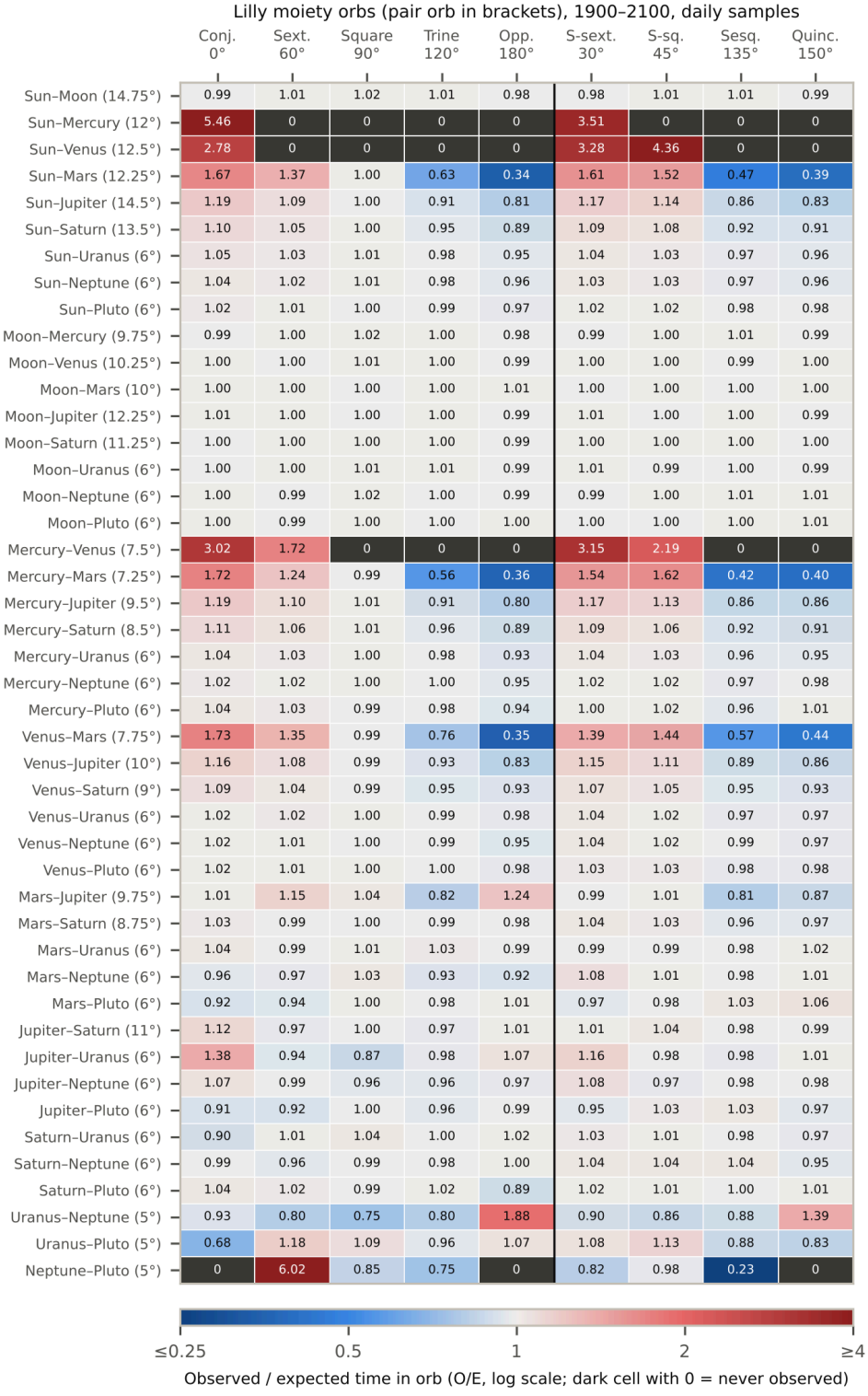


Figure 1. Ratio of observed to uniformly expected share of time in orb (O/E) for 45 pairs and nine aspects, moiety orbs, 1900–2100. The orb of each pair is given in brackets. Dark cells marked 0 are combinations that never occurred. With nine aspects an angle inside two overlapping windows goes to the nearer aspect, so a few ratios for major aspects differ slightly from the five-aspect analysis in Supplementary Table S5.

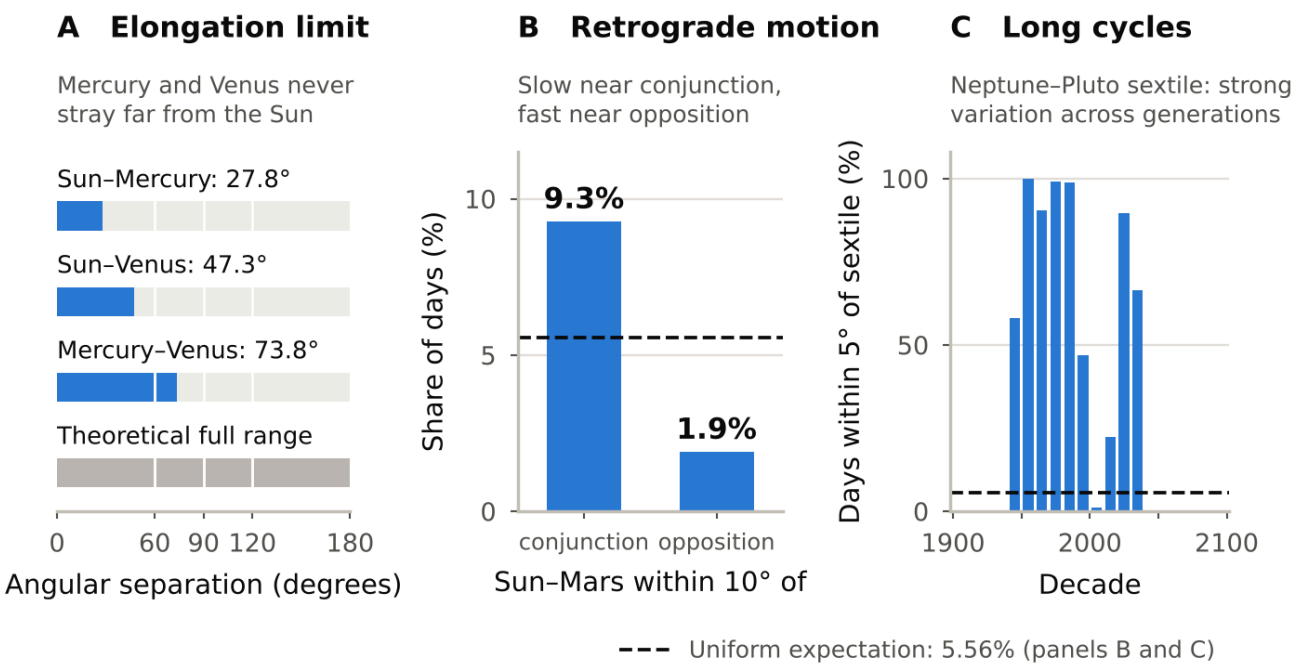


Figure 2. Three causes of non-uniform aspect frequencies, 1900–2100. A: the largest angular separation observed in the daily data between the Sun, Mercury and Venus, against the full range of 180°; white marks show 60°, 90° and 120°. B: share of days on which the Sun and Mars were within 10° of conjunction and of opposition. C: share of days in each decade on which Neptune and Pluto were within the moiety orb (5°) of a sextile. Dashed lines mark the uniform expectation.

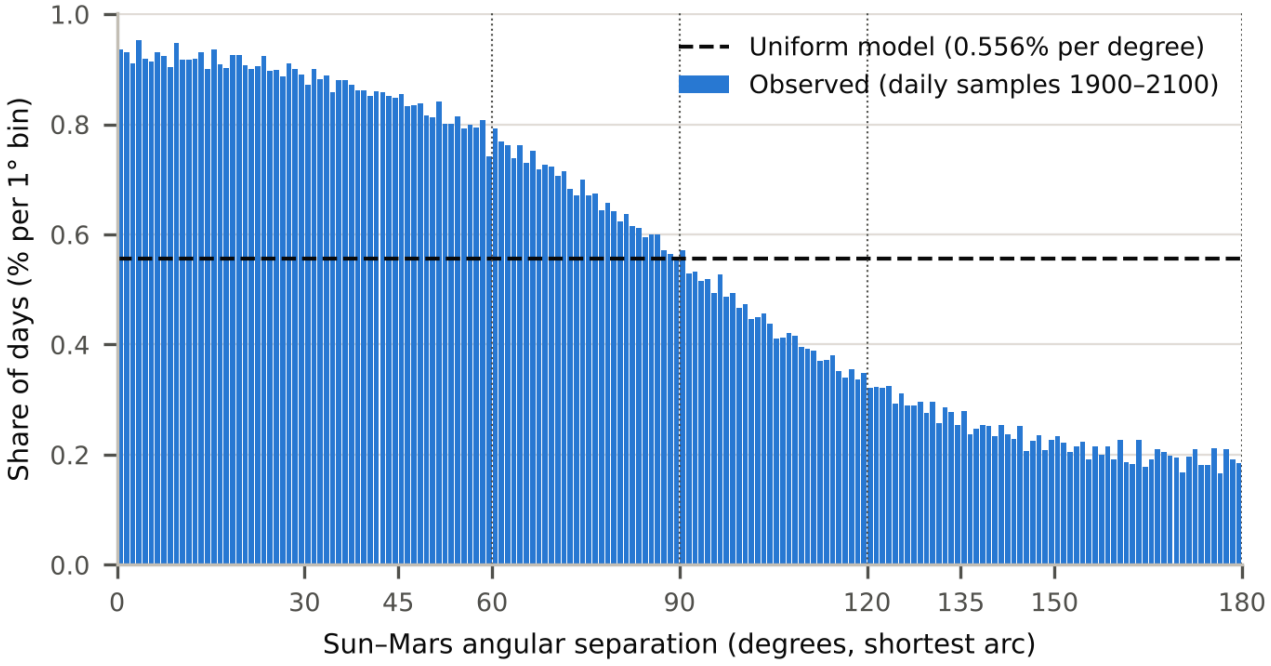


Figure 3. Distribution of the angle between the Sun and Mars in daily samples, 1900–2100, in bins of 1°, against the uniform model.

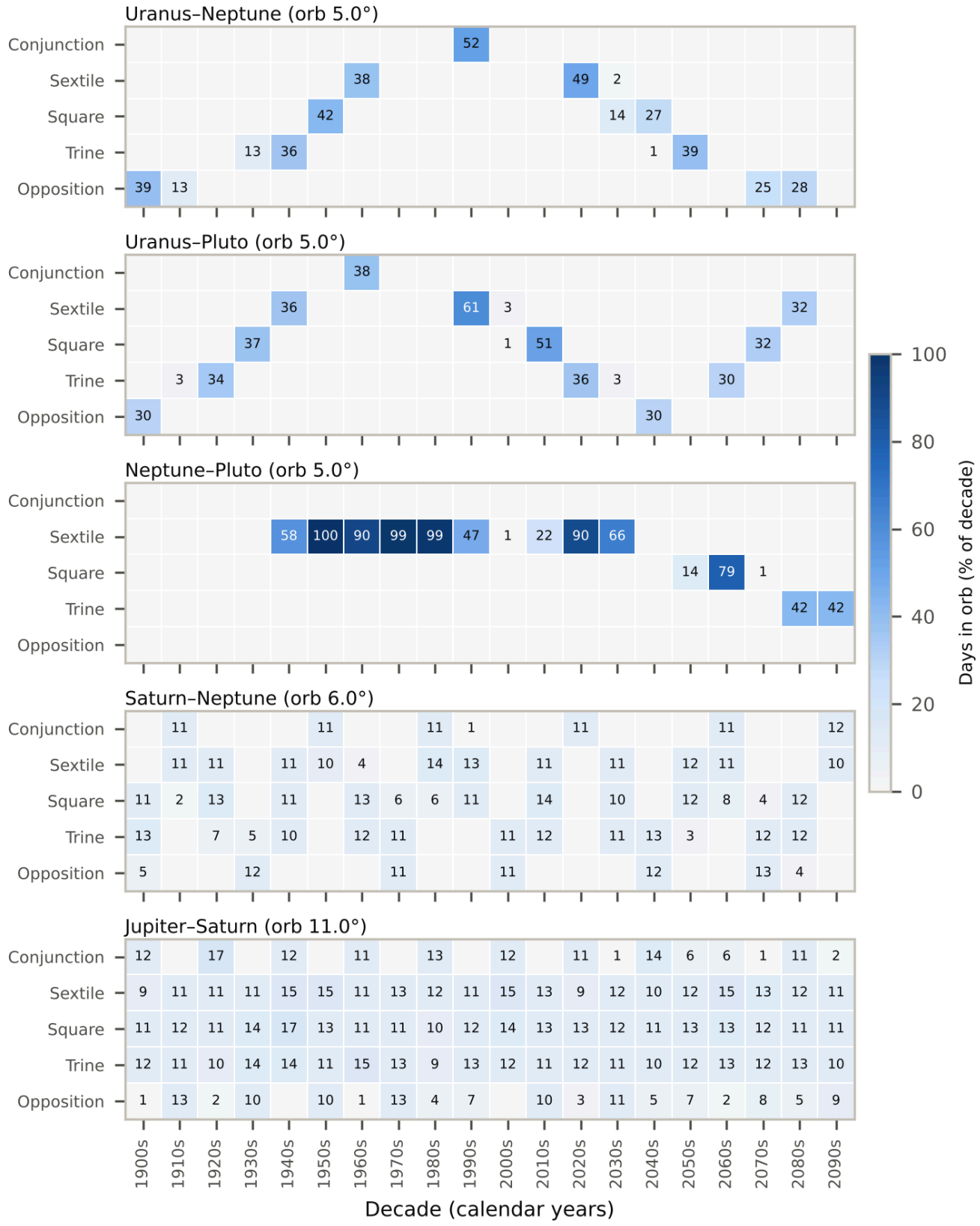


Figure 4. Share of days within orb of each major aspect by decade for five slow pairs, moiety orbs. Empty cells are zero.

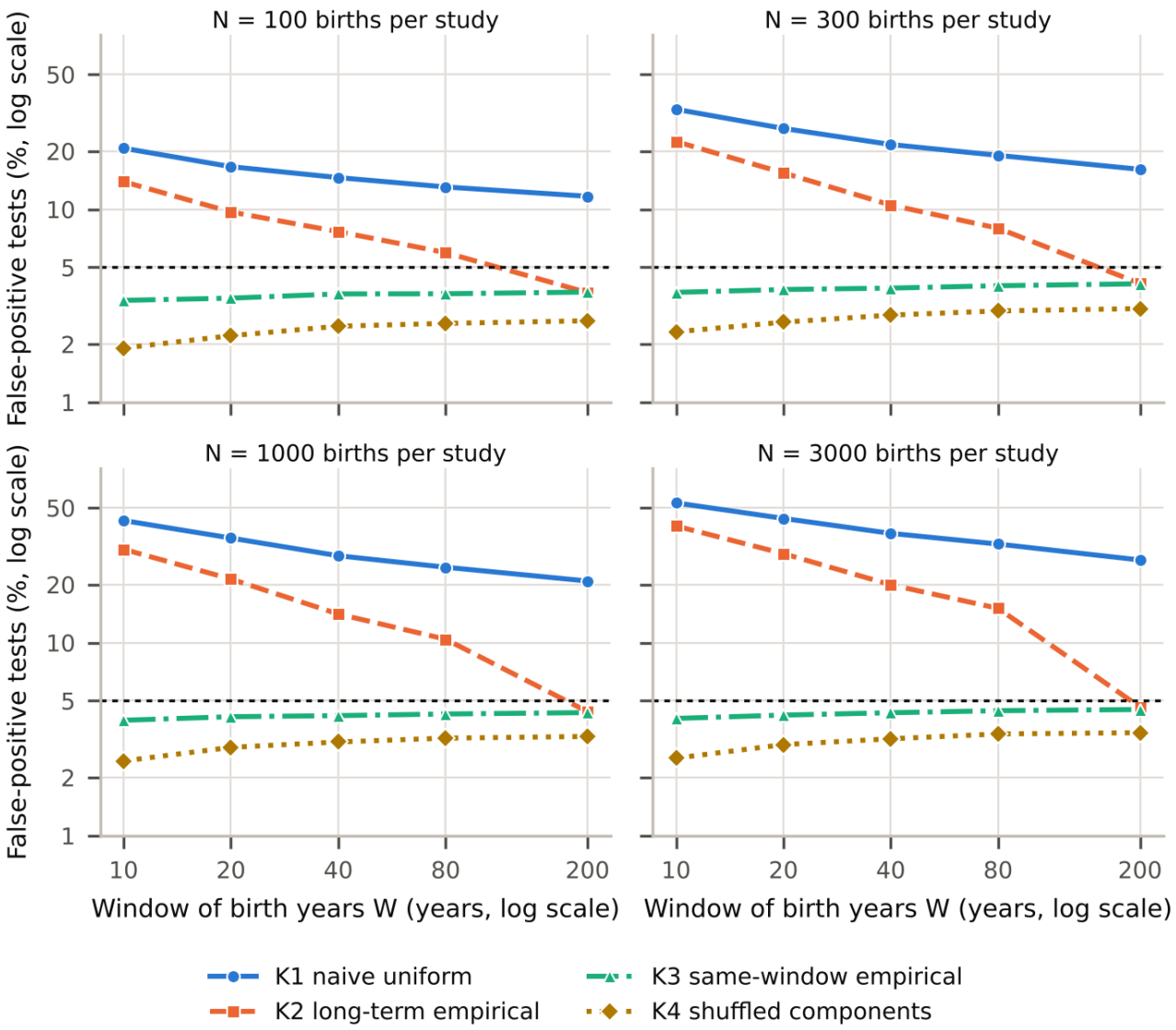


Figure 5. Share of tests with p < .05 in simulated studies with no effect, by length of the window of birth years, sample size and baseline; moiety orbs. The dotted line marks the nominal 5%. Both axes are logarithmic.

Supplementary tables

Table S1

Share of tests with p < .05 in simulated studies with no effect (per cent), uniform 8° orb

Baseline	Window (years)	N = 100	N = 300	N = 1,000	N = 3,000
K1 uniform expectation	10	26.7	32.9	42.5	52.4
K1 uniform expectation	20	21.5	26.4	34.5	43.4
K1 uniform expectation	40	18.1	21.8	28.0	36.2
K1 uniform expectation	80	16.0	19.2	24.5	32.0
K1 uniform expectation	200	13.6	16.2	20.7	26.0
K2 long-term empirical rate	10	17.4	22.4	30.6	40.1
K2 long-term empirical rate	20	12.1	15.7	21.6	29.3
K2 long-term empirical rate	40	9.0	10.8	14.5	20.5
K2 long-term empirical rate	80	6.9	8.3	11.1	16.0
K2 long-term empirical rate	200	4.0	4.0	4.4	4.7
K3 same-window empirical rate	10	3.4	3.7	3.9	4.0
K3 same-window empirical rate	20	3.5	3.9	4.0	4.3
K3 same-window empirical rate	40	3.7	4.0	4.2	4.3
K3 same-window empirical rate	80	3.8	4.0	4.3	4.4
K3 same-window empirical rate	200	4.0	4.0	4.3	4.5
K4 shuffled components	10	1.9	2.2	2.4	2.4
K4 shuffled components	20	2.2	2.6	2.7	2.9
K4 shuffled components	40	2.4	2.8	3.0	3.1
K4 shuffled components	80	2.6	2.9	3.2	3.3
K4 shuffled components	200	2.7	3.1	3.2	3.4

Note. As Table 3, with a uniform orb of 8° for all pairs.

Table S2

Simulated studies with at least one of 225 tests at p < .05 (per cent), moiety orbs

Baseline	Window (years)	N = 100	N = 300	N = 1,000	N = 3,000
K1 uniform expectation	10	100.0	100.0	100.0	100.0
K1 uniform expectation	20	100.0	100.0	100.0	100.0
K1 uniform expectation	40	100.0	100.0	100.0	100.0
K1 uniform expectation	80	100.0	100.0	100.0	100.0
K1 uniform expectation	200	100.0	100.0	100.0	100.0
K2 long-term empirical rate	10	100.0	100.0	100.0	100.0
K2 long-term empirical rate	20	100.0	100.0	100.0	100.0
K2 long-term empirical rate	40	100.0	100.0	100.0	100.0
K2 long-term empirical rate	80	100.0	100.0	100.0	100.0
K2 long-term empirical rate	200	100.0	100.0	100.0	100.0
K3 same-window empirical rate	10	100.0	100.0	100.0	100.0
K3 same-window empirical rate	20	100.0	99.9	100.0	100.0
K3 same-window empirical rate	40	100.0	100.0	100.0	100.0
K3 same-window empirical rate	80	99.9	100.0	100.0	100.0
K3 same-window empirical rate	200	100.0	100.0	100.0	100.0
K4 shuffled components	10	98.1	99.1	99.4	99.6

Baseline	Window (years)	N = 100	N = 300	N = 1,000	N = 3,000
K4 shuffled components	20	99.0	99.7	99.8	99.8
K4 shuffled components	40	99.5	99.7	100.0	99.8
K4 shuffled components	80	99.6	100.0	100.0	100.0
K4 shuffled components	200	99.7	99.9	100.0	99.9

Note. No correction for multiple testing.

Table S3

Simulated studies with at least one discovery after the Benjamini–Hochberg procedure at 5% (per cent), moiety orbs

Baseline	Window (years)	N = 100	N = 300	N = 1,000	N = 3,000
K1 uniform expectation	10	100.0	100.0	100.0	100.0
K1 uniform expectation	20	100.0	100.0	100.0	100.0
K1 uniform expectation	40	100.0	100.0	100.0	100.0
K1 uniform expectation	80	100.0	100.0	100.0	100.0
K1 uniform expectation	200	100.0	100.0	100.0	100.0
K2 long-term empirical rate	10	100.0	100.0	100.0	100.0
K2 long-term empirical rate	20	100.0	100.0	100.0	100.0
K2 long-term empirical rate	40	86.1	100.0	100.0	100.0
K2 long-term empirical rate	80	62.7	99.8	100.0	100.0
K2 long-term empirical rate	200	2.2	4.1	4.4	5.3
K3 same-window empirical rate	10	2.6	3.1	3.7	3.4
K3 same-window empirical rate	20	1.9	4.0	3.7	3.9
K3 same-window empirical rate	40	3.3	4.3	4.2	4.7
K3 same-window empirical rate	80	2.7	3.8	3.9	4.7
K3 same-window empirical rate	200	2.2	4.1	4.3	4.9
K4 shuffled components	10	0.7	1.3	1.4	1.4
K4 shuffled components	20	1.0	1.9	2.5	1.6
K4 shuffled components	40	1.7	2.1	1.8	2.4
K4 shuffled components	80	1.4	1.8	2.6	2.8
K4 shuffled components	200	1.7	2.5	2.8	2.5

Note. The procedure was applied to the 225 tests of each study.

Table S4

Engine longitudes against JPL Horizons at 100 random instants

Body	Largest absolute difference (degrees)	Largest absolute difference (arcseconds)
Sun	0.0000577	0.208
Moon	0.0001213	0.437
Mercury	0.0000650	0.234
Venus	0.0000620	0.223
Mars	0.0000606	0.218
Jupiter	0.0000693	0.249
Saturn	0.0000716	0.258
Uranus	0.0000652	0.235
Neptune	0.0000660	0.238
Pluto	0.0000758	0.273

Note. Apparent geocentric ecliptic longitude of date. Horizons reports DE441 as its source; the engine uses DE442s.

Table S5

Observed and expected share of time in orb for all 225 combinations, moiety orbs, major aspects

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E	95% interval of O/E
Sun–Moon	Conjunction	14.75	8.08	8.19	0.99	0.97–1.00
Sun–Moon	Sextile	14.75	16.51	16.39	1.01	1.00–1.01
Sun–Moon	Square	14.75	16.66	16.39	1.02	1.01–1.02
Sun–Moon	Trine	14.75	16.56	16.39	1.01	1.00–1.02
Sun–Moon	Opposition	14.75	8.03	8.19	0.98	0.97–0.99
Sun–Mercury	Conjunction	12	36.41	6.67	5.46	5.41–5.51
Sun–Mercury	Sextile	12	0.00	13.33	0.00	0.00–0.00
Sun–Mercury	Square	12	0.00	13.33	0.00	0.00–0.00
Sun–Mercury	Trine	12	0.00	13.33	0.00	0.00–0.00
Sun–Mercury	Opposition	12	0.00	6.67	0.00	0.00–0.00
Sun–Venus	Conjunction	12.5	19.29	6.94	2.78	2.60–2.97
Sun–Venus	Sextile	12.5	0.00	13.89	0.00	0.00–0.00
Sun–Venus	Square	12.5	0.00	13.89	0.00	0.00–0.00
Sun–Venus	Trine	12.5	0.00	13.89	0.00	0.00–0.00
Sun–Venus	Opposition	12.5	0.00	6.94	0.00	0.00–0.00
Sun–Mars	Conjunction	12.25	11.35	6.81	1.67	1.46–1.89
Sun–Mars	Sextile	12.25	18.92	13.61	1.39	1.34–1.44
Sun–Mars	Square	12.25	13.63	13.61	1.00	0.91–1.09
Sun–Mars	Trine	12.25	8.22	13.61	0.60	0.53–0.68
Sun–Mars	Opposition	12.25	2.34	6.81	0.34	0.30–0.39
Sun–Jupiter	Conjunction	14.5	9.59	8.06	1.19	1.14–1.23
Sun–Jupiter	Sextile	14.5	17.66	16.11	1.10	1.07–1.12
Sun–Jupiter	Square	14.5	16.10	16.11	1.00	0.98–1.02
Sun–Jupiter	Trine	14.5	14.54	16.11	0.90	0.88–0.92
Sun–Jupiter	Opposition	14.5	6.54	8.06	0.81	0.79–0.84
Sun–Saturn	Conjunction	13.5	8.27	7.50	1.10	1.08–1.12
Sun–Saturn	Sextile	13.5	15.80	15.00	1.05	1.04–1.06
Sun–Saturn	Square	13.5	15.01	15.00	1.00	0.99–1.01
Sun–Saturn	Trine	13.5	14.20	15.00	0.95	0.94–0.96
Sun–Saturn	Opposition	13.5	6.71	7.50	0.89	0.88–0.91
Sun–Uranus	Conjunction	6	3.49	3.33	1.05	1.03–1.06
Sun–Uranus	Sextile	6	6.86	6.67	1.03	1.02–1.04
Sun–Uranus	Square	6	6.70	6.67	1.01	1.00–1.01
Sun–Uranus	Trine	6	6.53	6.67	0.98	0.97–0.99
Sun–Uranus	Opposition	6	3.18	3.33	0.95	0.94–0.97
Sun–Neptune	Conjunction	6	3.47	3.33	1.04	1.03–1.05
Sun–Neptune	Sextile	6	6.82	6.67	1.02	1.02–1.03
Sun–Neptune	Square	6	6.71	6.67	1.01	1.00–1.01
Sun–Neptune	Trine	6	6.54	6.67	0.98	0.97–0.99
Sun–Neptune	Opposition	6	3.20	3.33	0.96	0.95–0.97
Sun–Pluto	Conjunction	6	3.41	3.33	1.02	1.02–1.03
Sun–Pluto	Sextile	6	6.73	6.67	1.01	1.00–1.01

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E	95% interval of O/E
Sun–Pluto	Square	6	6.65	6.67	1.00	0.99–1.00
Sun–Pluto	Trine	6	6.59	6.67	0.99	0.98–0.99
Sun–Pluto	Opposition	6	3.24	3.33	0.97	0.96–0.98
Moon–Mercury	Conjunction	9.75	5.34	5.42	0.99	0.97–1.00
Moon–Mercury	Sextile	9.75	10.85	10.83	1.00	0.99–1.01
Moon–Mercury	Square	9.75	11.01	10.83	1.02	1.01–1.03
Moon–Mercury	Trine	9.75	10.93	10.83	1.01	1.00–1.02
Moon–Mercury	Opposition	9.75	5.33	5.42	0.98	0.97–1.00
Moon–Venus	Conjunction	10.25	5.70	5.69	1.00	0.98–1.01
Moon–Venus	Sextile	10.25	11.44	11.39	1.00	0.99–1.01
Moon–Venus	Square	10.25	11.55	11.39	1.01	1.00–1.03
Moon–Venus	Trine	10.25	11.41	11.39	1.00	0.99–1.01
Moon–Venus	Opposition	10.25	5.62	5.69	0.99	0.97–1.00
Moon–Mars	Conjunction	10	5.56	5.56	1.00	0.98–1.02
Moon–Mars	Sextile	10	11.10	11.11	1.00	0.99–1.01
Moon–Mars	Square	10	11.11	11.11	1.00	0.99–1.01
Moon–Mars	Trine	10	11.13	11.11	1.00	0.99–1.01
Moon–Mars	Opposition	10	5.59	5.56	1.01	0.99–1.02
Moon–Jupiter	Conjunction	12.25	6.85	6.81	1.01	0.99–1.02
Moon–Jupiter	Sextile	12.25	13.66	13.61	1.00	0.99–1.01
Moon–Jupiter	Square	12.25	13.56	13.61	1.00	0.99–1.00
Moon–Jupiter	Trine	12.25	13.65	13.61	1.00	0.99–1.01
Moon–Jupiter	Opposition	12.25	6.71	6.81	0.99	0.97–1.00
Moon–Saturn	Conjunction	11.25	6.24	6.25	1.00	0.98–1.02
Moon–Saturn	Sextile	11.25	12.55	12.50	1.00	0.99–1.02
Moon–Saturn	Square	11.25	12.56	12.50	1.00	1.00–1.01
Moon–Saturn	Trine	11.25	12.46	12.50	1.00	0.99–1.01
Moon–Saturn	Opposition	11.25	6.20	6.25	0.99	0.97–1.01
Moon–Uranus	Conjunction	6	3.33	3.33	1.00	0.97–1.03
Moon–Uranus	Sextile	6	6.67	6.67	1.00	0.98–1.02
Moon–Uranus	Square	6	6.74	6.67	1.01	0.99–1.03
Moon–Uranus	Trine	6	6.71	6.67	1.01	0.99–1.02
Moon–Uranus	Opposition	6	3.30	3.33	0.99	0.96–1.02
Moon–Neptune	Conjunction	6	3.34	3.33	1.00	0.98–1.03
Moon–Neptune	Sextile	6	6.60	6.67	0.99	0.97–1.01
Moon–Neptune	Square	6	6.78	6.67	1.02	1.00–1.03
Moon–Neptune	Trine	6	6.66	6.67	1.00	0.98–1.02
Moon–Neptune	Opposition	6	3.30	3.33	0.99	0.96–1.02
Moon–Pluto	Conjunction	6	3.34	3.33	1.00	0.98–1.03
Moon–Pluto	Sextile	6	6.59	6.67	0.99	0.97–1.01
Moon–Pluto	Square	6	6.68	6.67	1.00	0.98–1.02
Moon–Pluto	Trine	6	6.64	6.67	1.00	0.97–1.01
Moon–Pluto	Opposition	6	3.35	3.33	1.00	0.98–1.03
Mercury–Venus	Conjunction	7.5	12.59	4.17	3.02	2.78–3.25
Mercury–Venus	Sextile	7.5	14.32	8.33	1.72	1.59–1.84
Mercury–Venus	Square	7.5	0.00	8.33	0.00	0.00–0.00
Mercury–Venus	Trine	7.5	0.00	8.33	0.00	0.00–0.00
Mercury–Venus	Opposition	7.5	0.00	4.17	0.00	0.00–0.00

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E	95% interval of O/E
Mercury–Mars	Conjunction	7.25	6.95	4.03	1.72	1.53–1.93
Mercury–Mars	Sextile	7.25	10.00	8.06	1.24	1.19–1.29
Mercury–Mars	Square	7.25	8.01	8.06	0.99	0.90–1.09
Mercury–Mars	Trine	7.25	4.51	8.06	0.56	0.48–0.65
Mercury–Mars	Opposition	7.25	1.47	4.03	0.36	0.29–0.45
Mercury–Jupiter	Conjunction	9.5	6.30	5.28	1.19	1.08–1.31
Mercury–Jupiter	Sextile	9.5	11.67	10.56	1.11	1.02–1.19
Mercury–Jupiter	Square	9.5	10.61	10.56	1.01	0.93–1.08
Mercury–Jupiter	Trine	9.5	9.50	10.56	0.90	0.82–0.99
Mercury–Jupiter	Opposition	9.5	4.24	5.28	0.80	0.71–0.90
Mercury–Saturn	Conjunction	8.5	5.24	4.72	1.11	1.00–1.22
Mercury–Saturn	Sextile	8.5	9.99	9.44	1.06	0.95–1.16
Mercury–Saturn	Square	8.5	9.56	9.44	1.01	0.94–1.09
Mercury–Saturn	Trine	8.5	9.02	9.44	0.96	0.87–1.05
Mercury–Saturn	Opposition	8.5	4.22	4.72	0.89	0.80–0.99
Mercury–Uranus	Conjunction	6	3.47	3.33	1.04	0.92–1.17
Mercury–Uranus	Sextile	6	6.89	6.67	1.03	0.92–1.16
Mercury–Uranus	Square	6	6.68	6.67	1.00	0.93–1.08
Mercury–Uranus	Trine	6	6.55	6.67	0.98	0.88–1.10
Mercury–Uranus	Opposition	6	3.11	3.33	0.93	0.82–1.05
Mercury–Neptune	Conjunction	6	3.41	3.33	1.02	0.90–1.15
Mercury–Neptune	Sextile	6	6.77	6.67	1.02	0.90–1.13
Mercury–Neptune	Square	6	6.70	6.67	1.00	0.93–1.08
Mercury–Neptune	Trine	6	6.65	6.67	1.00	0.89–1.11
Mercury–Neptune	Opposition	6	3.18	3.33	0.95	0.84–1.07
Mercury–Pluto	Conjunction	6	3.46	3.33	1.04	0.91–1.17
Mercury–Pluto	Sextile	6	6.84	6.67	1.03	0.91–1.14
Mercury–Pluto	Square	6	6.60	6.67	0.99	0.92–1.06
Mercury–Pluto	Trine	6	6.52	6.67	0.98	0.88–1.09
Mercury–Pluto	Opposition	6	3.14	3.33	0.94	0.84–1.04
Venus–Mars	Conjunction	7.75	7.44	4.31	1.73	1.51–1.96
Venus–Mars	Sextile	7.75	11.67	8.61	1.36	1.25–1.47
Venus–Mars	Square	7.75	8.57	8.61	0.99	0.90–1.10
Venus–Mars	Trine	7.75	6.57	8.61	0.76	0.66–0.88
Venus–Mars	Opposition	7.75	1.51	4.31	0.35	0.30–0.41
Venus–Jupiter	Conjunction	10	6.42	5.56	1.16	1.04–1.28
Venus–Jupiter	Sextile	10	12.02	11.11	1.08	1.01–1.16
Venus–Jupiter	Square	10	11.01	11.11	0.99	0.92–1.06
Venus–Jupiter	Trine	10	10.31	11.11	0.93	0.86–1.00
Venus–Jupiter	Opposition	10	4.61	5.56	0.83	0.75–0.92
Venus–Saturn	Conjunction	9	5.43	5.00	1.09	0.98–1.20

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E	95% interval of O/E
Venus–Saturn	Sextile	9	10.48	10.00	1.05	0.97–1.13
Venus–Saturn	Square	9	9.93	10.00	0.99	0.93–1.06
Venus–Saturn	Trine	9	9.46	10.00	0.95	0.88–1.01
Venus–Saturn	Opposition	9	4.64	5.00	0.93	0.83–1.03
Venus–Uranus	Conjunction	6	3.40	3.33	1.02	0.92–1.13
Venus–Uranus	Sextile	6	6.83	6.67	1.02	0.96–1.10
Venus–Uranus	Square	6	6.67	6.67	1.00	0.93–1.08
Venus–Uranus	Trine	6	6.60	6.67	0.99	0.92–1.07
Venus–Uranus	Opposition	6	3.26	3.33	0.98	0.86–1.09
Venus–Neptune	Conjunction	6	3.41	3.33	1.02	0.91–1.14
Venus–Neptune	Sextile	6	6.71	6.67	1.01	0.93–1.09
Venus–Neptune	Square	6	6.64	6.67	1.00	0.93–1.07
Venus–Neptune	Trine	6	6.59	6.67	0.99	0.92–1.07
Venus–Neptune	Opposition	6	3.16	3.33	0.95	0.84–1.07
Venus–Pluto	Conjunction	6	3.38	3.33	1.02	0.91–1.14
Venus–Pluto	Sextile	6	6.71	6.67	1.01	0.94–1.09
Venus–Pluto	Square	6	6.69	6.67	1.00	0.93–1.09
Venus–Pluto	Trine	6	6.65	6.67	1.00	0.92–1.07
Venus–Pluto	Opposition	6	3.26	3.33	0.98	0.87–1.09
Mars–Jupiter	Conjunction	9.75	5.48	5.42	1.01	0.85–1.19
Mars–Jupiter	Sextile	9.75	12.43	10.83	1.15	1.01–1.29
Mars–Jupiter	Square	9.75	11.30	10.83	1.04	0.94–1.15
Mars–Jupiter	Trine	9.75	8.96	10.83	0.83	0.73–0.92
Mars–Jupiter	Opposition	9.75	6.69	5.42	1.24	0.99–1.48
Mars–Saturn	Conjunction	8.75	5.01	4.86	1.03	0.88–1.21
Mars–Saturn	Sextile	8.75	9.67	9.72	0.99	0.89–1.11
Mars–Saturn	Square	8.75	9.71	9.72	1.00	0.89–1.10
Mars–Saturn	Trine	8.75	9.58	9.72	0.98	0.87–1.10
Mars–Saturn	Opposition	8.75	4.78	4.86	0.98	0.81–1.18
Mars–Uranus	Conjunction	6	3.47	3.33	1.04	0.85–1.25
Mars–Uranus	Sextile	6	6.59	6.67	0.99	0.88–1.11
Mars–Uranus	Square	6	6.72	6.67	1.01	0.90–1.12
Mars–Uranus	Trine	6	6.86	6.67	1.03	0.91–1.15
Mars–Uranus	Opposition	6	3.29	3.33	0.99	0.82–1.17
Mars–Neptune	Conjunction	6	3.19	3.33	0.96	0.82–1.09
Mars–Neptune	Sextile	6	6.47	6.67	0.97	0.88–1.06
Mars–Neptune	Square	6	6.90	6.67	1.03	0.93–1.16
Mars–Neptune	Trine	6	6.19	6.67	0.93	0.83–1.03
Mars–Neptune	Opposition	6	3.06	3.33	0.92	0.76–1.10
Mars–Pluto	Conjunction	6	3.07	3.33	0.92	0.79–1.07
Mars–Pluto	Sextile	6	6.28	6.67	0.94	0.86–1.03
Mars–Pluto	Square	6	6.69	6.67	1.00	0.89–1.12
Mars–Pluto	Trine	6	6.55	6.67	0.98	0.87–1.10
Mars–Pluto	Opposition	6	3.37	3.33	1.01	0.83–1.22
Jupiter–Saturn	Conjunction	11	6.84	6.11	1.12	0.65–1.70
Jupiter–Saturn	Sextile	11	12.06	12.22	0.99	0.73–1.28
Jupiter–Saturn	Square	11	12.16	12.22	1.00	0.75–1.28
Jupiter–Saturn	Trine	11	11.86	12.22	0.97	0.75–1.21

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E	95% interval of O/E
Jupiter–Saturn	Opposition	11	6.17	6.11	1.01	0.67–1.36
Jupiter–Uranus	Conjunction	6	4.61	3.33	1.38	0.81–2.03
Jupiter–Uranus	Sextile	6	6.25	6.67	0.94	0.65–1.24
Jupiter–Uranus	Square	6	5.78	6.67	0.87	0.61–1.16
Jupiter–Uranus	Trine	6	6.52	6.67	0.98	0.71–1.26
Jupiter–Uranus	Opposition	6	3.57	3.33	1.07	0.66–1.49
Jupiter–Neptune	Conjunction	6	3.57	3.33	1.07	0.62–1.52
Jupiter–Neptune	Sextile	6	6.58	6.67	0.99	0.71–1.27
Jupiter–Neptune	Square	6	6.41	6.67	0.96	0.68–1.28
Jupiter–Neptune	Trine	6	6.43	6.67	0.96	0.70–1.25
Jupiter–Neptune	Opposition	6	3.24	3.33	0.97	0.55–1.42
Jupiter–Pluto	Conjunction	6	3.03	3.33	0.91	0.53–1.36
Jupiter–Pluto	Sextile	6	6.16	6.67	0.92	0.67–1.24
Jupiter–Pluto	Square	6	6.65	6.67	1.00	0.69–1.30
Jupiter–Pluto	Trine	6	6.41	6.67	0.96	0.69–1.26
Jupiter–Pluto	Opposition	6	3.31	3.33	0.99	0.59–1.44
Saturn–Uranus	Conjunction	6	3.01	3.33	0.90	0.38–1.48
Saturn–Uranus	Sextile	6	6.74	6.67	1.01	0.63–1.41
Saturn–Uranus	Square	6	6.93	6.67	1.04	0.70–1.44
Saturn–Uranus	Trine	6	6.64	6.67	1.00	0.67–1.34
Saturn–Uranus	Opposition	6	3.39	3.33	1.02	0.55–1.53
Saturn–Neptune	Conjunction	6	3.31	3.33	0.99	0.48–1.61
Saturn–Neptune	Sextile	6	6.40	6.67	0.96	0.61–1.35
Saturn–Neptune	Square	6	6.60	6.67	0.99	0.64–1.38
Saturn–Neptune	Trine	6	6.56	6.67	0.98	0.65–1.35
Saturn–Neptune	Opposition	6	3.34	3.33	1.00	0.49–1.55
Saturn–Pluto	Conjunction	6	3.45	3.33	1.04	0.50–1.65
Saturn–Pluto	Sextile	6	6.82	6.67	1.02	0.65–1.42
Saturn–Pluto	Square	6	6.63	6.67	0.99	0.64–1.36
Saturn–Pluto	Trine	6	6.77	6.67	1.02	0.68–1.40
Saturn–Pluto	Opposition	6	2.97	3.33	0.89	0.43–1.45
Uranus–Neptune	Conjunction	5	2.58	2.78	0.93	0.36–1.67
Uranus–Neptune	Sextile	5	4.45	5.56	0.80	0.41–1.27
Uranus–Neptune	Square	5	4.17	5.56	0.75	0.39–1.16
Uranus–Neptune	Trine	5	4.47	5.56	0.80	0.43–1.23
Uranus–Neptune	Opposition	5	5.21	2.78	1.88	1.04–2.80
Uranus–Pluto	Conjunction	5	1.89	2.78	0.68	0.18–1.33
Uranus–Pluto	Sextile	5	6.58	5.56	1.18	0.71–1.78

Pair	Aspect	Orb (degrees)	Observed (% of days)	Expected, uniform (% of days)	O/E	95% interval of O/E
Uranus–Pluto	Square	5	6.05	5.56	1.09	0.62–1.66
Uranus–Pluto	Trine	5	5.31	5.56	0.96	0.52–1.44
Uranus–Pluto	Opposition	5	2.98	2.78	1.07	0.47–1.81
Neptune–Pluto	Conjunction	5	0.00	2.78	0.00	0.00–0.00
Neptune–Pluto	Sextile	5	33.44	5.56	6.02	5.00–7.12
Neptune–Pluto	Square	5	4.71	5.56	0.85	0.40–1.32
Neptune–Pluto	Trine	5	4.19	5.56	0.75	0.36–1.24
Neptune–Pluto	Opposition	5	0.00	2.78	0.00	0.00–0.00

Note. Intervals from a block bootstrap over calendar years; for pairs of slow planets they understate the uncertainty.

Table S6

Share of tests with p < .05 for three variants of the shuffled control (per cent), moiety orbs

Window (years)	Sample size	K4: own sample, Fisher exact test	K4i: independent sample, Fisher exact test	K4p: own sample, Monte Carlo test	K3 same-window rate (main simulation)
10	100	1.9	4.7	2.9	3.4
10	300	2.2	5.1	3.2	3.7
20	100	2.2	4.6	2.9	3.5
20	300	2.7	5.1	3.4	3.8
40	100	2.4	4.7	3.0	3.6
40	300	2.9	5.2	3.5	3.9
80	100	2.6	4.8	3.1	3.6
80	300	3.0	5.2	3.6	4.0
200	100	2.6	4.9	3.2	3.7
200	300	3.1	5.4	3.6	4.1

Note. Follow-up simulation, 1,000 studies with no effect per row, 225 tests each. The control of K4 and K4i has ten times the size of the sample; K4p uses 199 shuffled copies of the sample and measures distance from the mean of all 200 counts.