What Makes Some People Think Astrology is Scientific?

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1 INTRODUCTION

Anyone reading this article is likely at some point to have read their horoscope. Astrology columns are widespread in print media, and have been a staple for a surprisingly long time. The first columnist was 17th century astrologer William Lily, who famously predicted the Great Fire of London, albeit 14 years early. Webster-Merriam dictionary defines astrology as 'divination of the supposed influences of the stars and planets on human affairs and terrestrial events by their positions and aspects'. A horoscope, on the other hand is defined as a'diagram of the relative positions of planets and signs of the zodiac at a specific time (as at one's birth) for use by astrologers in inferring individual character and personality traits and in foretelling events of a person's life'. The more common understanding of horoscopes is that they are astrological forecasts, such as those that appear in newspapers. It is this definition that I use for the rest of the paper. Ten years ago, just under half of Americans read their horoscope at least occasionally in 1999 (National Science Board, 2000) and 44 percent of British citizens in 1996 and there is little reason to think that the numbers have declined since then.

It is one thing to read an astrology column for amusement or entertainment, but quite another to believe that astrological predictions about events or personality will come true. A surprisingly large quantity of scientific research has been carried out to evaluate the claims of astrology. Less surprisingly, there is really no evidence to support such claims (Blackmore & Seebold, 2001; Carlson, 1985; Eysenck & Nias, 1982). It is therefore cause for concern if citizens make important life decisions based on entirely unreliable astrological predictions. For this reason, in 1984, the Committee for Skeptical Inquiry (at that time the Committee for Scientific Investigation of Claims of the Paranormal) began a campaign to persuade American magazines and newspapers to attach a 'health warning' to horoscope columns to indicate that they were to be read for entertainment purposes only. Only around 70 publications out of 1000 or more in America that carry horoscopes have agreed thus far to carry such a warning. This probably indicates that newspaper proprietors don't want to spoil their readers' enjoyment by telling them that they should really ignore all the advice given. But perhaps people do not set any store by astrological predictions and a health warning is really not necessary. After all, one does not need to believe something is true to be entertained by reading it. However it appears that belief in astrological claims is quite widespread, at least in America. Losh and colleagues, in a review of 20 years of US survey data, found that many Americans believed in astrology, with polls putting the figure at around 25 percent (Losh, Tavani, Njoroge, Wilke, & Mcauley, 2003; National Science Board, 2002).

1.1 Astrology and science

Why should the credulity of some sections of the public towards astrology be a matter for concern for science communicators? Even if people do believe in astrology, or ghosts and alien abductions for that matter, does this have a bearing on people's understanding of and engagement with science? Again, the evidence is that it probably does. For not only do sizeable proportions of the American and European publics believe in the efficacy of astrology, they also believe that it is scientific. The ability of citizens to distinguish between scientific and pseudo-scientific claims is seen by many as an important component of scientific literacy. In a social and economic environment increasingly permeated by science, and the technological developments that flow from it, citizens require some basic competencies in order to meaningfully engage in rational judgments about a whole host of issues. For example, climate change, biofuels, stem-cell cloning, synthetic biology are all topics that have acquired, or are quickly gaining, political status, which in turn require societal decisions to be made. In Miller's framework for measuring civic scientific literacy, the rejection of astrology is an empirical criterion for identifying those who are and are not scientifically literate (Miller, 2004). Surveys in Europe and America have tracked public beliefs about astrology and science since 1988. In America, respondents have been asked whether astrology is 'very scientific, sort of scientific or not at all scientific'. Around 60 per cent said astrology is not at all scientific with around 30 per cent saying it is 'sort of scientific' in seven surveys between 1988 and 2001. In 2004, the proportion rejecting astrology rose slightly, to 66 per cent (National Science Board, 2006). In Europe, there appears to be more widespread belief that astrology is scientific. In 1992, respondents were asked how scientific they thought astrology was, with a 5-point scale anchored at either end with 'very scientific' or 'not at all scientific'. Only one quarter considered astrology 'not at all scientific', with another quarter considering it 'very scientific' and the remaining respondents falling somewhere in between (INRA, 1993). In 2001 the question was asked in a slightly different way, with only two response options offered – 'rather scientific' or 'not scientific'. 53 per cent thought astrology was 'rather scientific' (European Commission, 2001a).

The evidence, then, suggests that a sizeable minority of Americans and an even greater proportion of Europeans believe that astrology in some sense 'works', either because it is based on scientific methods or for other reasons. What might account for this widespread belief? And more interestingly, perhaps, what might explain differences in degree of belief in astrology between individuals and groups?

The most widely held explanation is less to do with the characteristics of the believer but more to do with the nature of astrological predictions themselves. The 'Barnum effect' has been

studied by extensively by psychologists. Named after the 19th century showman Phileas T. Barnum, it refers to the idea that people will believe statements about their personality that is vague or trivial if they think that it derives from some systematic procedure tailored to especially for them (Dickson & Kelly, 1985; Furnham & Schofield, 1987). The more birth detail is used in an astrological prediction or horoscope, the more credulous people tend to be (Furnham, 1991). The fact that people tend to assume that the more complex the information used as input into astrological readings, perhaps points to the reasoning that people use in mistaking astrology for science. "It sounds complicated – it must be scientific!"

1.2 The present study

While the Barnum effect is a fairly well-understood phenomenon that has been observed over experiments with an array of different kinds of participants, much less is known about heterogeneity of belief about astrology. The present study sets out to evaluate several potential explanations for variation in the credibility given to astrology *qua* science by European citizens, using a recent Eurobarometer survey. In doing so, I also examine how astrology is viewed alongside other knowledge generating practices, scientific or otherwise, in order to understand where astrology is located in the European public's representational field. In the following sections, I briefly outline some putative factors that I consider might account for variation in citizens' beliefs before describing in more detail the data and methods used for the empirical analysis.

1.2.1 The 'immunisation' hypothesis

From a traditional science communication perspective, it is scientific knowledge, particularly knowledge of the methods of science, that would be expected to 'immunise' citizens against false belief in pseudoscience. Hence those who are more scientifically literate, who understand principles of experimentation, the combining of empirical evidence with logical inference and so forth, should be more likely to realise that astrology, for all its formalistic presentation, is not consistent with the tenets of scientific method. The survey evidence broadly supports this hypothesis, albeit indirectly. In both Europe and America, correlates of scepticism about astrology's 'scientificness' tend to be higher levels of education, higher social class and income although there is some inconsistency between surveys. In 1992 Eurobarometer surveys showed that more highly educated Europeans were less likely to think that astrology is scientific, whereas in 2001, this was not the case (European Commission, 2001a). In America, education has been a consistent predictor. For example, the most recent NSF data show that while 84 per cent of

college graduates think that astrology is not at all scientific, just 62 per cent of those who only graduated from high school share this belief (National Science Board, 2008). Education is not, of course, coterminous with scientific knowledge, but it is strongly correlated (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008; Miller, 2004). Income and social class are themselves invariably correlated with education. Examining the relationship between scientific knowledge and belief in astrology as a science net of education, income and social class, would be a stronger test of the 'immunising' hypothesis, and one which I test in this paper.

1.2.2 What's in a name?

One of the better established findings in survey measurement is that responses can be extremely sensitive to the particular form of words used in the asking of the question (Schuman & Presser, 1996). In the European surveys reviewed earlier, the English version of the questionnaire uses the word 'astrology' as the stimulus object of the item: "People can have different opinions about what is scientific and what is not. I am going to read out a list of subjects. For each one tell me how scientific you think it is by the scale on this card … [other subjects] … Astrology". It is possible that people are unfamiliar with the this term but may be more familiar with terms like 'horoscopes', 'star signs', 'sun signs', which, if asked how scientific they are, might elicit different results. In fact, there is some evidence on this from the 1992 Eurobarometer survey. Respondents were randomised to two different versions of the list of subjects. One simply contained the single word, as above, while in the other condition, a brief explanation of each subject was given. For astrology, the explanation was: "…that is the study of occult influence of stars, planets etc. on human affairs". There was no significant difference in responses between the two conditions (INRA, 1993). However, in most European languages the suffix 'ology', 'ologie', 'ologia' connotes an academic field of study. This may be enough to encourage respondents to think that astrology is indeed a science where the use of an alternative term may bring to mind a different kind of activity. Another hypothesis that has intuitive plausibility, but which has not previously been tested, is that many people mistake astrology for astronomy – a simple semantic confusion. The extent to which this might occur is also likely to vary across countries according to the similarity of the two terms in different languages.

1.2.3 The stars down to earth

The explanations just outlined for belief, or apparent belief, in the scientificness of astrology are, in one form or another, based on deficits of understanding and information. There may be other

reasons why some people more than others place faith in astrological predictions. One of the most interesting social psychological viewpoints on this question is found in the work of Theodor Adorno. In 1952-3, Adorno carried out a study of Caroll Righter's Los Angeles Times astrology column. The fruits of this did not appear in English until published in 'Telos' in 1974 as 'The stars down to earth' (Adorno, 1974). In the study, referred to by the author as a 'content analysis', Adorno analyses, somewhat haphazardly and selectively, the advice given to readers in the column over a period of several months. He identifies many of the aspects of astrological readings that other psychological research (e.g. Forer, 1949) confirmed were effective in making them convincing: the Barnum effect, the tendency to personalise general statements and so forth. He is witheringly critical of astrology, dubbing it, with the rest of occultism, a 'metaphysic of dunces' and suggesting that 'a climate of semi-erudition is the fertile breeding ground for astrology'(Adorno, 1994 p.44). The claim is that it resembles other 'irrational creeds' like racism by offering a shortcut to (erroneous) knowledge which actually requires no intellectual effort or capacity (Dutton, 1995).

What is more interesting for the present study, though, is the connection drawn between astrology (and other forms of popular occultism) with authoritarianism, fascism and modern capitalism. Adorno sees astrology as emphasising conformity and deference to higher authority of some kind. Nederman and Goulding sum this up concisely as 'Take things as they are, since you are fated for them anyway' (Nederman & Goulding, 1981). Adorno posits an 'astrological ideology' that he claims 'resembles, in all its major characteristics, the mentality of the 'high scorers' of the Authoritarian Personality' (Adorno, 1994). The work on 'Authoritarian Personality' by Adorno and colleagues has been much criticised since its appearance in 1950 (Adorno, Frenkel-Brunswik, Levinson, & Sanford, 1950; Kirscht & Dillehay, 1967) with particular criticism being directed towards the test items in the 'F-Scale' (Hyman & Sheatsley, 1954). Nevertheless, it is possible to deduce a reasonably clear empirical hypothesis from 'stars down to earth'. Those who value conformity, obedience and tend towards uncritical acceptance of in-group moral authority will be more likely to give credence to the claims of astrology.

Adorno also discusses the relationship of organised religion, or religious belief with astrological belief. He suggests that part of astrology's appeal is that it formalises the notion of some higher authority at work controlling life events yet does not come with the explicitly restrictive structure of formal religious adherence, churchgoing and so on. This is part of what, for Adorno, makes astrological belief and capitalist individualism such well-suited bedfellows. That is to say that religious belief and astrological belief are both consistent with the same authoritarian trait of personality. If this is true, one might expect beliefs about astrology and about religion or God to be related.

1.3 Hypotheses and questions

The foregoing discussion leads to the derivation of the following hypotheses:

H1 The suffix 'ology' means that people should tend to rate 'astrology' as more scientific than 'horoscopes'.

H2a Because of potential confusion or elision of meaning between 'astronomy' and 'astrology', we should expect there to be a positive correlation between how people rate the scientificness of these two subjects.

H2b Assuming H2a to be correct, we should not expect to see the same positive correlation between ratings of horoscopes and astronomy because the potential for semantic confusion is much less.

H3 Citizens who are more knowledgeable about science should be less likely to rate astrology as scientific.

H4 Following Adorno's thesis, we should expect that people who score higher on a measure of authoritarianism will be more likely to rate astrology as being scientific.

In addition to the evaluation of these empirical expectations, there are two more general questions that are addressed in the analysis that follows:

Q1 How is astrology viewed by Europeans in relation to other scientific and non-scientific subjects?

Q2 How much of the variability in beliefs about astrology across Europe related to country of citizenship?

2 DATA AND MEASURES

2.1 Data

The data for this study come from the Special Eurobarometer 224 and 225 surveys, 'Europeans, Science and Technology', 'Social Values, Science and Technology' (European Commission, 2005a; 2005b). Both these survey modules were fielded as part of the same face-to-

face interview to citizens in 25 EU member states during the fall of 2004. Approximately 1000 respondents were interviewed in each country, using a multistage probability design. (For more details on the survey methodology see European Commission, 2005a). The resultant dataset contains rich information on citizens' beliefs, attitudes and knowledge about science and technology, as well as on political and social values. Also embedded within the survey was a split-ballot randomised question wording experiment.

2.2 Measures

The key dependent variable, belief in the scientificness of astrology, was measured by asking respondents how scientific they consider each of ten subjects to be, on a scale from 1 to 5 where 1 indicates "not at all scientific" and 5 indicates "very scientific". As part of the list of ten subjects a randomised half of the sample was asked about "astrology" and the other half about "horoscopes". The other nine subjects were: physics, medicine, astronomy, economics, history, homeopathy, psychology, biology and mathematics. (The exact question wordings and response alternatives for the English questionnaire for all of the measures employed in the analysis are shown in the appendix).

Authoritarian values are measured with a single indicator. While this is a good way short of ideal in terms of best practice in measurement, the question employed has what appears to be good face validity. Respondents are shown a list of qualities that children might be encouraged to learn. One of these qualities is 'obedience'. Responses to this item are on a 4-point scale ranging from 'not at all important' to 'very important'. Also related to Adorno's work on authoritarianism is religious belief. To capture this, I use an item that asks whether a respondent believes in 'God', a 'spirit' or neither. From this categorical variable, two dummy variables have been derived, indicating belief in God or belief in a spirit (both versus no belief). I also use a dummy variable indicating whether or not the respondent is Catholic. The majority of Europeans are Christians of some type, so distinguishing between Catholics and all others is a reasonable way of simply controlling for religious denomination in the analysis in the absence of any particular hypotheses about denomination-based differences in beliefs about astrology.

Knowledge about science is measured in a number of ways in the survey and in the analysis I use three separate indicators. Two of these tap into respondents' understanding of scientific process and method. An understanding of method is arguably central to being able to distinguish between scientific and pseudoscientific claims. People were asked 'what does it mean to study something scientifically?' The verbatim responses were coded into one of several mutually exclusive categories, based on what was said (in other words, not pre-coded). Typically this

question has been a very good predictor of attitudes and beliefs about science [see miller xxxx] with the mention of hypothesis testing and experimentation as the critical component. Here I use this as an indicator of greater scientific understanding along with another indicator based on the mentioning of 'measurement' in response to the question. The third indicator is a summated scale of correct responses to a series of 13 true/false quiz items that tap textbook type knowledge about scientific facts. For the purposes of this analysis, 'don't know' responses are coded with a zero, the same way as incorrect true/false answers. The scale has reasonable internal consistency with a Cronbach's Alpha coefficient of 0.72.

A range of other background characteristics were measured in the survey and used in the analysis. Respondent age was coded in bands: 16-24, 25-39, 40-54, 55+. Occupational status was measured with a dummy variable contrasting white collar and management occupations with all others. This is a necessarily crude indicator as it is based on standardised Eurobarometer occupational coding that needs to be comparable across European states. However, as it is only being used as a control variable in the analyses that follow, it is not critical to obtain a more fine-grained estimate of the effects of occupational status on beliefs about astrology. Education is measured, again quite bluntly, with a variable that indicates whether or not the respondent left full time education after the age of 20. This broadly distinguishes the graduate population, and it is this distinction that has in previous research been shown to be the most diagnostic of differences in attitudes and beliefs about science and technology (e.g. Miller, Pardo, & Niwa, 1997). Finally, the type of area in which the respondent lives is captured with a variable that indicates residence in a large town versus other types of area. Typically one might expect urban populations to have different cultural and political orientations to rural and provincial populations, net of education and occupational differences, hence this variable is used as a control.

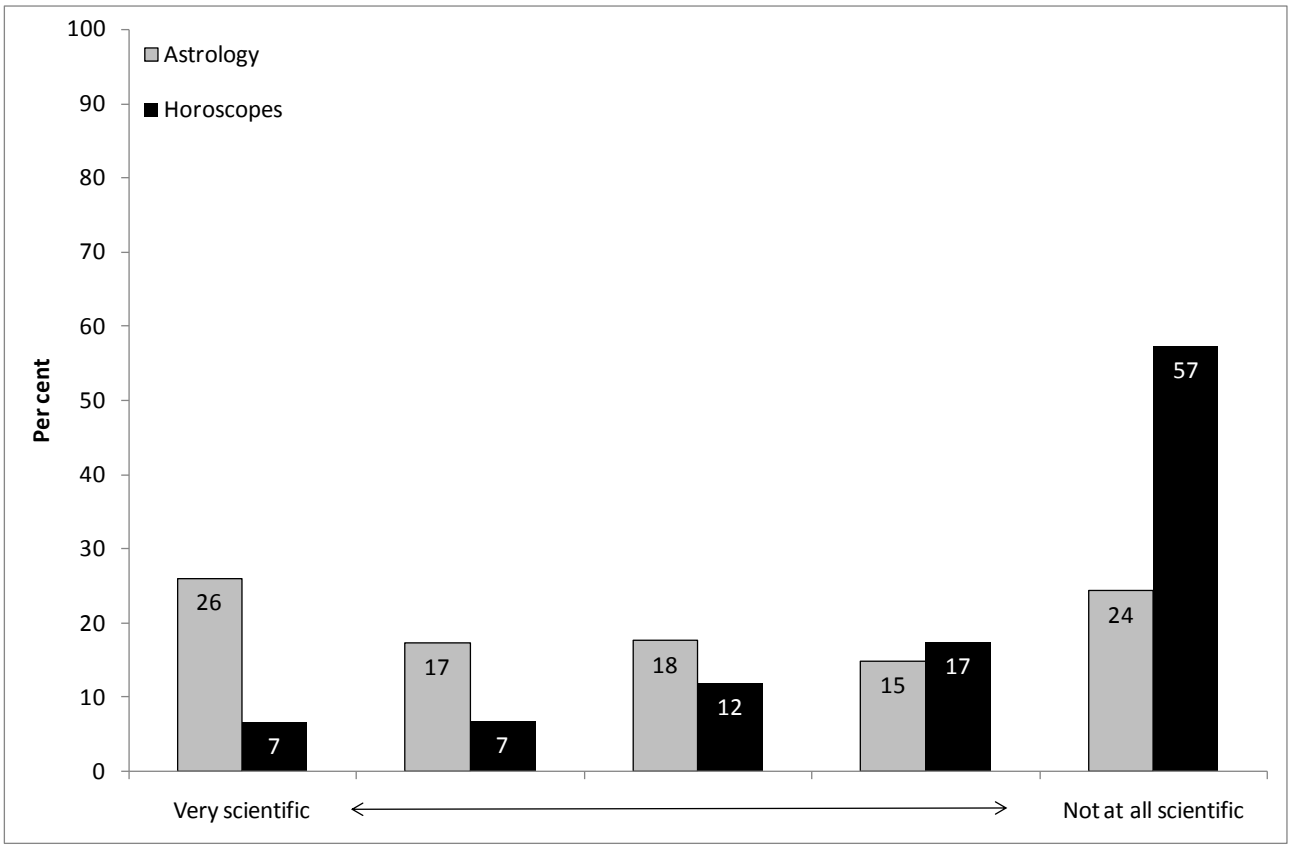
3 RESULTS

3.1 Split ballot experiment

Figure 1 shows the response distributions for the two experimental conditions. In one condition, respondents were asked how scientific they thought astrology was and in the other how scientific did they think horoscopes were. Quite clearly, many more Europeans think astrology scientific than horoscopes. 57 per cent think that horoscopes are "not at all scientific", while only 24 per cent believe the same about astrology. About one quarter of the sample believe astrology to be "very scientific", while only 7 per cent think that horoscopes are "very scientific". The difference in distributions is highly significant (Chi2 3400 (4df), $p<.001$. n=23,473). Astrology is clearly

viewed as greatly more scientifically credible than horoscopes and this is in line with the expectations set out in H1. Another point to note is that the there is a great deal more heterogeneity in beliefs about astrology than about horoscopes, with both 'very scientific' and 'not at all scientific' each attracting one quarter of all respondents.

Figure 1 How scientific is astrology/are horoscopes?



3.2 The relationship between astrology, horoscopes and other subjects

Figure 2 shows the distribution of European beliefs about the scientificness of all 11 subjects included in the questionnaire (including both horoscopes and astrology). The chart is ranked in descending order according to the percentage of people thinking each subject is 'very scientific'. As can be seen, the list includes a range of more or less scientific subjects, including both horoscopes and astrology, along with homeopathy, as examples of pseudoscience.

Medicine is viewed as the most scientific subject, followed closely by physics and then biology. Horoscopes are least likely to be thought "very scientific", followed by homeopathy, history and economics (17,18 and 19 per cent respectively). In most respects this is not a surprising

result. The natural sciences are at the top with social and behavioural subjects lower down. What is somewhat surprising, although in line with other surveys (European Commission, 2001b), is that astrology is considered to be more scientific than economics, and only just less so than is psychology.

Figure 2 'Scientificness' of eleven activities (%)

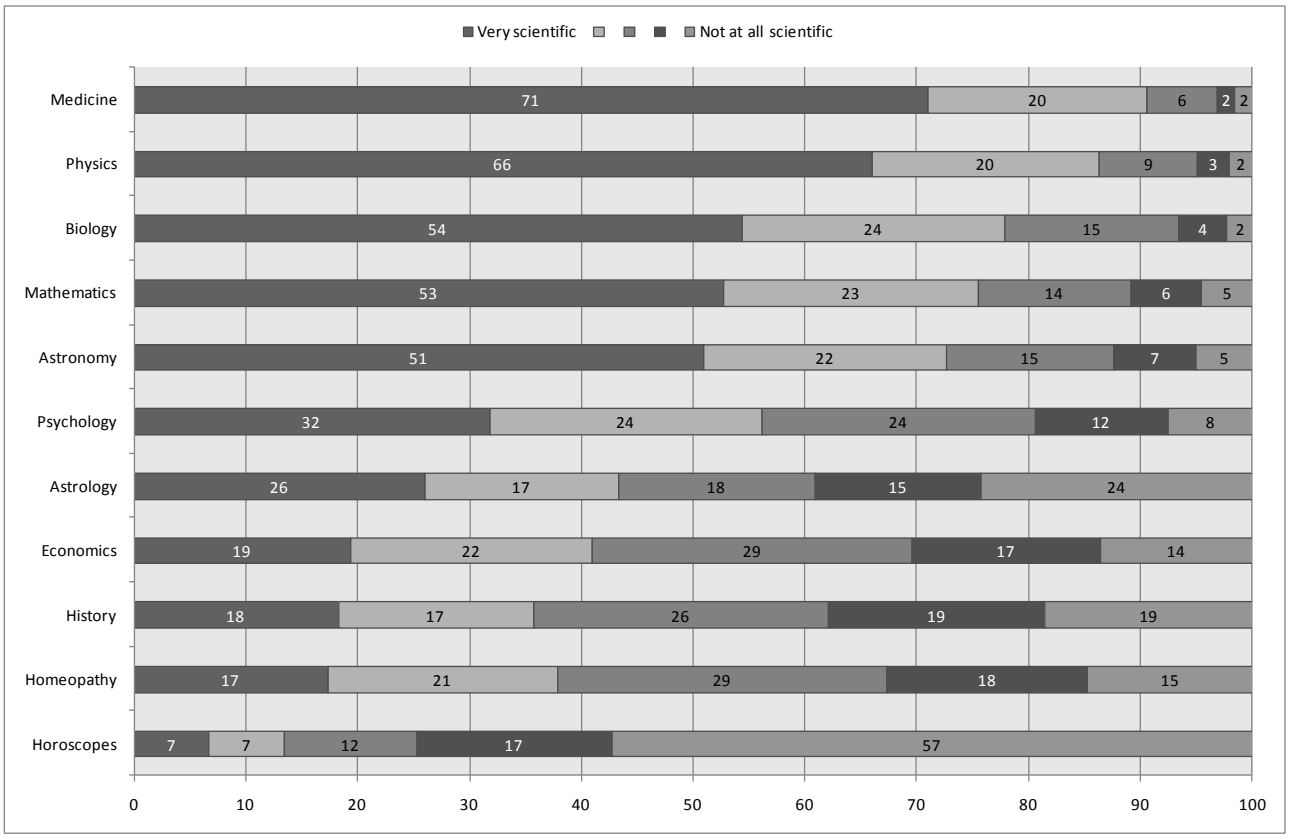


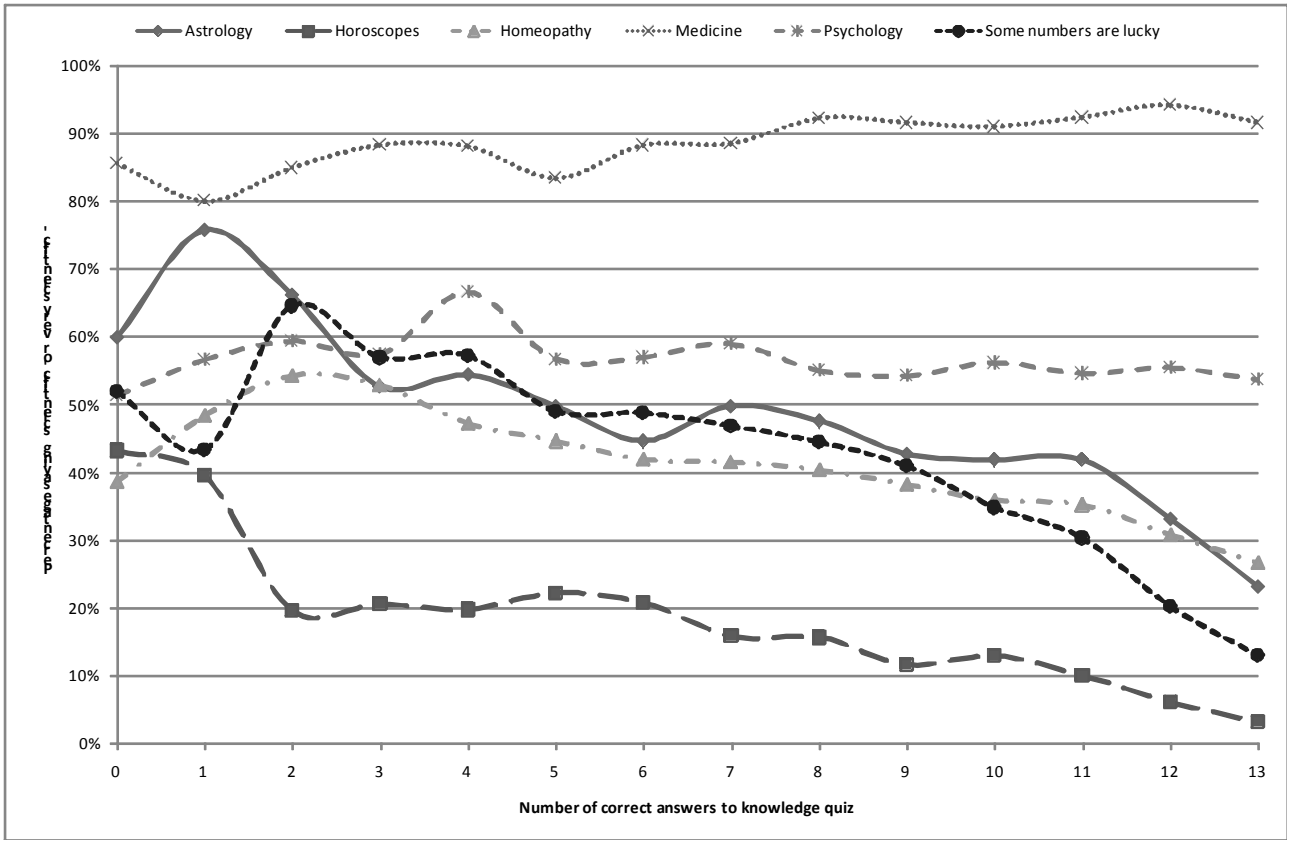
Figure 2 suggests some ambivalence about the scientific status of astrology if not homeopathy and horoscopes. Hypothesis 3 predicts that those who are more scientifically literate will be less likely to regard astrology as scientific. In more general terms, one might expect a higher degree of understanding of science to confer greater ability to discriminate between science and pseudoscience in general. Later in the paper I shall return to this hypothesis in a multivariate setting but it is interesting to see what happens when the result in

Figure 2 is stratified by scientific knowledge

The number of correct answers given by each respondent was used as an indicator of science literacy that runs from 0 to 13. Figure 3 plots the percentage of Europeans selecting "very

scientific" or the scale point below at each successive level of scientific knowledge. Also plotted out of interest is the percentage agreement with another the statement in the questionnaire that arguably taps into superstitious beliefs "some numbers are lucky for some people".

Figure 3 Beliefs about 'scientificness' vs science knowledge



The plot shows that there is a noticeably steep negative gradient with scientific knowledge for belief in the pseudosciences homeopathy, astrology and in lucky numbers. For instance between 50 and 60 per cent of citizens scoring 3 out of 13 on the knowledge quiz believe in the scientific credibility of homeopathy and astrology, and believe in lucky numbers. That percentage drops to just 15 to 25 per cent for those that obtain a maximum score on the knowledge quiz. In contrast, for both medicine and psychology, which, recall, are quite a long way apart in the rank ordering shown in

Figure 2, there is little or no difference between the beliefs of the better or worse informed citizen. (The lines for physics, biology and mathematics are similar to that for medicine and are not shown here, in order to keep the graph intelligible.)

A further exploration of the basis on which Europeans make judgments about the scientificness of these subjects was carried out using factor analysis. Two separate analyses, one

for each split half of the sample, were performed using maximum likelihood estimation and oblique rotation. Table 1 shows the factor loadings for the three factor model that resulted, based on an examination of the scree plot and substantive interpretability. An obliquely rotated solution was preferred because I assume that there are individual differences in the propensity to agree or disagree that any subject is scientific, as well as a tendency to discriminate between groups of similar subjects. The assumption is therefore that the factors will be positively correlated, which is what the oblique rotation achieves.

Table 1 Three factors underlying perceptions of scientificness (astrology condition)

	Rotated Factor Pattern Loadings (Tot. var. explained 42%)		
	'Hard science'	'Soft science'	'New age science'
Physics	0.88	-0.07	-0.12
Biology	0.61	0.00	0.04
Medicine	0.58	-0.01	0.12
Astronomy	0.49	-0.02	0.11
Mathematics	0.49	0.29	-0.12
Economics	0.02	0.71	0.01
History	-0.03	0.62	0.06
Homeopathy	0.00	0.07	0.62
Astrology	0.03	-0.02	0.44
Psychology	0.11	0.32	0.37

(Oblique rotation, Maximum Likelihood)

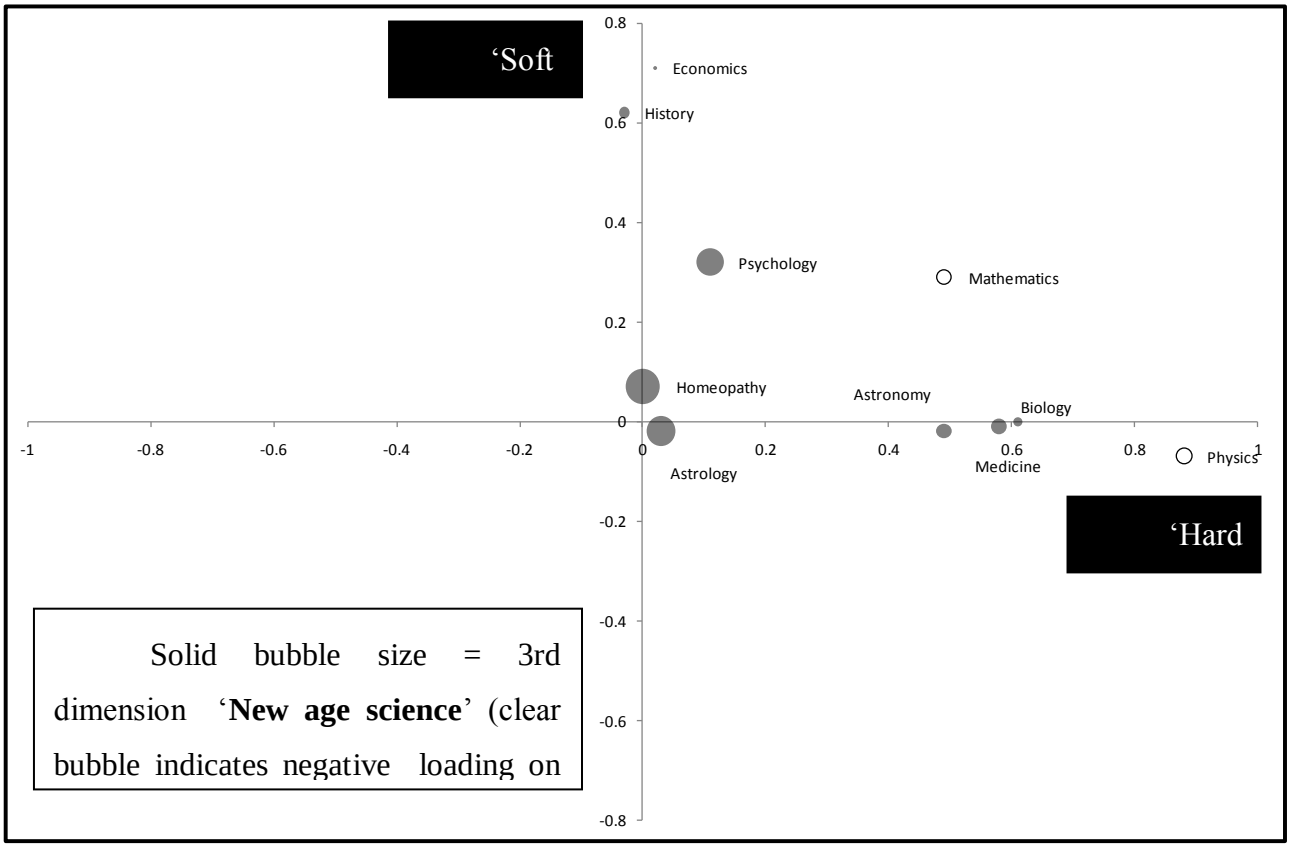
I have labelled the three factors 'hard science', 'soft science' and, for want of a better term, 'new-age science'. The highest factor loading for 'hard science' is physics at 0.88, while the 'soft science' includes economics and history, anchored by economics, at 0.71. Homeopathy, astrology and psychology form the 'new-age science' group, although psychology has a weak cross-loading with 'soft science'.

Figure 4 plots these loadings in the first two dimensions, with the third dimension, 'new-age science', indicated by the size of the bubbles. The reason for the 'new age' label is that the three subjects that load on this factor are the kind of subjects that people expect to see in the self-help, pop-psychology or new age therapy sections of bookstores. The representation of psychology for the European public is perhaps less about, for instance, cognitive neuroscience and more about self-help for overcoming depression.

In

Table 2, the rotated solution for the sample that were asked about horoscopes is presented. The main difference is that only two factors are needed to describe the cognitive structure organising responses to the ten subjects.

Figure 4 Factor loadings plot: astrology condition



There is no separate 'new-age science' dimension, with horoscopes, homeopathy and psychology joining history and economics to form a 'soft science' group. The 'hard science' subjects remain the same, with physics again anchoring the factor with the highest loading, at 0.78.

Table 2 *Two factors underlying perceptions of scientificness (horoscopes condition)*

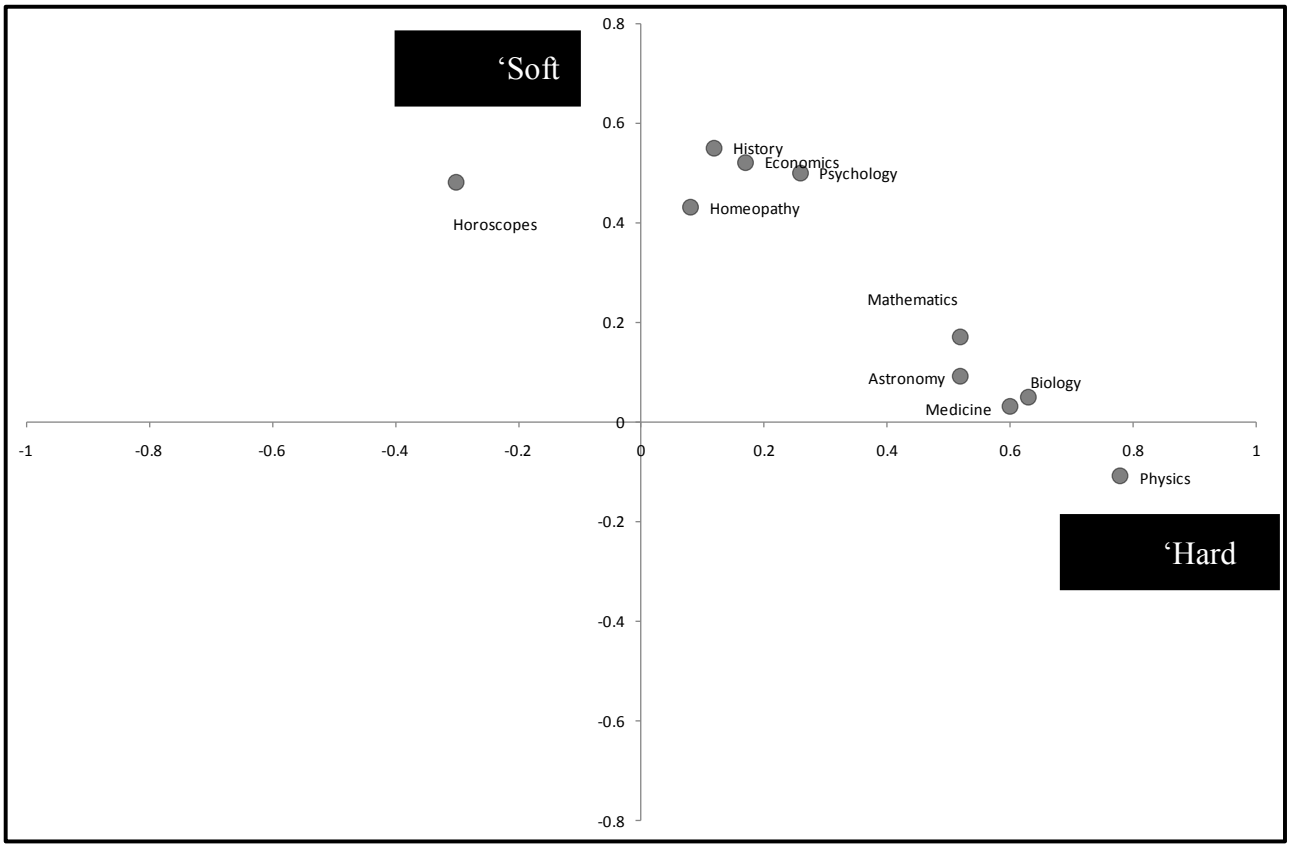
	Rotated Factor Pattern Loadings (Tot. var. explained 36%)	
	'Hard science'	'Soft science'
Physics	0.78	-0.11
Biology	0.63	0.05
Medicine	0.60	0.03
Mathematics	0.52	0.17
Astronomy	0.52	0.09
History	0.12	0.55
Economics	0.17	0.52
Psychology	0.26	0.50
Horoscopes	-0.30	0.48
Homeopathy	0.08	0.43

(Oblique rotation, Maximum Likelihood)

The factor loadings are plotted in Figure 5, where it is possible to clearly see the two groupings. Note also that horoscopes is the only 'soft science' subject that loads negatively on the hard science dimension. This was not the case for astrology, demonstrating further evidence that the latter perceived as being more like a science subject.

The results seen thus far indicate fairly unequivocally that while horoscopes and astrology are to all intents and purposes the same thing, at least in so far as the casual engagement of the average citizen is concerned, the two terms have rather different connotations.

Figure 5 *Factor loadings plot: horoscopes condition*



Astrology probably ‘sounds’ more scientific than horoscopes, it is consequently evaluated as being more scientific and is viewed in a more similar way to psychology and homeopathy than are horoscopes. Having elaborated a description of how astrology is perceived, the following section turns to the question of what might underlie the variation in these perceptions amongst citizens and across European states.

3.3 Variation in beliefs between citizens

The final part of the analysis is a multivariate investigation of social and psychological factors that might influence individuals’ propensity to believe that astrology is a scientific subject. To do this I use a variant of an OLS multiple regression model.

This analysis is primarily to examine individual level factors associated with beliefs about astrology. However, there is also likely to be heterogeneity of beliefs between the 25 European countries, even after taking into account individual characteristics. Modelling this situation calls for country to be included as either a fixed or random effect. The first approach essentially gives each country its own dummy variable and regards each as a unique entity, so to speak. The second approach treats the countries in the dataset as a random sample of potential countries that could have been included and estimates a single mean and variance for a continuous random variable that

captures the heterogeneity across countries (Raudenbusch & Bryk, 2001). The model parameters can then be used to derive an estimate of each country's location in the distribution of this variable.

If the individual level effects are uncorrelated with this country random effect, the random effects estimator is unbiased and preferred over the fixed effects one, because it is more efficient. If this assumption is not met, the fixed effects approach is appropriate. The result of a Hausman test (Hausman, 1978), which tests for the presence of this correlation, was highly non-significant (Chi^2 5.86, 17df, p=0.99) so the final model presented here uses the random effects estimator.

Table 3 Random effects regression estimates (individual characteristics)

(n=11622)	B	SE	Z	p
Age (reference category 15-24)				
25-39	-.12	.04	-2.66	.01
40-54	-.14	.04	-3.34	<.01
55+	-.22	.04	-5.22	<.01
Female	.06	.03	2.18	.01
Higher education	-.19	.03	-5.75	<.01
Professional or management occupation	-.08	.04	-1.89	.06
Large town or city dweller	-.10	.03	-3.04	<.01
Religious belief				
Catholic	.13	.04	3.70	<.01
God	.08	.04	2.02	.04
Spirit	.12	.04	3.21	<.01
Right wing political orientation	.01	.004	2.26	.02
Science knowledge				
Quiz score	-.09	.01	-17.42	<.01
Mentions hypothesis testing	-.25	.06	-4.55	<.01
Mentions measurement	-.21	.05	-4.52	<.01
Authoritarian	.22	.02	10.36	<.01
Astronomy scientific	.32	.01	26.80	<.01
All scientific	.24	.02	12.41	<.01
(Intercept)	1.18	.14	8.67	<.01

Table 3 presents the estimates for the model predicting beliefs about astrology. Higher scores on the dependent variable indicate stronger belief that astrology is scientific. The included predictors account for 17 per cent of the variance in beliefs. Turning first to hypothesis H2a, the expectation was that there should be some correlation between beliefs about astronomy and beliefs about astrology because of semantic confusion. This is indeed the case here. The coefficient for astronomy is .35 with a very small standard error. Net of all other modelled influences, the more likely it is that citizens believe astronomy is scientific, the more likely they are to think that astrology is also scientific. It appears that the two subjects are not always well differentiated in European public imagination. In order to counter potential objections to this conclusion, I have included an additional variable ('all scientific') that is calculated as the mean of respondents' belief scores on all the other subjects except for horoscopes and homeopathy. Without this control, it could be argued that the correlation between astronomy and astrology is due to individual differences in the propensity to express the view that *anything* is scientific. The inclusion of this variable, though, does not eliminate the positive coefficient for astronomy.

Hypothesis H2b, if supported, would corroborate further this interpretation. I would not expect to see the same positive relationship between astronomy and horoscopes, precisely because they do not sound similar. To test this, I fitted the same model using the other split half of the sample and designating horoscopes as the dependent variable. The pattern of results is very similar to that in Table 3 but, crucially, the coefficient for astronomy is very small, at .05 (SE=.01; Z=4.23; $p<.01$), compared to the estimate in the astrology model.

Hypothesis three concerns the relationship of scientific knowledge or literacy with perceptions of astrology. The expectation is that those who are better endowed with civic scientific literacy will be better able to distinguish science from pseudoscience. Therefore, I expect positive coefficients for the knowledge measures. Looking at Table 3, one can see that this is indeed the case. The coefficients for all three knowledge variables are negative and statistically significant, meaning that the more knowledgeable a person is, the less scientific they believe that astrology is. To get a sense of the magnitude of the effects, if one compared a citizen who scored at the mean on the quiz and mentioned neither hypothesis testing nor measurement in their open ended answer, their expected rating of astrology would be one point higher on the five point scale (in the 'more scientific' direction) than a European mentioning both measurement and hypothesis testing and who scored at the maximum on the quiz, with all other variables held constant. Particularly interesting is the fact that science knowledge has an effect even after controlling for education.

The fourth hypothesis addressed in the analysis considers the relationship of authoritarian personality type with beliefs about astrology. The coefficient for the authoritarianism question is

positive, at .22, and highly significant. For each one point increase on the 'importance of obedience' question the model predicts just under a one quarter point increase in the scientificness of astrology rating. So, controlling for all the other covariates, the predicted difference in belief about astrology between Europeans who don't think obedience is at all important to teach to children and those who think it very important is just slightly more than one scale point. Here, then, is empirical support for Adorno's linking of authoritarianism and openness to pseudoscience. Note again that this relationship is robust to the full range of other controls in the model, in particular age, education and conservative or right wing political orientation.

People who report believing in God or in a 'spirit of some kind' are more likely to think astrology is scientific. Catholics are also more likely to express this view. These results are again in line with what one might expect from Adorno's account of the appeal of astrology to those who have a propensity to defer to higher authority of different kinds, including religion. I have no clear explanation for why Catholics should be more likely to be credulous of astrology but it should be borne in mind that this finding of course controls for country as well as for individual characteristics. This means that religious denomination here is not simply a proxy for divergent beliefs of citizens from predominantly Catholic and non-Catholic European states.

The coefficients for the other socio-demographic variables are worth noting. Women are slightly more likely than men to think astrology is scientific, as are people who self-identify as being politically on the right. Those who live in large urban areas, who are better educated and in high status occupations are all less likely to accord astrology scientific credibility. A rather interesting finding is that older people tend to be less credulous of astrology. It is the youngest age group, 15-24, that regards astrology as most scientific. This invites speculation as to whether it is a lifecycle or a cohort effect we are seeing here. Do people become more sceptical as they age? Or are younger generations in general less sceptical than their parents? This is something for further research to establish.

3.4 Variation in beliefs between countries

Table 4 shows the variance components estimates for both individual and country levels. This can be thought of as the proportion of unexplained, residual variation between individuals and between countries. The first two columns of the table show these variance estimates and the corresponding percentages for a model where only the intercept is fitted. In other words, it simply partitions total variation into within-group and between-group (individual and country). As little as 13 percent of the variation in beliefs about astrology is systematically related to country, while the remainder is due to inter-individual variation. When the full model, with all the independent

variables is estimated, the proportion due to country drops by around on third, to 8 percent. This indicates that some of the apparently systematic country variation is due to compositional differences in populations on the individual characteristics entered into the model. In general terms, it would appear that the social-psychological factors that influence beliefs about astrology and science across Europe are broadly common to citizens from all countries.

Table 4 Variance components for intercept-only and full models

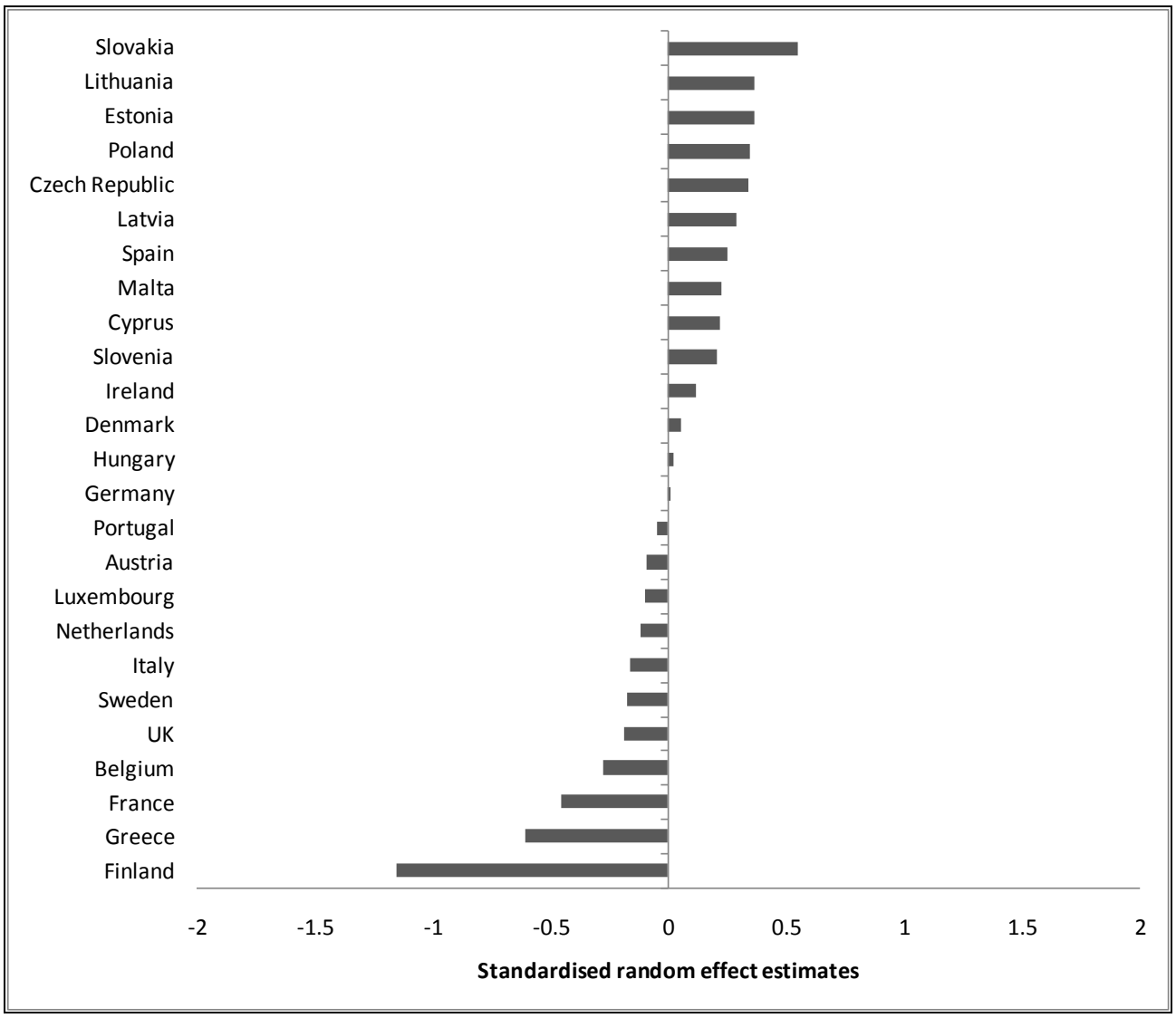
	Intercept-only model		Full model	
	Variance (SE)	% of total variance	Variance (SE)	% of total variance
Individual level residual	2.08 (.03)	87	1.80	92
Country residual	.27 (.08)	13	.14	8

Nevertheless, this is not to say that there is no systematic difference between countries at all. One way of exploring this is to obtain estimates of the unobserved country level random effect variable and to compare estimates across countries. These estimates are also known as 'empirical Bayes estimates'(Raudenbusch & Bryk, 2001). These can be thought of as unexplained country level residuals, expressed in standard deviations from the mean (zero), after taking into account all the individual level variables in the model. There is a surprisingly clear pattern to the variation. Controlling for the individual characteristics of citizen, all of the former Eastern bloc countries are more accepting of astrology as being scientific than the model would predict, while the majority of western European states have more skeptical citizens than would be expected given the individual attributes of their citizens.

Figure 6 shows standardised random effects estimates for each of 25 European member states. These can be thought of as unexplained country level residuals, expressed in standard

deviations from the mean (zero), after taking into account all the individual level variables in the model. There is a surprisingly clear pattern to the variation. Controlling for the individual characteristics of citizen, all of the former Eastern bloc countries are more accepting of astrology as being scientific than the model would predict, while the majority of western European states have more skeptical citizens than would be expected given the individual attributes of their citizens.

Figure 6 Standardised random effect estimates for 25 European countries



4 CONCLUSION

Europeans have a range of beliefs about astrology and its status as a scientific or quasi-scientific subject. The evidence from the experiment and from the observational data show that there is considerable blurring over what the term means. There is a clear confusion between astronomy and astrology. There are also widely differing opinions on horoscopes as compared to astrology, even though one might consider the two as functionally equivalent to most intents and purposes. Astrology is regarded as more scientific than horoscopes. Perhaps previous research on science literacy that has gauged the credulousness of citizens about astrology has led to rather more pessimistic conclusions than are really warranted.

However, science literacy clearly makes a difference. Net of a range of other potential confounding influences, the better is one's understanding of scientific terms and concepts, as well

as factual knowledge of science, the better one is able to distinguish science from pseudo-science. This immunising effect of scientific knowledge is perhaps not a surprising finding, but one that underlines the utility of these survey indicators in distinguishing between modes of citizen reasoning about science and confirms the importance of scientific literacy in helping Europeans make informed judgments about the validity of pseudoscientific claims. While this study has not focused on health and consumer choices, it is quite possible that the model presented here holds across a range of pseudo-scientific domains in which citizens are confronted with the need to make choices.

The result that authoritarian-type values are associated with greater credulity towards astrology is fascinating and in line with Adorno's prediction. Whether it is because of a general propensity to defer to any kind of authority, or whether it is bound up with anti-rational culture in the way that Adorno hypothesised is open to question. Further research could profitably be directed towards a greater elaboration of the mechanisms underlying the observations made in the present study. Perhaps linked to this finding are the systematic country variations. Former Eastern bloc states seem to be more accepting of astrology and more likely to consider it scientific. This holds true even conditioning on science literacy, religion, education, political orientation and values. Citizens of these countries have a recent history of state and civil society being organised along authoritarian lines, and this cultural norm may be reflected in the readier acceptance of astrology in Eastern Europe, over and above that due to variation in individual personality traits.

This investigation has explored some of the correlates and putative causes of different beliefs about astrology and its relationship with science. As a final note, it should probably be borne in mind that for most people, reading a horoscope is a leisure activity and not one of central importance either. Nevertheless, by understanding how Europeans differ in their perceptions of astrology and horoscopes, it is possible to gain some insight into the bases of how citizens evaluate scientific and pseudoscientific claims more generally.

APPENDIX

Question items

Here is a list of qualities that children might be encouraged to learn at home. Please indicate for each of them how important you consider it to be. .....'Obedience'	Very important, Fairly important, Not very important, Not at all important, Don't know (not offered by interviewer as a response)

REFERENCES

Adorno, T. (1974). The Stars Down to Earth. *Telos, 6*(Spring).

Adorno, T. (1994). The stars down to earth: the Los Angeles Times astrology column. In S. Crook (Ed.), *The stars down to earth and other essays on the irrational in culture*. London: Routledge.

Adorno, T., Frenkel-Brunswik, E., Levinson, D. J., & Sanford, R. N. (1950). *The authoritarian personality*. New York: Harper & Row.

Allum, N., Sturgis, P., Tabourazi, D., & Brunton-Smith, I. (2008). Science knowledge and attitudes across cultures: a meta-analysis. *Public Understanding of Science 17*(1), 35-54.

Blackmore, S., & Seebold, M. (2001). The effect of horoscopes on women's relationships. *Correlation, 19*(2), 17-32.

Carlson, S. (1985). A double-blind test of astrology. *Nature, 318*, 398-399.

Dickson, D. H., & Kelly, I. W. (1985). The 'Barnum effect' in personality assessment: A review of the literature. *Psychological Reports, 57*, 367-382.

Dutton, D. (1995). Theodor Adorno on astrology. *Philosophy and Literature, 19*, 424-430.

European Commission. (2001a, December). *Europeans, science and technology*. Available: http://europa.eu.int/comm/public_opinion/archives/eb/ebs_154_en.pdf.

European Commission. (2001b). *Europeans, Science and Technology (55.2) - SPSS dataset*. Available: www.data-archive.ac.uk.

European Commission. (2005a). *Special Eurobarometer 224: Europeans, Science & Technology*. Brussels.

European Commission. (2005b). *Special Eurobarometer 225: Social values, Science & Technology*. Brussels.

Eysenck, H. J., & Nias, D. K. B. (1982). *Astrology: science or superstition?* London: Maurice Temple Smith.

Forer, B. R. (1949). The Fallacy of Personal Validation: A classroom Demonstration of Gullibility. *Journal of Abnormal Psychology, 44*, 118-121.

Furnham, A. (1991, 26th January). Hooked on horoscopes: We may not be able to persuade people that astrology and graphology are nonsense. But psychology, with the help of a showman, reveals why they are so popular. *New Scientist*.

Furnham, A., & Schofield, S. (1987). Accepting personality test feedback: A review of the Barnum effect. *Current Psychological Reviews and Research, 6*

162-178.

Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica, 46*(6), 1251-1271.

Hyman, H., & Sheatsley, P. (1954). The Authoritarian Personality - a methodological critique. In R. Christie & M. Jahoda (Eds.), *Studies in the scope and method of the "Authoritarian Personality"*. Illinois: Glencoe.

INRA. (1993, December). *Europeans, science and technology: public understanding and attitudes*. Available: http://europa.eu.int/comm/public_opinion/archives/eb/ebs_154_en.pdf.

Kirscht, J. P., & Dillehay, R. (1967). *Dimensions of Authoritarianism: a Review of Research and Theory*. Lexington: University of Kentucky Press.

Losh, S., Tavani, C., Njoroge, R., Wilke, R., & Mcauley, M. (2003). What does education really do? *Skeptical Inquirer, 27(5):30-35.*(5), 30-35.

Miller, J. D. (2004). Public Understanding of, and Attitudes toward, Scientific Research: What We Know and What We Need to Know. *Public Understanding of Science, 13*(3), 273-294. Available: http://pus.sagepub.com/cgi/content/abstract/13/3/273

Miller, J. D., Pardo, R., & Niwa, F. (1997). *Public perceptions of science and technology: a comparative study of the European Union, the United States, Japan and Canada*. Bilbao: Fundacion BBV.

National Science Board. (2000). *Science and Engineering Indicators - 2000*. Arlington, VA: National Science Foundation.

National Science Board. (2002). *Science and Engineering Indicators - 2002* (NSB-02-1). Arlington, VA: National Science Foundation.

National Science Board. (2006). *Science and Engineering Indicators - 2006*. Arlington, VA: National Science Foundation.

National Science Board. (2008). *Science and Engineering Indicators - 2008*. Arlington, VA: National Science Foundation.

Nederman, C., & Goulding, J. (1981). Popular Occultism & Critical Social Theory: Exploring some Themes in Adorno's Critique of Astrology & the Occult. *Sociological Analysis: A Journal in the Sociology of Religion, 4* (Winter), 325-32.

Raudenbusch, S., & Bryk, A. (2001). *Hierarchical Linear Models: Applications and Data Analysis Methods*. (2nd ed.). Thousand Oaks, CA: Sage.

Schuman, H., & Presser, S. (1996). *Questions and answers in attitude surveys: experiments on question form, wording, and context*. Thousand Oaks, CA: Sage.