

Is it written in the stars? Studying zodiac signs and horoscopes as cultural phenomena

CSS Lab Holiday Paper Series 2022

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1 Introduction

Who doesn't like horoscopes for a little bit of fun to speculate about which love adventures and successes are waiting for you? Well, it turns out, astrologers themselves don't like horoscopes at all. For them, press horoscopes are a caricature of what they are actually doing because horoscopes pretend there are only 12 groups of personalities and futures. So astrologers try to fight against horoscopes every now and then but have largely learned to live with them because they're just such good publicity. We want to show some solidarity with astrologers in this holiday paper. So we'll distinguish astrology from horoscopes and then talk only about horoscopes. For this paper in the Holiday Paper Series, we learned a whole lot of what we are writing about astrology and horoscopes from an absolute astrology expert, Serge-Bret Morel, in the podcast "L'astrologie, ça marche! Trop."¹ ("Astrology, it works!... Too well.") by Méta de Choc, which we wholeheartedly recommend. Sorry if you don't speak French.

Astrologers see horoscopes as a kind of click-bait astrology for the masses: horoscopes assume that 12 zodiac signs divide people into 12 groups. This then makes for 12 types of personalities, with 12 types of futures, successes, problems, and pasts. All you need to know is where the sun is at the time of a person's birth - problem solved. Never mind where they were born or which stars were visible at the time, or what all the other planets and moons did at the time. Never mind that there are obviously many more than 12 different kinds of people and life histories. No wonder astrologers don't like horoscopes. What they do is much more sophisticated and personalized. In a way, horoscopes are to astrology what the Myers-Briggs Type Indicator is to psychometrics.

Astrology itself consists of a variety of circular geometrical systems, and an even larger variety of pretty complex symbolic interpretation systems around them (cosmobiology, humanist, conditionalist, anthroposophic, karmic or horary astrologies, just to name a few Western traditions). Most astrological

¹<https://metadechoc.fr/podcast/lastrologie-ca-marche-trop/>

maps have points on them that represent the sun and moon, the 9 planets (or was it 8? Oops, somebody should update astrology on this one), (assumed) trajectories around the circle, changing angles between all of these objects moving through the sky over time, and (assumed) rectangular sections in the circle around constellations of stars - the zodiac signs in Western astrology. People turn to astrologers when they look for orientation about the future, to understand themselves, or when looking for help with a problem. Astrologers then offer highly individualized insights as inspiration, based on a person's place of birth, the exact minute they were born in (let's hope the doctor recorded it right when the baby came out!), and additional astrological maps based on the current moment in time.

Astrology is a very popular topic, as indicated by the enormous amount of meme on the subject available online and linked in this paper. A YouGov survey found that about one in four Americans believes in astrology [1]. Maybe the popularity can be explained by the fact that astrology is a science-sounding word, which can be confused with hard sciences like geology or astronomy [2]. We wanted to study this popular phenomenon and for some inexplicable reason, we got interested in the horoscope as a cultural phenomenon, how horoscope websites come up with their predictions, ChatGPT's interpretations of the zodiac, zodiac signs in romantic relationships, and much more. We hope you have as much fun reading this as we did preparing it!

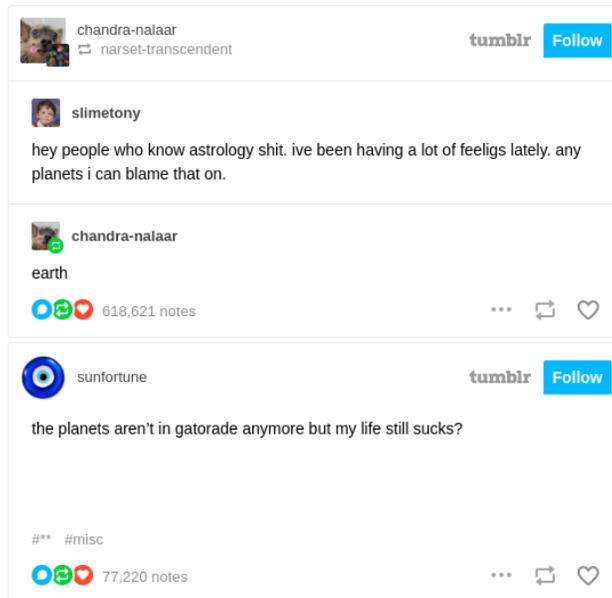


Figure 1: Meme that captures our attitude towards horoscopes after researching on the topic (top) and a telling meme for how much people understand horoscopes (bottom).

2 Lazy horoscope writers

We discovered proof of why astrologers don't like horoscopes in a text analysis of data from the website www.horoscope.com. In October 2022, this was the 7th most visited website on the topic "faith and beliefs", and the 1st most visited site related to zodiac and horoscopes². This Kaggle dataset is constituted by a collection of the horoscopes published on the website from June 16th, 2020 to June 16th, 2021³ and divided into five categories: 'birthday', which is a horoscope specific for the person whose birthday is on the chosen day, 'general', 'wellness', 'love' and 'career'. When analysing this dataset, we found a striking pattern of repetitions among the horoscopes for different signs (usually the closest by month of birth). The birthday horoscopes seem not to change over the years, so the horoscope for one's birthday is the same every year. Quite disappointing, isn't it? We also found repetitions in all the other categories except for 'general'. The repetitions follow a pattern that differs among categories. In 'wellness' and 'career' the most repetitions occur between zodiac signs that are close regarding the birth dates (e.g. Virgo and Libra), while for 'love' the repetitions are among the opposite zodiac signs. Does this mean that opposites attract, and imitating others is good for your health and career?

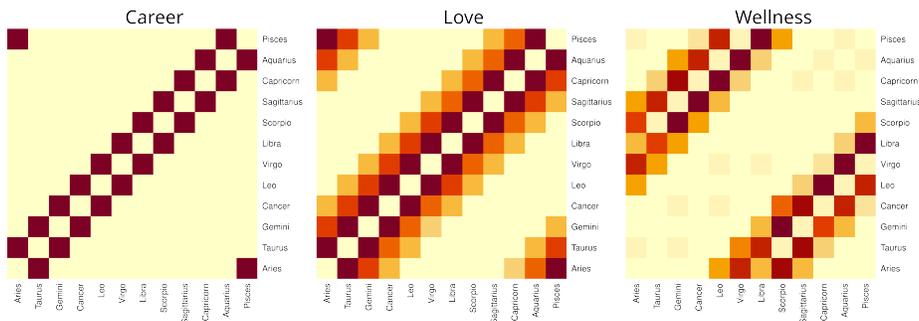


Figure 2: Heat-map of the horoscopes that are repeated among zodiac signs in the categories 'career' (left), 'love' (center) and 'wellness' (right).

Figure 2 shows heat-maps for 'wellness', 'love' and 'career' that reveal these suspicious patterns. We see that in the category 'love', the horoscopes of one zodiac sign repeat in the three preceding and the three following signs. For 'career', the same pattern occurs but only for one preceding and one following sign. The sloppiness of the writer of this horoscope is considerable, as more than 50% of the 'career' horoscopes are not original. For 'wellness' the pattern is the opposite, and repetitions show up among the four or five furthest signs in the horoscope.

What could all of this mean? Either, there are even fewer than 12 groups of people and futures, and the stars have decided that people should have more

²www.similarweb.com

³<https://www.kaggle.com/datasets/shahp7575/horoscopes>

similar love lives than careers. Or somebody whose job is to write horoscopes was too lazy to write even 12 different horoscopes in 3 categories per day, let alone to base them on some well-established astrological theory (not as well-established as it could get, we have to admit). Note that the repeated horoscopes do not necessarily fall on the same calendar day - so if you check only a specific day, you might not notice. With this anecdotal evidence, we'll let you decide which explanation is more probable.



Figure 3: Online discussion that accurately depicts how horoscopes are made to fit each zodiac sign.

3 Text similarity within signs

The repetition patterns above made us wonder if there is any consistency among the horoscopes of each sign or if texts are mostly shuffled around without a very clear text marker for each sign besides mentioning it explicitly. We tested this with a text-as-data approach, applying a large language model to compute a vector representation of each text that allows us to measure similarity between horoscope texts as the cosine similarity between their vectors. More precisely, we used the huggingface all-mpnet-base-v2 model⁴ to embed each horoscope into a 768-dimensional vector.

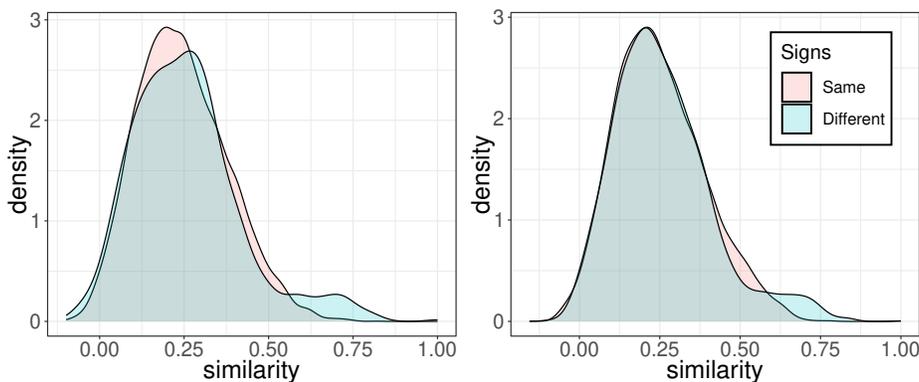


Figure 4: Kernel density plots of the distributions of similarity between pairs of horoscopes of the same and different signs. The left panel shows the distributions for all horoscopes except the “birthday” category and the right one only for the “general” category.

If the text of horoscopes is more homogeneous for two horoscopes for the same sign, the cosine similarity between horoscopes for the same sign should be higher on average than for pairs of horoscopes of different signs. We tested this by sampling 10,000 random pairs of horoscopes from all categories except birthday and recorded their cosine similarity and whether they are for the same sign or not. The left panel of Fig. 4 shows a kernel density plot of the distribution of similarities for horoscopes of the same and of different signs. With the exception of a bump on the right for the case of the same sign, both distributions look remarkably similar. The mean similarity for the same sign is 0.257 and for different signs is 0.246 and t-test comparing them has a p-value of 0.05048, which is tempting to interpret that the similarity is higher for same-sign pairs until you notice that these distributions are right-skewed and a t-test is a bad idea. If you instead run a Wilcoxon test, the p-value is 0.557 despite the large sample size of the test. We repeated this exercise for 10,000 pairs of horoscopes only within the general category, just in case the problem was due to comparing across categories. The result can be seen in the right panel of Fig. 4: there is a

⁴<https://huggingface.co/sentence-transformers/all-mpnet-base-v2>

tail that gives a bit higher chance for same-sign pairs to have higher similarity, but a Wilcoxon test here has $p=0.28$. One can imagine that those bumps of higher similarity are due to the horoscopes mentioning explicitly the sign they make predictions for, while the rest of the text is largely inconsistent and two horoscopes for the same sign are as similar as horoscopes for different signs. This evidence further backs up the interchangeability of zodiac signs found in the analysis of repetitions of horoscopes. Therefore, next time you read a horoscope, make sure to pick the zodiac sign whose forecasts best fit your mood and situation, not the ones that are assigned to your canonical zodiac sign.

4 Balance at the end of the year

Towards the end of the year, many people reflect on the past year and take stock. On balance, was it a good or bad year? Looking backwards, we are interested in the general course of events throughout the year and not in a particular point in time. For these kinds of considerations, does it matter what your zodiac sign is? To find out, we analysed the average sentiment of horoscopes throughout the year per zodiac sign. This might also uncover if the year was “a bad year” for some and “a good year” for others. We quantified positive and negative emotions with word counts from LIWC dictionary wordlists. We assumed that the average length of horoscopes does not change across zodiac signs, and then subtract the counts of negative words from the ones of positive words to obtain an emotion score. This score is positive if horoscopes of a particular zodiac sign are positive overall and negative when they are negative overall. We found that in every category (career, love, wellness, general), the yearly average sentiment of one zodiac sign overlaps with one of the other zodiac signs. This is somewhat expected for ‘love’, ‘wellness’ and ‘career’ because the horoscope text itself is repeated (see Figure 2). However, this is not expected for ‘general’, where every horoscope is unique. Apparently, horoscopes do not explain why some perceive their year to have been bad and others are fully satisfied. What’s more, the mean sentiment of every zodiac sign and on every category is very similar and, especially, markedly positive. According to horoscopes, nobody should, on balance, arrive at the conclusion that their previous year was bad. In other words, according to horoscopes, the year analysed must have been positive for everyone in general, and in particular in the areas of love, wellness and career. Looks suspiciously like somebody wants you to like reading your horoscope, doesn’t it?

Additionally, we use our recent transformer model, LEIA ⁵, to predict the emotion from the textual description of each sign. In LEIA-land, about 96% of the signs evoke the social emotion of affection. Another striking homogeneity! Fig. 5 shows the prevalence of other emotions, amounting to a total of less than 5% but surprisingly containing some anger and fear.

⁵<https://huggingface.co/saroyehun/LEIA-large>. A model freshly rejected from ICWSM. We will publish an article about LEIA soon!

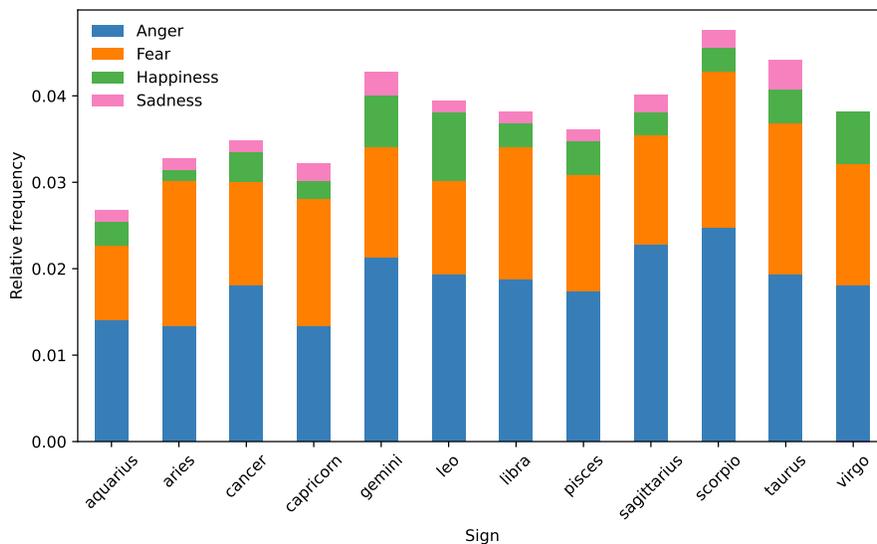


Figure 5: Relative frequency of emotions predicted by LEIA within each sign. Affection is excluded from the figure as it accounts for about 96% of emotions within each sign.

Happy Virgo, thou shall never feel sad! This is what we gather from a close analysis of the emotion split predicted by LEIA.

5 Why so popular?

In a Pew study from 2017 [3], 27% of US adults considered themselves as spiritual but unaffiliated with any traditional religious group, marking an 8% increase since 2012. Around the same time, astrology services such as the AI-generating horoscopes app Co-Star gained extreme popularity. And all of a sudden, you find yourself at a party creating a Co-Star account to check the compatibility of your star sign with the chart of someone that you only just met two minutes ago (you should try it, though, it's actually quite funny). From the ultimate party trick to a serious search for identity, there are many reasons for people to use astrology services. While it can be extremely entertaining and has become highly accessible via mobile apps, (click-bait) horoscopes may offer a sense of spiritual meaning to some, and a degree of certainty and explanation to others when the world around them seemingly goes more and more crazy.⁶ We look into three reasons in particular that may explain why Zodiac signs have become so appealing:

⁶While this may be true for Western societies, star signs are seen as repressive and regressive in many other parts of the world, e.g., India).

Me: I hate astrology
Horoscope: You're beautiful
Me:



Me: Horoscopes are a bunch of nonsense
Horoscope: You're lonely and tired
Me:



Figure 6: When reading a horoscope, everyone feels as if they are understood. This is probably one of the reasons horoscopes are so popular.

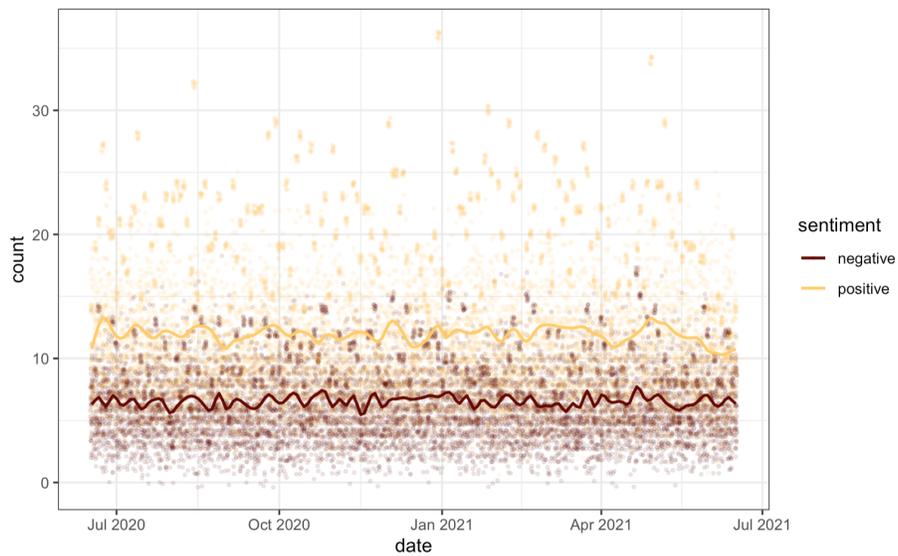


Figure 7: Positive vs. negative sentiment in the horoscopes over one year.

1. **Positivity:** Every day, people are flooded with news that quite often contain negative information. Horoscopes, on the contrary, are mostly framed in a positive way: Figure 7) compares positive and negative sentiment as counted by LIWC-22, relying on the Kaggle horoscope dataset, which collects a year of horoscopes as published on the website horoscope.com. The graph shows two things: First, the sentiment has not changed over time which is in line with the repetitiveness of horoscopes outlined earlier. Second, the count of words indicating positive sentiment has been higher than the count of negative words. No wonder that people like to read horoscopes.
2. **The Burnam effect:** Information in horoscopes is presented in a way that readers can always find some detail that resonates with their reality, their gut feeling or intuition. We can analyze this by either looking at the range of topics or by identifying suggestive use of language, e.g., subjunctives. Analyzing the text of the horoscopes with a dictionary-based approach, we counted words indicating tentative vs. certain language dimensions (see LIWC-22 documentation). Across all Zodiac signs and horoscope topics, we observe a higher number of tentative words than words expressing certainty with little variation: General horoscopes or horoscopes related to love tend to be more tentative than career-related horoscopes (Figure 8). Interestingly, the horoscopes used more tentative words towards the end of the year, and more certain words in summer, especially for air signs (Gemini, Libra, Aquarius).

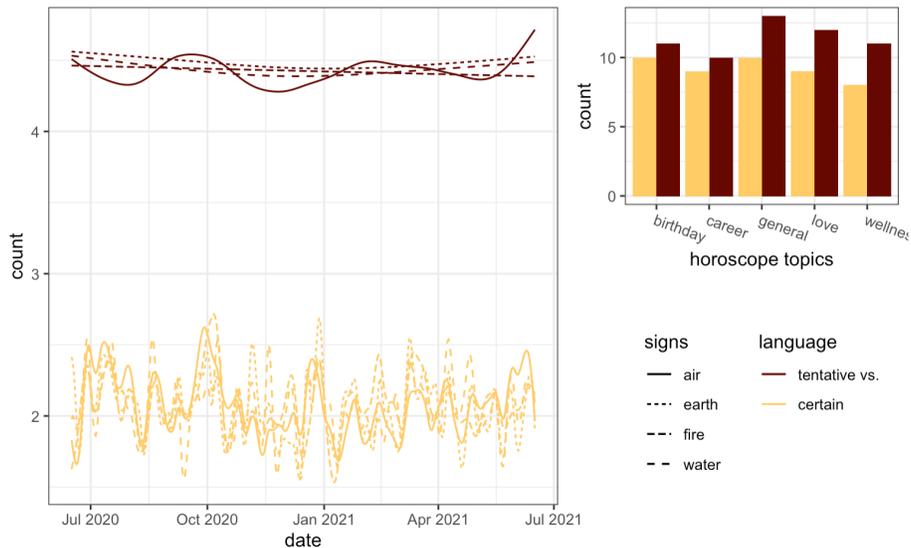


Figure 8: Words expressing tentativeness vs. certainty in the horoscopes over one year and per category, divided by element.

- The Placebo effect: As a result, people may adapt their behavior to the horoscopes read in the morning and the predictions turn out to be true. By far, horoscopes have mentioned money and positive sentiment mostly for Capricorns, regardless of the season.

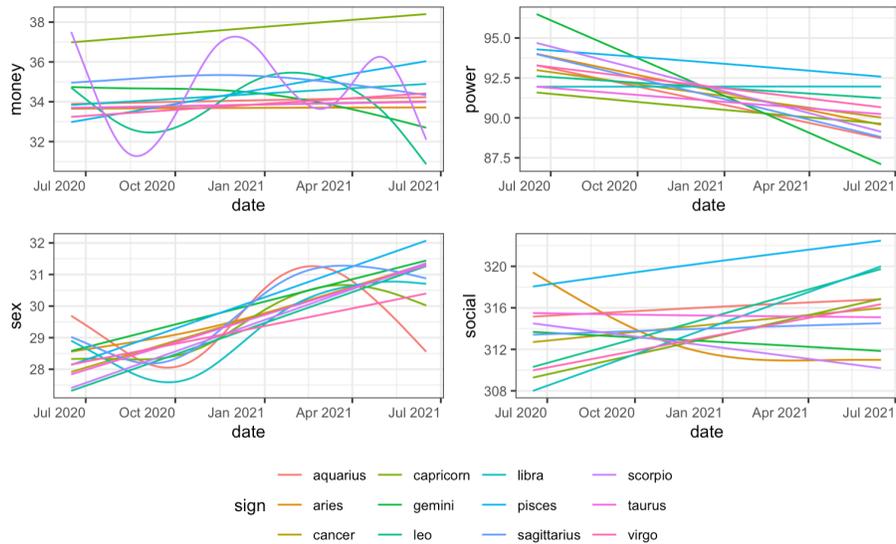


Figure 9: Trends of positive mentions of the topics 'money', 'power', 'sex' and 'social' for all zodiac signs.

For Virgos, on the other hand, the period between June 2020 and July 2021 was a financial roller coaster. If we compared the horoscope predictions to the trustworthy stats listing the wealthiest people by star sign in an article by The Sun⁷, we would see that Libras are the most well-off signs (despite Jeff Bezos being a Capricorn?). Furthermore, positive mentions of power seem to have decreased for all star signs, whereas positive mentions of sex have increased for most signs. Additionally, the sexuality of air signs is strongly dependent on seasonality, with a lower positive mention of the topic between September and November and a considerable increase in the period between January and April. Anybody else feels meteoropathic? Moreover, it seems that many signs have been able to keep their social lives stable during the COVID-19 pandemic but the Pisces have shown to be the real social butterflies in 2020-2021.

So, if horoscopes are mostly positive and affirming and they make people believe in a better future, what harm can they bring?

We also look at the total trends in all horoscopes together by running VADER over each horoscope and recording its composite score. Figure 10 shows

⁷<https://www.thesun.co.uk/fabulous/14157988/rich-list-2021-zodiac-sign-destined-fortune-libra/>

the time series of VADER sentiment in all four horoscope categories after calculating the mean over all signs in a 30-day rolling window. First, it is possible to see the general positivity of the horoscopes, with all categories scoring almost always above 0.4, where the VADER scale goes from -1 to 1 and 0 is neutral. The most positive categories are wellness and love and the most negative is, unsurprisingly, career, with the general horoscope oscillating between the sentiment levels of the other categories. Looking more closely at the wellness and career sentiments, we can see the repetitions shown earlier. In particular, the sentiment expressed by horoscopes in the category of wellness has a nearly identical time series that oscillates four times per year, and the career category does the same twice a year. Just by looking from a bird’s eye view of sentiment aggregates, we can already see how the text has been reused for these two categories.

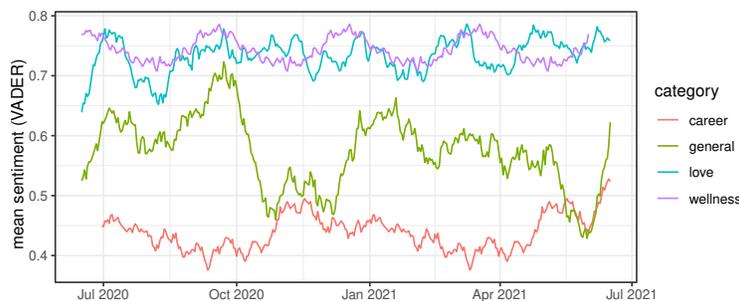


Figure 10: Mean VADER sentiment of horoscopes per category over a full year. The scale of sentiment ranges from -1 (negative) to 1 (positive), with 0 being neutral.

Looking closely at the sentiment time series of all four categories, one can see that the general category seems to switch between phases and is, according to the period of the year, more similar to the love category or to the career category. Using the similarity metrics we applied in section 3, we can test this oscillation of similarity of the general category and the others, as shown in Figure 11. The figure shows the mean similarity in each month between the horoscopes of the general category versus each of the other three categories. You can see that the general category is most similar to the love category between January and August, dropping to a lower level of similarity in the Autumn months between September and December. The similarity between career and wellness oscillates with the same periods we found when analysing sentiment, where the similarity of the general category with the career category is the highest in July and December, and with wellness it has four peaks: February, May, August, and November. One might ask whether the writers and editors of the website horoscope.com are very attentive to the regular influences of planets on the actions of every zodiac sign or if they deploy a (not so) sophisticated excel file that creates such strong patterns in their predictions.

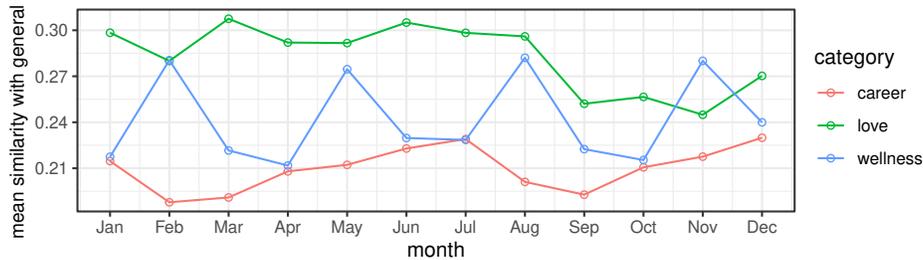


Figure 11: Mean cosine similarity per month between horoscopes of the general category and the other three categories.

6 Talking about zodiac signs on Twitter

In order to analyse the popularity of horoscopes, we used Brandwatch to calculate the number of tweets mentioning at least one zodiac sign (except cancer to avoid capturing tweets about the disease) and the total number of tweets in each US state between December 1st, 2018 and December 1st, 2022. We ignored retweets in this calculation, and thus only counted original tweets and replies. The fraction of tweets mentioning zodiac signs this way ranges between less than 0.1% and more than 0.3%, as shown in Figure 12. A striking pattern in the map is the higher fraction of zodiac tweets in the “Bible belt”, which is three times higher than in the northwest.

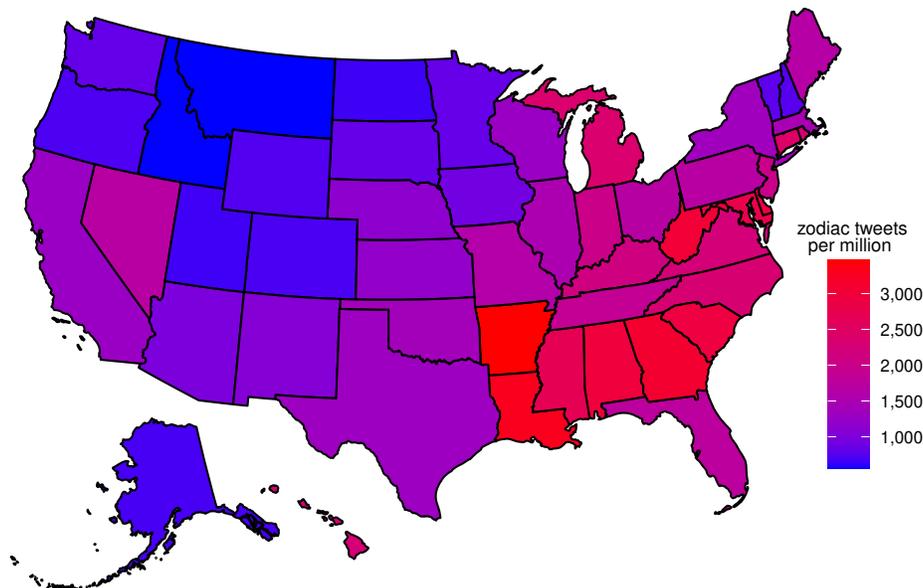


Figure 12: Tweets mentioning a zodiac sign per million across US states.

A common feature of the “Bible belt” states is the importance of religion, so we tested its relationship with the presence of zodiac tweets. Using data from a Pew survey, we find that the fraction of respondents that consider religion very important in their life has a significant correlation of 0.54 with the fraction of zodiac tweets. This does not mean that religious people are more likely to talk about the zodiac on Twitter, but perhaps the zodiac is a replacement for religion among non-religious people in societies in which religion is very important. The fraction of zodiac tweets is also correlated with educational attainment across states, measured as the fraction of the population with a High School degree or higher, with a significant correlation coefficient of -0.53 . This seems to be a non-linear correlation where the variance of tweet fractions is higher for countries with low educational attainment. Thus a spearman correlation coefficient is even stronger: -0.63 . This could be an individual-level correlation where higher education reduces the interest in zodiac signs, as show in previous research about social media in Russian high schools[4] and also in a YouGov US survey [1].



Twitter: @pricepeterson

Figure 13: People might turn to horoscopes in places where spirituality is deemed very important for the individual.

7 AI-designed zodiac

You'd assume that horoscopes (and astrology) are based on the actual position of the moon, sun, and planets in the zodiac. Sorry to tell you, it turns out that they aren't (this was news to us as well! If you want a reference for all that follows, learn French and check the podcast with Serge Bret-Morel we recommended in the Introduction.). At some point in time, when planets were still turning around the earth rather than the sun, and a bit later, when their orbits were thought to be circles rather than ellipses, it was really hard to predict the position of planets. So, somebody made some assumptions that were more or less correct. Western astrology, it turns out, has its roots in astronomy before Johannes Kepler discovered the elliptic orbits, and never got properly updated. Still today, different currents of astrology do not agree about the actual planets exerting gravitational forces or something similar. Instead, they rely on their own geometric systems with points in different rectangles (the zodiac). The rectangles are drawn on a freely defined band through the sky (the celestial wheel), around constellations of stars. Different cultures and civilizations see and saw different things in these constellations – with interpretations for the same set of stars ranging from crocodile to turtle. So, if all these cultures, civilizations, and today's astrologers could just come up with their own ideas, we thought we also could define our own system.

Twitter is currently on fire about ChatGPT⁸. What about probing its wisdom for personality prediction based on stars? We prompted ChatGPT with questions of the format “What is the most unrelated word to X?” where X was replaced with each of the 12 zodiac signs. This gave us a list of AI-generated zodiac signs. We then asked ChatGPT to generate a behavioral description of a typical person of each of these new signs with a prompt of the format “How is a typical person of Y zodiac sign?”, where we replaced Y with the new zodiac sign. ChatGPT noticed that some of these were not real signs and refused to make such a wild characterization, but this was just in a couple of cases. After insisting or generating another sign with the unrelated word question, we ended up having the AI-designed zodiac of Figure 14. The descriptions generated for each new sign can be found in Table 1.

If we were not so used to zodiac signs being called Aries, Cancer, or Pisces, we are sure we could find a fitting sign from the GPTChat zodiac system. The descriptions of the signs are remarkably similar to the type of speech used by the traditional, Western horoscope. So please feel free to pick the sign that mirrors you best from the table. Do you feel more like a Sushi or a Bubblegum sign?

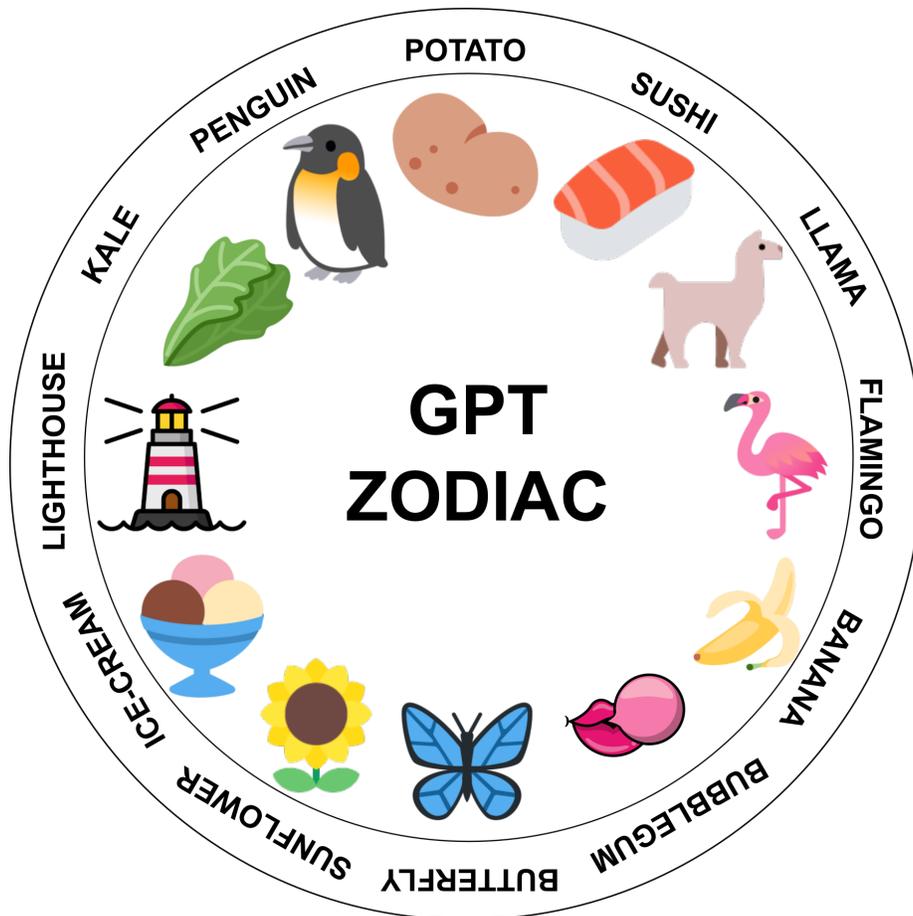


Figure 14: New Zodiac signs designed with ChatGPT.

sign	ChatGPT description
Potato	A typical person of the Potato zodiac sign is reliable, practical, and hardworking. They are strong-willed and determined, and often have a grounded and down-to-earth approach to life. They are loyal and supportive of those close to them, and can be counted on to be there in times of need. They value stability and security, and are often drawn to careers and lifestyles that provide these things. Despite their tendency towards practicality, they also possess a creative and imaginative side that they may not always show to others.
Sushi	A person with the Sushi zodiac sign is typically considered to be very adaptable and open-minded. They enjoy trying new things and are always looking for ways to improve and evolve. They are social and outgoing, and often have a large circle of friends and acquaintances. They can be creative and spontaneous, and are known for their innovative ideas and approach to problem-solving. They are also highly intuitive and can sense the emotions and needs of others. Overall, a person with the Sushi zodiac sign is dynamic, curious, and always seeking new experiences.
Llama	A typical person of the Llama zodiac sign is independent, self-sufficient, and adaptable. They are natural leaders who are confident and assertive, but also possess a strong sense of responsibility and integrity. They are intelligent and analytical, and have a strong desire to learn and grow. They are also patient and have the ability to remain calm and focused in difficult situations. Overall, they are driven and determined individuals who strive for success and excellence in all areas of their lives.
Flamingo	Typical people of the Flamingo zodiac sign are known for their fun-loving and social nature. They are outgoing and enjoy being around other people, often taking the lead in group activities and gatherings. They are often very creative and have a flair for the dramatic, expressing themselves through art or performance. They are also known for their patience and ability to remain calm in difficult situations. Overall, they are warm and compassionate individuals who enjoy bringing joy and positivity to those around them.
Banana	A typical person of the Banana zodiac sign is generally a creative and adaptable individual. They are often known for their sense of humor and their ability to connect with others. They are also known for their intelligence and their ability to think outside the box. They tend to be open-minded and flexible, and they enjoy trying new things and exploring new experiences. They are often drawn to careers that allow them to use their creativity and problem-solving skills, and they are known for their ability to think on their feet and come up with creative solutions to complex problems. Overall, a typical person of the Banana zodiac sign is a fun-loving, imaginative, and intelligent individual who is always looking for new challenges and opportunities to grow and learn.
Bubblegum	People who are born under the Bubblegum zodiac sign are typically playful, fun-loving, and spontaneous. They are known for their sweet and bubbly personalities, and are often the life of the party. They are also fiercely independent and have a strong sense of self. They are sensitive and emotional, and are often drawn to creative and artistic pursuits. They are also very social and enjoy spending time with friends and loved ones.
Butterfly	People born under the Butterfly zodiac sign are typically imaginative, creative, and artistic. They are often seen as dreamers and may have a strong connection to their spiritual side. They are sensitive and caring individuals who are deeply empathetic towards others. They enjoy spending time in nature and may have a love for music and art. They can also be adventurous and spontaneous, always seeking new experiences and growth.
Sunflower	People of the Sunflower zodiac sign are typically vibrant, energetic, and optimistic. They have a strong sense of self and are confident in their abilities. They are social and enjoy being around others, but also value their independence. They are creative and have a deep appreciation for beauty and art. They are often open-minded and adaptable, and enjoy trying new things. They have a sunny disposition and tend to look on the bright side of life.
Ice cream	People who are born under the Ice Cream zodiac sign are typically known for their fun-loving and adventurous personalities. They are often described as being spontaneous and playful, with a keen sense of curiosity and an insatiable appetite for new experiences. They are also known for their creativity and ability to think outside the box, which often leads them to pursue careers in fields such as art, design, and entertainment.
Lighthouse	People born under the Lighthouse zodiac sign are typically independent, strong-willed, and reliable. They are natural leaders who are often admired for their determination and perseverance. They are also known for their loyalty and dependability, making them excellent friends and companions. They can be quite independent and may sometimes have a tendency to be a little stubborn, but they are always willing to help others and are known for their generosity and kindness.
Kale	People of the Kale zodiac sign are typically known for their intelligence and quick wit. They are analytical and logical thinkers, and enjoy engaging in deep, intellectual discussions. They are curious and always seeking to learn new things. They are also independent and confident, and enjoy pursuing their own interests and goals.
Penguin	Penguin zodiac signs are typically loyal, playful, and intelligent individuals who value their close relationships and enjoy spending time with loved ones. They are often determined and resilient, and tend to be organized and detail-oriented. Penguins are also known for their sense of humor and ability to adapt to new situations.

Table 1: Description of the typical person of each sign of GPT Zodiac.



Figure 15: Horoscopes always feature relationship advice and estimate the wellness of fit between two people based only on their birth month. Is it a good idea to believe in their forecasts with respect to love and relationships?

8 Have you consulted the horoscope before getting married?

8.1 Weddings

Do certain combinations of zodiac signs marry more often than others? In other words, are people actually drawn to partners belonging to zodiac signs that in some way fit their own? In particular, if zodiac signs are linked to some personality traits, people belonging to a zodiac sign would be attracted by partners from a zodiac sign that offer the characteristics they look for in a partner. Or are people actually checking the compatibility of their zodiac signs when their love story becomes serious? Should this happen before or after introducing a partner to your parents? With the aim of testing the hypothesis that certain combinations of zodiac signs make couples more often than others, we analysed an aggregated dataset of Austrian wedding records from Statistik Austria. In particular, we accessed the count of pairs of zodiac signs of married couples living in the same household in December 2022. Both traditional and civil weddings are included in the analysis.

We consider how random the zodiac sign distribution is in such data. In particular, we compute the ratio between the observed probability of a wedding between two specific zodiac signs and the product of the probability of observing the two signs in the data:

$$\frac{P(\text{sign1}, \text{sign2})}{P(\text{sign1}) * P(\text{sign2})} \quad (1)$$

A value of 1 indicates that the specific pairing of zodiac signs occurs as often as expected at random, a value larger than 1 indicates that the pairing happens more often than expected at random and a value below 1 means that the match is recorded in fewer cases than expected at random. The computation of this value is already corrected for the number of people belonging to a specific zodiac sign in the data. The results are reported in Figure 16. In the analysis, we find

⁸<https://chat.openai.com/chat>

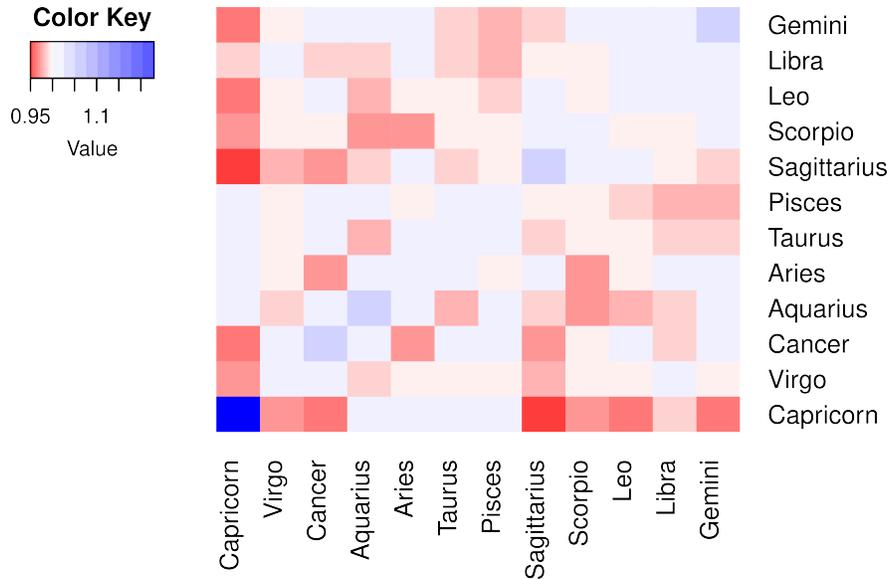


Figure 16: Heat-map of the ratio between observed weddings and the number of weddings expected at random in the Austrian population. A number below 1 (red) indicates less weddings than expected at random, while a value above 1 (blue) hints to more weddings than at random.

that there is a tendency towards same-sign couples, which is especially marked for couples where both partners are Capricorn. In particular, Capricorns tend to marry partners of the same zodiac sign 22% more often than expected at random. In this case, the observed marriage frequency is significantly higher than at random, as well as in the case of partners both of the sign of Aries, Gemini, Cancer, Leo, Virgo, Scorpio, Sagittarius, Capricorn, Aquarius and Pisces. On the contrary, the pairs that marry less often than at random are Cancer with Aries, Scorpio with Aries, Cancer with Capricorn, Gemini with Capricorn, Leo with Capricorn, Virgo with Capricorn, Scorpio with Capricorn and Sagittarius with Capricorn. It seems like only Capricorns can cope with dating a Capricorn. We thought that the higher probability of marrying within the sign might just be due to the proximity of birthdays and perhaps celebrating together, but contiguous signs in the calendar are not necessarily more likely to appear than at random. Examples of contiguous pairs with lower chances than random are Taurus and Gemini, Leo and Virgo, Libra and Scorpio, Pisces and Aries, and of course Capricorn and Sagittarius.

8.2 Divorces

Horoscopes From Last Week So You Can See If They Were Right

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By: Jasmine Pierce

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Figure 17: We took inspiration from this meme for analysing divorces on the basis of the love compatibility of zodiac signs. Were the forecasts right?

Zodiac signs are often used to estimate the compatibility of romantic partners on the basis of their zodiac signs. In order to test whether they are right, we analyse the quality of the prediction of horoscopes on divorce data. In particular, we consider a database of divorces between the years 2000 and 2015 in Xalapa, Mexico ⁹. Based on the birth dates of the partners, we could compute the zodiac sign of the partners for more than 4,000 divorces. We consider both the Western zodiac, which is based on the day and month of birth, and the Chinese zodiac, which is also dependent on the year of birth. We collect compatibility data for the Western zodiac system from two different sources ^{10,11} and for one the Chinese zodiac ¹². The Chinese horoscope data and one of the Western horoscopes only list a few best and worst matches for each sign, therefore most combinations of zodiac signs are not mentioned. In contrast, the horoscope from *rd.com* lists the compatibility scores for every combination of zodiac signs. In this case, we divide signs into balanced classes according to their compatibility in four quartiles: low, mid-low, mid-high and high quartiles.

In our analysis, we compute the ratio of pairs belonging to good and bad matches in the divorce data. If the zodiac compatibility scores are correct, we

⁹<https://www.kaggle.com/code/aagghh/python-vs-astrology-testing-zodiac-predictions>

¹⁰<https://www.rd.com/list/zodiac-signs-compatibility/>

¹¹<https://numerologysign.com/astrology/zodiac/compatibility/>

¹²<https://www.chinahighlights.com/travelguide/chinese-zodiac/compatibility.htm>

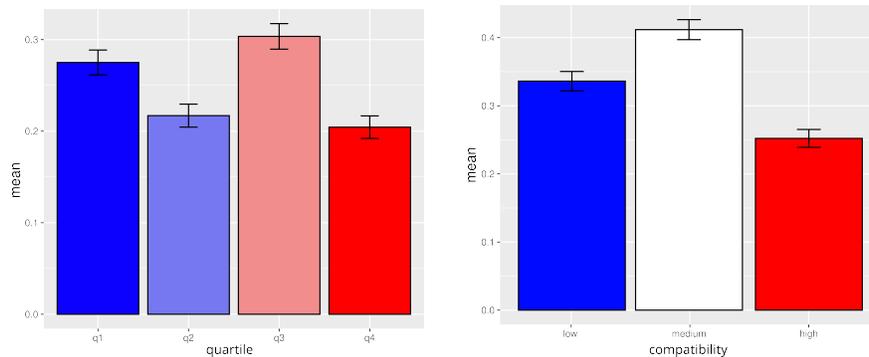


Figure 18: Mean percentage of divorces according to compatibility scores in two Western horoscopes. On the left, we divide the scores in four quartiles: low (q1), mid-low (q2), mid-high (q3), high (q4). On the right, we divide the couples on the basis of best or worst fit. Combinations of signs that are not mentioned are in the 'medium' tier and bars show 95% bootstrapping confidence intervals.

expect to see more bad matches in the divorce dataset than good matches. Moreover, if horoscopes are based on some ground truth, the two Western compatibility scores should contain similar predictions and therefore lead to similar results. We start analysing the case of the Western horoscope from numerologysign.com. If horoscopes had some truth in them, the pairs belonging to the highest quartiles should have a lower rate of divorces than the pairs of zodiac signs belonging to the lowest quartiles. However, we find that 27.5% of all divorces happen between pairs whose compatibility is in the lowest quartile, 21.7% between couples in the mid-low quartile, 30.4% in the mid-high quartile and 20.4% in the high quartile. When bootstrapping, we find that all these differences are significant apart from the ones between quartiles 2 and 4, where the difference is statistically not significant (see Figure 18, left panel). Thus, the probability of divorce is the same for couples whose compatibility is estimated to be between 48% and 68% (the mid-low quartile) and couples with compatibility between 88% and 98%. Weird, right? Moreover, even if pairs in the lowest range of compatibility do divorce more often than the ones in the highest range, the highest divorce rate is recorded among the pairs whose compatibility score is higher than the average, in particular ranging between 68% and 88% (mid-high quartile). These couples would be expected to work out better than the average pair. Wouldn't you also believe in a future of happiness, if you and your partner would have a compatibility rate of 85%?

We then analyse the second Western compatibility source. In light of the previous results, if horoscopes were consistent, we would also expect this source to predict more divorces among the highest tiers than among the lowest ones. However, we find that for this source couples with low compatibility makeup 33.6% of the divorce dataset, while the ones with high compatibility represent only 25% of the divorces (see Figure 18, right panel). Among the pairs of zodiac

signs which were not mentioned as best or worst matches and were assumed to be in the medium compatibility range, 41.1% went through a divorce. However, the latter result is probably due to an imbalance of the data for medium compatibility matches. Thus, it is very important to choose a trustworthy source where to check the compatibility with your soon-to-be spouse, as different sources have different degrees of predictive accuracy.

We further tested the robustness of these results with the Gong-Liu method to test statistical significance inspired by nanobiosensors technology [5], using Gimp to edit the figures because we are too cheap to buy Photoshop. Results are shown in Figure 19 and reveal that anything can be significant if you make the Ts small enough.

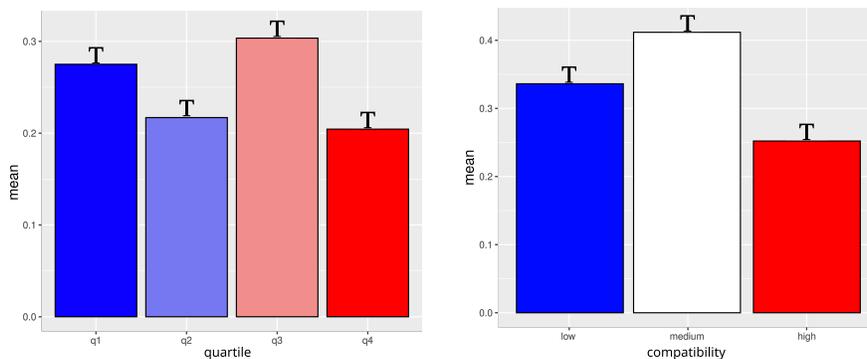


Figure 19: Robustness replication of results with the Gong-Liu method.

Lastly, we decided to test whether Chinese compatibility predictions are more reliable in predicting couples' happiness. One might expect so, as they do consider one additional source of information: the year of birth. Also in this source, some matches were classified as good or bad, while most combinations were not taken into account. We consider these as medium compatibility. In Figure 20 the results of this analysis are reported. In particular, we find that there are significantly more divorces among good matches than among bad ones, while the medium category is the one that is most represented in the dataset, but this is probably due to the different sizes of the categories. In more detail, we find that 19.3% of divorces occur among well-matched couples, 14.6% among bad matches, and 66% of divorces happen among the medium fitting couples.

We do not have information on the married couples that did not divorce in the Mexican divorces dataset, so we can only advise putting as much effort into finding a good sign compatibility source as in looking for the right partner to marry. Perhaps do avoid the medium compatibility range: it looks like something unfavorable is happening there!

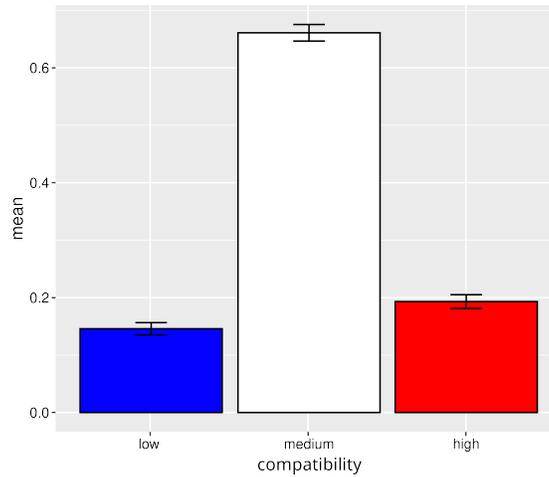


Figure 20: Divorces split by sign compatibility according to the Chinese horoscope. The bars indicate 95% confidence interval in a bootstrap analysis.

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