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The validity of astrological predictions on marriage and divorce: a longitudinal analysis of Swedish register data

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Abstract

This paper examines astrology, a concept that is considered unscientific by broad segments of the population in the western world. Despite this, astrology remains for some an important source for advice regarding choices in a range of different matters, including career and relationships. The continuing popularity of astrology may at least partly be linked to an insufficient body of empirical research that has been able to test hypotheses formulated by astrological theory, both due to a lack of data beyond very small study populations as well as astrological predictions frequently being vague and thereby difficult to test. This article examines how differences in astrological favorability influence partner choice in marriage as well as the divorce risk among married couples using longitudinal individual-level data from Sweden over the period 1968–2001. The results fail to provide any consistent evidence to support the notion that astrologically more compatible couples are either overrepresented among observed marital unions or associated with a lower risk of divorce.

Keywords: Astrology, Marriage, Divorce, Longitudinal analysis

Introduction

Scientific progress has played a fundamental role in achieving the high standards of living that we currently enjoy. Undoubtedly, innovations and scientific discoveries accomplished by mankind have laid the foundation for progress that individuals with only one or two generations earlier could never have imagined. While most are likely to acknowledge the role of the scientific process for many of the innovations we today take for granted, nontrivial sections of populations across countries in the developed world are skeptical toward the scientific community and either unable or unwilling to weigh the merits of evidence accumulated from carefully designed empirical studies against anecdotal evidence or outlier observations. Recent examples that have attracted substantial media coverage include proponents of anti-vaccination campaigns and supporters of the view that global warming as a result of greenhouse gas emission is a hoax, not to mention current skepticism toward wearing a face mask to counteract the spread of an airborne virus during a global pandemic.



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Scientific literacy has been identified as greatly important for well-functioning nations and societies, with claims that populations that are more scientifically literate facilitate democratic societies to make informed and fair decisions about issues that are based on science (National Academies of Sciences, Engineering, and Medicine, 2016). The concept of scientific literacy roughly refers to individuals' ability to understand and interpret scientific findings, as well as the capacity to evaluate information on the basis of its source and the methods used to generate it (Miller, 1998). The concept of scientific literacy therefore represents an important societal characteristic, as the lack of it empowers decision-making based on opinions and emotions rather than refutable facts. This paper examines the validity of astrological predictions within the realm of romantic relationships, a concept that is met with considerable skepticism by the scientific community and sometimes viewed as synonymous with scientific illiteracy (Allum, 2011). It is, however, a phenomenon that has been embraced and consulted by sizeable audiences across the world for centuries. Indeed, astrology continues to offer advice to individuals about personal matters including relationships and career choices in books, on the internet, and in magazines and newspapers, possibly influencing the lives of its most devoted followers. Despite valuable contributions from previous research into the validity of astrological predictions, the bulk of it is based on very small and sometimes strongly selected samples. The main contribution of this article is its use of longitudinal individual-level data over the time period 1968-2001 for a large study population in Sweden to test to what extent predictions regarding couples' compatibility based on easily accessible astrology outlets are supported by empirical data. More specifically, this is done through examining to what extent favorable sun-sign combinations are reflected in marital partner choice, as well as analyzing its influence on the divorce risks of married couples. While recognizing our study's limitations, only examining Sweden and a small subset of the astrological predictions available, our results fail to provide any consistent support of the hypotheses tested.

Background

Ideas guided by astrological principles have existed in just about every human civilization, going back several millennia before the birth of Christ (Tester, 1989). The basic underlying concept is that the positioning of celestial objects at a time that is of significance to the individual influences fundamental aspects of their personality, motivations, wants, and needs. As a consequence, the astrologer, an individual trained to calculate the position of relevant objects and make an accurate reading will be able to make predictions or recommendations positively influencing individual well-being. Astrology represented an essential part of the culture of several ancient civilizations and was until comparatively recently considered to be a science. Western astrology goes back several centuries prior to the birth of Christ, with the birth of modern astrology being attributed to Ptolemy's *Tetrabiblos*, considered to be the earliest comprehensive textbook on astrology (Woolfolk, 2006). A key characteristic of western astrology is its horoscopic nature, implying that predictions can be made based on the positioning of the planets, and stars at a given point in time, typically at the individual's time of birth. From the end of the Roman Empire until today, the popularity of astrology among the general public in what is today the western world has varied considerably. It experienced a considerable resurgence among both intellectuals and the general public

during the Renaissance, while it came under increasing scrutiny during the age of Enlightenment. This was largely due to the scientific discoveries of—among others—Copernicus, Galileo, Kepler, and Newton, displacing the Earth from the center of the solar system as well as introducing a new understanding of physics.

In recent centuries, however, astrology has experienced a revival, again becoming widely popular and used primarily for entertainment, but in certain cases also with the intent to obtain guidance. Individuals in western countries are exposed to weekly or monthly horoscopes in just about every printed newspaper. Bogart (1989) reports that about 85% of American newspapers included an astrology column in 1987, a figure that is most likely very similar today. In addition, there is a plethora of horoscopes or other information related to astrology available on the internet as well as in books, for those who consider themselves to be more than a casual consumer. While data is scarce, and it is difficult to directly compare across different studies, the persistence of horoscopes in popular media confirms that the general public's consumption of astrology remains high. Maitre (1966) examined a sample of Parisians, showing that about 30% of those surveyed reported to be consumers of astrology. Some 20 years later, in the UK, in 1988, Bauer and Durant (1997) report that 73% of the adult population read horoscopes or astrology reports, with the majority doing so "fairly often" or "often." For the USA, in 1999, about half of the population surveyed for the 2000 Science and Engineering Indicators report claimed that they read their horoscope at least occasionally (National Science Board, 2000).

Existing data suggests that the majority of individuals who read horoscopes do so primarily for the entertainment value of it, with less than one of ten individuals in the UK, claiming that they take astrology reports "seriously" or "fairly seriously" (Bauer & Durant, 1997). More recent statistics from many different countries, however, indicate that the share of the population who look to horoscopes not only for entertainment but also believe them to have scientific value is considerably higher than what is suggested by the figure from the UK. A 2005 Gallup survey in the USA, for example, revealed that one-quarter of those interviewed believed that "astrology (...) can affect people's lives" (Lyons, 2005). This remains true even more recently, with 42% of Americans in 2012 claiming astrology is either "sort of scientific" or "very scientific" (National Science Board, 2014). Indeed, the same survey reports that the share rejecting astrology as "not at all scientific" in 2012 was at its lowest point since 1983. Another interesting observation from the US survey that has also been reported from Europe (Allum, 2011), is that there is a negative relationship between age and believing in astrology.

In Europe, net of a range of individual-level characteristics, beliefs in astrology are shown to vary substantially across countries. While the results display no clear geographical pattern, Sweden emerges as one of the countries with the lowest share of individuals believing in astrology. Indeed, the 2015 wave of a Swedish attitude survey indicated that only 13% were leaning toward believing in astrology, with only 3% expressing a firm belief that "the positioning of the planet at the time of the individual's birth influences their daily lives and personality" (Foreningen Vetenskap och Folkbildning, 2015). Further corroborating evidence for the comparatively low level of belief in astrology in Sweden comes from the 2005 Special Eurobarometer, surveying individuals in 25 EU countries. Overall, the survey found that 41% of those surveyed gave astrology a score of 4 out of 5 when asked to assess how scientific it is. This study, along with

others, have however indicated that individuals tend to conflate astrology and astronomy, indeed suggested by a substantially smaller share who assesses the scientific qualities of horoscopes as high, only amounting to 13% (see also Allum, 2011).

Theoretical framework

The theoretical foundation upon which astrology predicts the relationship compatibility of two individuals is based on a belief that the position of celestial bodies at the time of birth has a profound influence on the personality (Orion, 2007). While the theory is rather clear about which characteristic that is influenced by which celestial body and about the strength of this influence depending on its position at the time of birth, it is less clear about the mechanism which produces the predicted outcome. The most comprehensive (and, arguably, precise) astrological reading is referred to as natal astrology, and requires information not only on the individual's time of birth but also the geographical location in order to thoroughly assess a range of different characteristics (Oken, 1988). This is needed in order to not only identify the location of the sun at the time of birth but also the location of several other celestial bodies, each associated with their unique influence on the individual's personality. All ten celestial bodies examined, from the Sun and the Moon to Venus and Uranus alternate between the twelve familiar different sun signs, at varying intervals, and with differing implications for how the individual's associated traits are expressed (Woolfolk, 2006). For example, if the planet Venus, associated with ruling the force of attraction, sexual and otherwise, is in Cancer at the time of the individual's birth, the individual is predicted to be a nester, whereas when it is in Scorpio, the love life tends to be stormier. The sign of the moon—describing emotional reactions, changes every 2-3 days, whereas those of more distant planets change much less frequently (Orion, 2007).

The astrologer also needs to address the twelve so-called houses, representing another dimension of authority over specific areas of interest of the individual's life. In terms of their areas of influence, the fifth house, for example, influences the individual's experience in the area of romance and children, whereas the seventh house influences marriage and partnerships. The ascendant, the rising sign or the first house, is the sign that was rising over the eastern horizon at the moment of the individual's birth, rotating overall twelve zodiac signs over the course of 24 h (once approximately every 2 h), implying that, for every day, each sign is the rising sign during a 24 h period. The outcome of this is that if an individual whose sun sign is Aries is born while Aries is the ascendant, the resulting personality traits will be courageous, ambitious, and impulsive. Having found the ascendant, assigning the remaining eleven houses is straightforward, since this follows the sign chart. Thus, if the ascendant is Gemini, the second house will be Cancer, followed by Leo and so forth, until all twelve houses are occupied.

While a full natal reading requires more comprehensive information and thereby also is argued to provide a more precise astrological reading, the majority of horoscopes consumed by the general public are represented by a sun-sign astrological reading. This type of horoscope bases the astrological prediction solely on the position of the sun on the day an individual was born, without accounting for the position of the remaining nine celestial bodies or the houses. Despite its comparatively greater simplicity, astrologers widely claim sun sign horoscopes to be highly informative regarding matters such

as relationships and career, and these represent what is normally encountered in magazines and newspapers (Crowe, 1990). The twelve sun signs are argued to be distinguishable according to three different qualities, which together form the basis for the individual's essential personality traits. The first dimension divides the sun signs into two categories, the positive (masculine) and the negative (feminine) signs. Individuals born under the positive signs are believed to be more extroverted, objective, and assertive, whereas the negative signs are associated with the opposite qualities, namely introversion, subjectivity, and being receptive (Hamilton, 2001). The next dimension is referred to as a sun sign's modality, dividing the sun signs into three categories which describe differences in individuals' forms of expression. Gemini, along with Virgo, Sagittarius, and Pisces, represent the *mutable* sun signs, considered to be flexible and versatile. In contrast, individuals belonging to the four fixed sun signs are focused and determined, whereas the last category, the four cardinal sun signs are enterprising, promoting change, and making things happen. The third and last dimension is represented by the elements, allocating each sign of the zodiac to one of the four elements: fire, earth, air, and water. Following the same logic as the previously discussed dimensions, the twelve sun signs are distributed evenly across the four elements, thus with three sun signs in each. The associated characteristics are informative about the individual's character, with the air signs (Gemini, Libra, Aquarius) being strong both when it comes to intellect and sociability, whereas the corresponding strengths for the fire signs (Aries, Leo, Sagittarius) are vitality, excitement, and intensity. Taking the three dimensions together, each sun sign is represented by a unique combination of characteristics, allowing the astrologer to make predictions about essential features of the individual, in addition to determining which sun signs are the most compatible in romantic relationships (Orion, 2007).

Previous research

Despite the contemporary scientific community's enduring skepticism toward astrology, frequently labeling it a pseudo-science (Thagard, 1978), there is a relative dearth of empirical studies examining its potential validity. Difficulties in evaluating the validity of astrology are intrinsically linked to predictions from horoscopes which are often very vague, making testable hypotheses difficult to formulate. Indeed, the vagueness of astrological predictions is likely to be a key reason for its persistent popularity among the general public, since individuals have a tendency to embrace unspecific (favorable) characterizations of themselves as accurate if they believe that they are the result of a systematic procedure and uniquely generated for them. This phenomenon is named the *Barnum effect*, and its relevance for astrology was first illustrated by Forer (1949) who conducted an experiment where he provided students with what they believed to carefully tailored personality evaluations. The evaluations handed out were, however, identical across all students, consisting of a rather general description of personality traits. The students' high degree of agreement with said evaluations led Forer to conclude that the students' behavior was consistent with the Barnum effect (see also Fichten & Sunerton, 1983).

Another feature linked to astrology is that of self-attribution, referring to how knowledge of one's horoscope influences how one remembers experiences (Glick & Snyder,

1986; Munro & Munro, 2000). More specifically, an individual who reads in their daily horoscope that they will meet with some unfortunate event is likely to pay particular attention to situations that could be perceived as threatening or dangerous, thus, positively reinforcing a confirmation bias. Similarly, an individual who knows that they are supposed to be short-tempered because of their particular sun sign, will be more likely to remember behavior consistent with this description than someone displaying a similar behavior but whose horoscope says that they are patient. Related to this, Hamilton (2001) suggested that a key determinant of an individual's acceptance of astrology is linked to the degree of favorability that it offers. As a consequence, astrology could affect an individual's experience, not necessarily because the astrological prediction is correct, but because it influences how individuals *perceive* events. Clobert, Van Cappellen, Bourdon, and Cohen (2016) confirm this through showing that individuals subjected to a positive astrological reading not only interpreted ambiguous events in a more favorable light but also that it positively affected cognitive performance and creativity. Further support for the hypothesis that observed effects are driven by self-attribution is provided by the fact that effects were the strongest for individuals self-professing to believe in astrology (Hamilton, 2001).

The vast majority of the empirical research has focused on whether an individual's displayed personality traits are consistent with those predicted by astrology, producing rather mixed results. One strand of literature has investigated to what extent individuals are able to accurately predict which out of two astrology readings—one actually made for them and one for another sign—applies to themselves, depending on their birth chart. The results have failed to confirm individuals' ability to do so (Carlson, 1985; Culver & Ianna, 1988; Dean, 1987). Another number of papers have examined a fundamental prediction in astrology, namely that individuals born with the sun in a positive sign are more extroverted. Analyzing the personality scores of a comparatively large sample of individuals, Mayo, White, and Eysenck (1978) clearly found differences in extroversion scores that are consistent with astrological predictions. While a number of subsequent studies confirmed their findings (e.g., Fuzeau-Braesch, 1997; Jackson, 1979; Smithers & Cooper, 1978), several scholars indeed found that the relationship observed was driven by self-attribution. As an example, van Rooij (1994) shows that aforementioned personality differences can only be observed among individuals with prior knowledge about astrology, a result which mirrors the findings of Eysenck (1981) as well as the later studies by Hamilton (1995) and Chico and Lorenzo-Seva (2006).

To our knowledge, only a small number of previous studies have examined the influence of astrology on outcomes relating to matters of love and relationships. The earliest example is Silverman (1971), who analyzes marriage and divorce records from Michigan in 1967 and 1968. While being a rather rudimentary test of compatibility, using predictions from two named astrologers, the study fails to find any indications suggesting that the predictions of two independent astrologers are consistent with what is observed in the data. These findings were challenged by Sachs (1999), using data from Switzerland to examine the relationship between zodiac sign combinations and marriages, divorces as well as a selection of other outcomes. According to Sachs, among the 13 sun-sign pairs that displayed higher than expected marriage probabilities, 12 belonged to pairings that are deemed astrologically compatible. Another study, by Blackmore and Seebold (2001) found that women who are subjected to positive love

advice through their horoscopes were observed with slightly elevated relationship scores, compared to women exposed to neutral advice. Effects were largest for women with greater belief in astrology, consistent with self-attribution. Lastly, Henningsen and Miller Henningsen (2013) examine a sample of married individuals, investigating to what extent the couple's astrological compatibility is associated with the degree of marital satisfaction. While simultaneously controlling for individuals' beliefs in astrology, thus attempting to cancel out the self-attribution influence, the study finds some support for astrological compatibility.

Data and methods

We use the Swedish Longitudinal Immigrant (SLI) database, hosted and administered at the Centre for Economic Demography, Lund University, Sweden. The SLI contains data from several administrative registers, providing longitudinal socio-demographic, economic, and health-related information on about 500,000 unique individuals, continuously observed over the time period 1968-2001. The database was originally developed to examine research questions focused on immigrant-native differences in socioeconomic and demographic outcomes and therefore contains an oversampling of the sixteen largest immigrant nationalities living in Sweden during the time period in question. Despite this oversampling of the foreign born, the nationally representative sample of natives represents by far the largest group in the data. As a result, the dataset is appropriate also for research without an explicit immigrant focus.

Since this study examines astrological predictions of relationship compatibility, the primary outcome of interest is divorce of those in marital unions. We restrict our analytical sample to Nordic born index individuals in heterosexual unions with Nordic born spouses. This provides a study population with a largely similar cultural background and thereby more similar views on marriage and divorce as well as a similar propensity to believe in, and consult, astrology. With the study population additionally restricted to individuals between the ages of 18 and 70, the number of marital unions observed in the data amount to roughly 66,000. Our analysis also examines the determinants of legal divorce with an additional sample restriction being that all examined unions were observed *from the beginning of the marital union*, since this is necessary to accurately measure time at risk of dissolution. Censoring in the data occurs when (i) either spouse dies or emigrates or (ii) the index individual turns 70 years of age. As a result, the number of unions examined in the divorce analysis drops to about 46,000, with 15,000 ending in divorce during the follow-up period.

Using information on date of birth, we determine the zodiac signs of both the index individual and their spouse, yielding 144 zodiac-sign combinations¹. A potential source of criticism of this method is that more detailed information containing the precise place of birth (latitude and longitude) as well as the precise time of day that the individual was born, is required in order for a more exact horoscope to be read. The majority of horoscopes consumed by the general public in magazines, online, and in newspapers is, however, based solely on the date of birth. Consequently, it would follow that our ability to assess zodiac signs only based on the date of birth does not represent an

¹78 unique combinations if, e.g., Aries-Pisces and Pisces-Aries are counted as one.

insurmountable disadvantage, but rather reflects the way these signs are constructed in daily use.

The measurements of relationship compatibility based on zodiac sign combinations that are examined in the analysis are summarized in Table 1. While we are using data on couples in Sweden, the majority of the relationship classifications tested in this article was provided in English, due to the dearth of source material in Swedish. We do not have any information on whether sample individuals actually believe in astrology, something that we claim should not matter, as astrological theory would suggest that individuals are influenced regardless of whether they have any knowledge of astrology.

The relationship compatibility classifications were obtained through accessing alexa.com's top 500 astrology websites as well as through Google searches. Among sources whose primary subject matter is astrology, we selected those that offered information on relationship compatibility based on partners' zodiac signs free of charge. The information furthermore had to unambiguously define varying degrees of compatibility between zodiac signs, enabling an operationalization for quantitative analysis that did not rely on researcher interpretation. As evident from the table, the classifications employ different methods to distinguish between relationship compatibility, with all

Table 1 Zodiac-sign compatibility classifications

Classification ^a	Operationalization	Share of zodiac sign combinations	Peak number of monthly visitors, past 6 months ^b
#1	0—less good	73.61	20.4 million
	1—good	26.39	
#2 ^d	1—low compatibility	16.67	80 thousand
	2—fairly compatible	33.33	
	3—good compatibility	16.67	
	4—high astrological affinity	33.33	
#3	10-92	57.73 ^c	7.7 million
#4	1—not favorable	41.67	16.2 million
	2—favorable match	16.67	
	3—great match	41.67	
#5	1—least compatible	15.38	150 thousand
	2—so-so compatible	46.15	
	3—most compatible	38.46	
#6 ^e	1—least compatible	9.72	80 thousand
	2	8.33	
	3	26.39	
	4	8.33	
	5	34.72	
	6—most compatible	12.50	

^a Sources: (1) www.horoscope.com (retrieved April 1, 2018), (2) www.eastrolog.com (November 28, 2016), (3) www.astrology-zodiac-signs.com (November 28, 2016), (4) www.astrologyanswers.com (April 1, 2018), (5) www.astromatcha.com (April 1, 2018), (6) www.astroguides.se (July 28, 2020)

^b Source, www.similarweb.com, retrieved July 29, 2020

^c Denotes the mean score across possible zodiac sign combinations

^d The classification has changed since it was originally accessed, with the updated classification not being straightforwardly possible to operationalize

^e The source is in Swedish

but one (#3), appropriate for a categorical operationalization. The following column shows the share of possible zodiac sign combinations that are allocated to each respective compatibility category, while the last column shows the visitor volume of each site. To illustrate the importance of these sources, two of the sites used obtained over 15 million monthly visitors during the first 6 months of 2020. Also note that while classifications 1-5 were provided in English, the final classification, #6, is provided in Swedish.

One issue associated with two of the classifications is their lack of symmetry. As an example, while an Aquarius may be indicated as being a great pairing for a Libra, the opposite does not apply. Unfortunately, the source does comment on whether the asymmetry is accidental or on purpose. Since our objective is to test the astrological predictions as they were provided, the main results classify relationships in accordance with the original source, with results adjusting for this asymmetry provided as a sensitivity analysis.

The initial analysis focuses on partner choice through marriage, where we examine the distribution of spouses' zodiac combinations of *all observed marital unions* in the dataset, conditional on sample restrictions. We examine the extent to which unions deemed more favorable appear more frequently than expected by chance. Put simply, if an individual is exposed to a marriage market consisting of 50% of individuals who are type "favorable match" and the other 50% being type "unfavorable match," the probability of marrying an individual belonging to either category simply by chance is 50%. If, however, preferences and compatibilities consistent with the hypotheses tested in this paper exist, the probability of marriage to an individual belonging to the "favorable match" category would exceed 50%. Consequently, if the *actual* number of "favorable" unions statistically significantly exceeds what would be expected had the process been driven solely by chance (or some other characteristic not correlated with the zodiac sign), this would support the hypotheses tested in the paper. More specifically, this would be consistent with a higher degree of compatibility among astrologically favorable couples, reflected in an elevated share among the observed marital unions. We approximate the marriage market population through the distribution across zodiac signs of the population of index individuals, and differences in means between the predicted and actual number of marriages are assessed using *t* tests.

The second part of the analysis is represented by the estimation of Cox proportional hazards models. Here, we examine whether astrologically favorable couples are less likely to divorce. The union represents the unit of analysis at risk of dissolution through a legal divorce from the time of marriage. Time at risk is specified as the number of days elapsed from marriage and unions are followed until legally divorcing or censoring. Apart from the key independent variables for the article, measuring the zodiac sign combination of the couple, the main models only control for the sex of the index person as well as their nativity. The motivation for this is that the majority of the standard control variables in an analysis of divorce can be argued to be simultaneously affected by the individual's zodiac sign, thus making them bad controls. For the sake of being able to compare the size of the associations between zodiac-combinations and the risk of divorce with the influence of other characteristics that are known to be important, such as educational attainment and the age difference between the spouses, we also estimate models including a full set of spousal sociodemographic characteristics. In addition to already mentioned determinants, the complete models also control for

whether the individual and their spouse were native born, the highest (observed) marriage order of the current union, and whether either spouse has any children under the age of 18. The sample means of the population examined in the multivariate analysis are presented in Table A1, Additional file 1.

Results

We begin the analysis by examining the extent to which astrologically favorable relationships are overrepresented among the 66,063 unions that are observed in the data, translating to an average of 458.8 unions for each of the 144 unique zodiac sign combinations. As previously mentioned, we expect the distribution of the index individuals to approximate the marriage market population, implying that—in the absence of any preferences that correlate with zodiac sign—an individual's probability of marrying someone who, e.g., happens to be Pisces should amount to 8.7% (5778/66,063), unconditional on the index person's own sign. As displayed in Table 2, the share of index individuals who have a spouse who is a Pisces ranges from a low among the Aquarius of 8.05 percent, to a high of 9.25% among index individuals belonging to the zodiac sign Cancer. As an initial test of the validity of the astrological predictions presented earlier, evidence in favor of the examined classifications is obtained if an overrepresentation similar to the Cancer-Pisces characterize zodiac sign combinations that are considered to be astrologically favorable. *Within each category of compatibility*, we compare the mean number of observed to expected unions across *all* zodiac sign combinations, using *t* tests to examine whether the difference is statistically significant, consistently finding this not to be the case ($p > 0.1$).

Table 3 shows the average number of marriages in each zodiac pairing that we would expect to occur as a result of a random process based on the assumption that the zodiac-sign distribution of the marriage market resembles the population of index individual, by categories of astrological compatibility. Beginning with classification #1, presented in Table 3, out of the 144 possible zodiac sign combinations, 38 are considered to be “good,” with remaining classified as “less good.” Across all zodiac sign combinations that according to classification #1 are “good,” the mean number of *observed* unions amounts to 462.47, while the average *predicted* (i.e., *random*) number of unions amounts to 463.01, with the difference not being statistically significant, even at the ten percent level. Thus, the mean actual number of unions is *lower* than what chance would predict based on the index population distribution, at odds with the expectation that comparably more favorable zodiac sign combinations would be overrepresented among married couples. Instead, the data reveals a slight overrepresentation of unions belonging to zodiac sign combinations that are considered to be less favorable, according to classification #1.

Similar results can be observed for remaining *categorical* measurements of relationship compatibility, also presented in Table 3². While zodiac sign combinations that according to classification #2 have “low compatibility” indeed are observed to be less common than predicted by chance, the same is observed among couples with “high astrological affinity.” A similar underrepresentation of observed couples belonging to the most favorable zodiac sign combinations is obtained for remaining classifications.

²The test is not straightforwardly applicable to a continuous classification of compatibility.

Table 2 Distribution of zodiac signs by index individual and spouse

		Zodiac sign of spouse													
		Aquarius	Aries	Cancer	Capricorn	Gemini	Leo	Libra	Pisces	Sagittarius	Scorpio	Taurus	Virgo	N	%
Zodiac sign of index individual															
Aquarius	833	9.09	8.93	8.02	8.52	7.66	8.05	8.05	7.61	7.76	8.91	9.07	5389	8.16	
Aries	796	9.78	8.87	6.84	9.83	8.02	8.06	9.02	6.94	7.07	9.63	7.99	6156	9.32	
Cancer	828	9.40	7.82	7.35	9.27	8.02	8.22	9.25	7.70	7.30	9.01	8.46	5806	8.79	
Capricorn	895	8.72	8.84	7.62	8.29	8.00	8.02	8.74	7.85	8.02	8.80	8.16	4828	7.31	
Gemini	779	10.27	9.13	6.79	9.15	8.27	7.96	8.62	7.21	7.10	9.61	8.10	5891	8.92	
Leo	776	9.29	8.67	7.26	9.16	7.63	9.12	8.67	6.75	7.45	9.02	9.23	5319	8.05	
Libra	812	9.28	8.92	7.24	8.77	9.07	8.77	8.91	7.18	6.79	8.77	8.16	5345	8.09	
Pisces	751	9.61	9.29	7.30	8.79	7.98	8.24	8.46	7.84	7.15	9.36	8.46	5778	8.75	
Sagittarius	834	8.69	9.10	7.71	8.65	7.31	7.81	9.22	6.82	8.00	9.48	8.87	4914	7.44	
Scorpio	843	8.77	8.55	7.80	8.43	7.98	7.32	8.33	7.92	8.23	9.96	8.29	4960	7.51	
Taurus	784	9.68	8.54	6.94	9.24	7.84	7.66	8.84	7.61	8.07	10.09	7.64	6123	9.27	
Virgo	880	8.86	8.84	7.09	8.59	8.84	7.85	8.80	7.85	7.40	8.43	8.64	5554	8.41	
Total	5389	6156	5806	4828	5891	5319	5345	5778	4914	4960	6123	5554	66,063	100	

Table 3 Predicted and observed mean number of marriages, by zodiac-sign compatibility classification

Classification #1	Less good	Good				
Predicted by chance	457.25	463.01				
Actually observed	457.44	462.47				
Difference	0.19	−0.54				
Classification #2	Low compatibility	Fairly compatible	Good compatibility	High astrological affinity		
Predicted by chance	458.43	458.94	459.16	458.57		
Actually observed	456.58	460.88	462.71	455.79		
Difference	−1.84	1.93	3.54	−2.78		
Classification #4	Not favorable	Favorable match	Great match			
Predicted by chance	461.21	458.18	457.45			
Actually observed	462.68	456.76	457.20			
Difference	1.48	−1.42	−0.25			
Classification #5	Least compatible	So-so compatible	Most compatible			
Predicted by chance	460.08	456.95	458.19			
Actually observed	464.28	451.67	456.10			
Difference	4.20	−5.28	−2.09			
Classification #6	1—least compatible	2	3	4	5	6—most compatible
Predicted by chance	471.84	475.96	460.79	449.31	447.13	471.54
Actually observed	473.00	487.83	466.13	430.08	447.18	464.11
Difference	1.16	11.88	5.34	−19.23	0.05	−7.43

Note: Differences in means between “predicted by chance” and “actually observed” within each classification and category are tested using *t* tests, with no statistically significant results ($p < 0.1$) being observed

Indeed, while differences between the mean number of observed to predicted number of unions in all classifications remain statistically insignificant, the results—if anything—consistently suggest a systematic overrepresentation of unions characterized by comparatively unfavorable zodiac sign combinations.

Turning to the second part of the analysis, we focus on the determinants of marriage dissolution, testing whether individuals in astrologically favorable relationships experience a lower risk of divorce, estimated by means of Cox proportional hazards regression. While our main models, presented in Table 4, only include covariates that can credibly be argued not to be influenced by the individual’s zodiac sign, corresponding models including a full set of sociodemographic characteristics are available in Table A2, Additional file 1.

Models in Table 4 display the hazard ratios from Cox proportional hazards models of the association between the degree of relationship compatibility predicted by the

Table 4 Cox proportional hazards regression output (hazard ratios)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Sex (ref = man)						
Woman	1.003 (0.0164)	1.003 (0.0164)	1.003 (0.0164)	1.003 (0.0164)	1.003 (0.0164)	1.003 (0.0164)
Nativity (ref = Swedish born)						
Nordic born	1.057** (0.0240)	1.057** (0.0240)	1.057** (0.0240)	1.057** (0.0240)	1.057** (0.0240)	1.057** (0.0240)
Classification #1 (ref = less good)						
Good	0.980 (0.0182)					
Classification #2 (ref = fairly compatible)						
Low compatibility		1.010 (0.0247)				
Good compatibility		1.035 (0.0251)				
High astrological affinity		0.971 (0.0196)				
Classification #3 (10-92)			1.000 (0.000321)			
Classification #4 (ref = favorable match)						
Not favorable				0.984 (0.0220)		
Great match				0.984 (0.0204)		
Classification #5 (ref = so-so compatible)						
Least compatible					0.974 (0.0230)	
Most compatible					0.953** (0.0226)	
Classification #6 (ref = "3 hearts")						
1 heart (least compatible)						0.972 (0.0292)
2 hearts						0.937** (0.0303)
4 hearts						0.980 (0.0324)
5 hearts						0.974 (0.0205)
6 hearts (most compatible)						0.968 (0.0270)
Observations	541,435	541,435	541,435	541,435	541,435	541,435
Pseudo R2	0.000	0.000	0.000	0.000	0.000	0.000
Number of unions	46,326	46,326	46,326	46,326	46,326	46,326
Number of divorces	14,920	14,920	14,920	14,920	14,920	14,920

Standard errors in parentheses
 *** $p < 0.01$
 ** $p < 0.05$
 * $p < 0.1$

websites used and the risk of divorce. The first classification, in Model 1, distinguishes between two categories of matches, with the reference category representing less compatible couples. In accordance with this expectation, the point estimate indeed suggests that the more compatible couples experience a lower risk of divorce. The size of the

association, however, suggests a rather small influence, only amounting to a 2% reduction in the risk of divorce. The point estimate is also not statistically significantly different from the reference category. Given the statistical power of the data used, the observed effect must be considered to be a null effect, and we must reject that these predictions exert any real influence on the outcome.

Model 2 tests classification #2, arranging couples' degree of compatibility along an ordinal scale, ranging from "low compatibility" to "high astrological affinity." The "fairly compatible" category is chosen as the reference category, with the results again failing to provide any consistent support for the hypothesis that astrologically more compatible couples experience a lower risk of divorce. The point estimates are not statistically significantly different from each other, and the magnitudes also fail to consistently indicate that increased compatibility is associated with a lower divorce risk. More specifically, whereas the most favorable zodiac sign combination category, "high astrological affinity" is observed with point estimates indicating a lower divorce risk all other groups, the higher divorce risk among couples with "good compatibility" compared to those that have "low compatibility" is inconsistent with the expectation.

Classification #3 is the only one that is operationalized as a continuous variable. Here, the compatibility score ranges from 10-92, with a higher score indicating a greater relationship compatibility. The results are presented in model 3, with the hazard ratio indicating the change in divorce risk associated with a one-unit increase in compatibility. This model fails to provide any support to the hypothesis that couples with zodiac sign combinations that reflect a higher degree of compatibility are less likely to divorce, since the hazard ratio of 1.00 (which is not statistically significant) implies that the compatibility score is not associated with the risk of divorce.

Returning to a categorical specification of relationship compatibility, model 4 tests classification #4, distinguishing between three different degrees of compatibility. The intermediate category, "favorable match," is the reference category, with "not favorable" and "great match" representing the other outcomes. Point estimates suggest both "not favorable" and "great match" zodiac sign combinations as experiencing a lower divorce risk than the intermediate reference category, both experiencing a 1.6% lower divorce risk. Consequently, the absence of a pattern between the categories that are consistent with the expectations, coupled with a lack of statistical significance, results in the refusal of yet another astrological prediction. We arrive at a similar conclusion from the test of classification #5, in model 5. Compared to the reference category, the intermediate level of compatibility, labeled "so-so," the divorce risk is lower both in unions characterized as being better ("most compatible") as well as worse ("least compatible"). The most compatible couples do experience a divorce risk that is almost five percent lower than the reference category, in addition to being statistically significant. However, as the hazard ratio for the least compatible group also is less than for the reference category, the most and least compatible categories become statistically indistinguishable from each other, thus refuting this classification as well.

Lastly, model 6 tests the only classification presented in Swedish, namely classification #6. This classification rates a couple's compatibility through assigning a number of hearts, effectively becoming another ordinal classification containing six unique degrees of compatibility. The reference category is represented by relationships that are assigned three hearts, i.e., neither particularly good nor, for that matter, bad. Again,

while the most compatible couple category is associated with a slightly lower probability of divorce compared to the reference category, it is not statistically significant. Additionally, all categories yield lower divorce probabilities than the reference, with the only category showing a statistically significant lower probability being judged as less compatible than the reference category.

Our results do not provide evidence in support of any of the classifications evaluated in this article. With few exceptions, point estimates have been small in size, something which is further emphasized when compared to associations between standard sociodemographic determinants and divorce, presented in Table A2, Additional file 1. For example, the spouses' educational attainment, the presence of children under the age of 18 as well as previous experiences of divorce are all consistently much more strongly associated with the risk of divorce within the current union than the couple's degree of astrological compatibility.

Robustness analysis

The results have yielded a consistent story, albeit one that fails to find any support for the examined astrological predictions about relationship compatibility, either in terms of marriages or divorces. Before turning to the conclusions, some caveats and our attempts to address them must be mentioned.

The first caveat is linked to the classifications used to identify relationship compatibility, which is only based on the individual's sun sign and not on a full astrological reading. One could argue that results would have been different if we were able to rely on a more comprehensive reading. Given the fact that sun-sign astrology is the predominant form of astrology consumed by the general public, in combination with many sources for more elaborate astrological readings also offering astrological advice solely based on the individual's day of birth, we believe it is a relevant subject of study.

Given the comparatively low degree of general belief in astrology in Sweden, the context should be close to ideal for the examination of a phenomenon of proposed universal validity such as astrology. Despite this, a second potential threat to the reliability of our results could be that couples in astrologically favorable unions and with knowledge of astrology are more willing to enter into as well as remain in a marital union. For the marriage analysis, the influence of such a bias is ambiguous. On the one hand, it may serve to increase the number of *observed* favorable marital unions, as individuals in relationships that they know to be astrologically favorable also may be more likely to enter into a marital union. On the other hand, the number of unfavorable marital unions may also become inflated due to their greater dissolution propensity, and thus greater remarriage probability among those affected. For the analysis of divorce, the outlined process would bias the results toward a lower risk of divorce for the astrologically favorable relationship categories, thus, further reinforcing the validity of our results.

As noted earlier, two of the examined classifications are not symmetrical, as, e.g., the pairing Aries-Capricorn may have been indicated as favorable, whereas Capricorn-Aries was not, despite belonging to one and the same classification scheme. For the main analysis, we opted not to make any adjustments for these asymmetries, as our aim was to test astrological predictions as they are provided to the general public. Table A3,

Additional file 1, however, displays results after making adjustments in order to achieve symmetry, with qualitatively identical results. It should be noted that the coefficient illustrating the experience of couples who according to the adjusted classification #1 are the most astrologically favorable now is associated with a risk of divorce that is 4.1% lower than a less compatible couple, as well as being statistically significant (see model 1). This result should, however, be interpreted in light of the entire set of analyses performed in this article, along with its comparatively marginal association with the outcome, thus, more likely representing an outlier rather than as being part of a consistent body of evidence suggesting astrological compatibility being an important determinant of divorce.

A final sensitivity check pertains to the adjustment of the sample to exclude cusp births. Cusp births refer to individuals born a few days before or after the transition from one zodiac sign to the next, and are sometimes believed to be influenced by both signs. Thus, an individual born on August 24, and thus technically a Virgo but right after the transition from Leo (ending August 23), may display characteristics of both signs. To investigate whether the presence of cusp births influences our results, we restrict the analysis to couples where both partners were born at least 4 days before and after the break dates between zodiac signs. Taking Leo as an example, the period for this sign ranges from July 23 to August 22, but we only include individuals born from July 28 and until August 18. These results (Additional file 1, Table A4) are virtually identical to those of the main analysis, suggesting that the somewhat less precisely defined characteristics of the sample when including cusp births are not driving the lack of results supporting relationship predictions founded in astrology.

Conclusion

To our knowledge, this is the first study, which uses large-scale longitudinal administrative register data with precise information on dates of birth and marriage and divorce allowing for a thorough examination of the issue at hand. As a result, trivial effect sizes and the lack of statistical significance cannot be the result of a lack of statistical power.

We empirically test astrologically based predictions about couples' degree of relationship compatibility obtained from six different, freely available, online sources. While by no means representing a comprehensive account of the astrological advice that is being offered online, the classifications tested were found through standard search methods from both high and low traffic websites. The analysis conducted in this article should serve as a valid test of the benefits associated with recommendations provided by astrology in order to achieve happiness in relationships. Our analysis, examining over 65,000 marital unions over the time period 1968-2001, rejects the validity of advice provided by these sites. First, there are no indications suggesting that individuals in astrologically favorable sun-sign combinations are over represented in marriage. Second, our results not only indicate rather trivial and statistically insignificant differences in the risk of divorce depending on couples' varying degree of astrological compatibility, but they also fail to suggest any systematically lower risk of divorce among couples who are indicated as being highly compatible.

Based on the results presented in the paper, what can be said about the external validity of the results and to what extent they reflect causality? In an international

comparison, Nordic natives rank very low in cross-country comparisons of beliefs in the supernatural, including religion as well as astrology. As a consequence, we assert that the Nordic countries represent an optimal context to test astrological predictions about couples' relationship compatibility. More specifically, the examined astrological principles should be considered to be in operation regardless of whether an individual believes in them or is even aware of their implications. Individuals who do believe in them are, however, more likely to be aware of what they predict and therefore also allow them to influence their decisions. Consequently, at the individual level, the knowledge of and belief in astrology represents an unobserved factor, which may bias the relationship between zodiac sign combination and the risk of divorce, as it is correlated with both. Thus, a lower divorce risk among "good" zodiac sign pairings may be the result of individuals more familiar with astrology choosing partners based on their time of birth, as well as holding out for longer until marriage dissolution simply due to these beliefs. If so, the estimate of the effect of relationship compatibility will not reflect a causal relationship. The examination of a context where the belief in astrology is comparatively low thereby ascertains that the influence of such sources of bias is minimized.

Supplementary information

Supplementary information accompanies this paper at <https://doi.org/10.1186/s41118-020-00103-5>.

Additional file 1: Table A1: Variable means, analytical sample. **Table A2:** Cox proportional hazards regression hazard ratios. Complete models, with all sociodemographic characteristic. **Table A3:** Cox proportional hazards estimates. Hazard ratios. Sensitivity analysis adjusting for asymmetries in original sources. **Table A4:** Cox proportional hazards estimates. Hazard ratios. Sensitivity analysis on sample excluding cusp birth index individuals and spouse.

Abbreviation

SLI: Swedish Longitudinal Immigrant database

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Authors' contributions

JH and KS contributed equally to all parts of the design, analysis and writing of the manuscript. The authors read and approved the final manuscript.

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Availability of data and materials

Individual-level data is confidential in accordance with the Swedish law. Access can, however, be granted through the Centre for Economic Demography, Lund University.

Competing interests

The authors declare no competing interests.

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