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The connection between handedness and the three major dimensions of personality revisited:

A study among 13- to 15-year-old students in England and Wales

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Abstract

Previous studies examining the connections between the Eysenckian dimensions of personality and handedness have often been limited by small samples and by the failure to take sex differences recorded on the personality scales into account. Addressing these limitations the present study draws on data provided by a sample of 26,730 13- to 15-year-old adolescents who completed the abbreviated form of the Junior Eysenck Personality Questionnaire, together with a measure of handedness. Binary logistic regression demonstrated that non-right-handedness was significantly associated with toughmindedness (higher psychoticism scores), introversion (lower extraversion scores), and emotional stability (lower neuroticism scores). The fitted logistic model was then calculated to predict probabilities for handedness.

Keywords: handedness, personality differences, sex differences, Eysenck, adolescents

Introduction

Setting the scene

Explorations concerning connections between handedness and individual differences in personality characteristics (broadly conceived) have been a matter of interest within empirical psychology since the 1970s (Hardyck et al., 1976). The issue remains of scientific interest, linking physiological and psychological phenomena. Specific findings have reported higher emotional instability scores among left-handers (Orme, 1970), higher manifest anxiety scores among left-handers (Hicks & Pellegrini, 1978a), higher divergent thinking scores among left-handed males (Coren, 1995), higher schizotypal personality scores among left-handers (Poreh et al., 1997), higher inhibition scores among left-handers (Wright et al., 2009), lower levels of general cognitive ability among left-handers (Nicholls et al., 2010), and higher levels of sensation seeking, experience seeking and thrill and adventure seeking among left-handers (Kuderer & Kirchengast, 2016). However, other studies have reported no differences in external locus of control among left-handers and right-handers (Hicks & Pellegrini, 1978b), and no difference in alcohol dependence among left-handers and right-handers (Poikolainen, 2000).

Taking a broader view of individual differences in personality, Coren (1994) employed the Interpersonal Adjective Scales (Wiggins, 1979, 1995) among a sample of 930 consistent left-handers and right-handers. The main finding from this study was that left-handers rated themselves higher on the arrogant/calculating dimension (claiming as accurate self-descriptors: cocky, crafty, cunning, boastful, wily, calculating, tricky, and sly) and higher on the cold-hearted dimension (claiming as accurate self-descriptors: ruthless, ironhearted, hardhearted, uncharitable, coldhearted, cruel, and unsympathetic).

Two streams of research have explored the location of handedness within well-established psychometric theories of personality: the big five factor model with its roots in

the work of Costa and McCrae (1985), differentiating among the factors of extraversion,

agreeableness, openness, conscientiousness, and neuroticism; and the three major dimensions

model with its roots in the work of Eysenck, differentiating originally between the two

dimensions of extraversion and neuroticism (Eysenck & Eysenck, 1964) and subsequently

among the three dimensions of extraversion, neuroticism, and psychoticism (Eysenck &

Eysenck, 1975). The big five factor model and handedness have been examined by Grimshaw

and Wilson (2013) and Sartarelli (2016). The Eysenckian model and handedness has been

examined by Mascie-Taylor (1981), Furnham (1983), Lester (1987), Camposano et al.

(1991), Kalodner et al. (1994), Beratis et al. (2011), and Wright et al. (2013). The present

study builds on the larger body of research established on the Eysenckian model.

The two models of personality (the big five factors and the major three dimensions)

are rooted in different theoretical and empirical frameworks. The Eysenckian model, the

earlier of the two models, was developed on the basis of the theory that there is a continuum

flowing from individual differences in normal personality into psychopathologies, leading to

the naming of the high scoring pole of two of the dimensions as neuroticism and

psychoticism (see Eysenck & Eysenck, 1976). Empirically items were selected to assess these

three dimensions on the assumption that the dimensions should be orthogonal. The big five

factor model was atheoretical in its origin and derived from the factor reduction of a wide

range of individual differences. As a consequence of this difference in origin, the definition

of 'personality' assumed by these two measures is different. While the three major

dimensions models intentionally confuses personality with psychopathology, the big five

factor model can be criticised for unintentionally confusing personality with character (Lloyd,

2015).

Within the Eysenckian dimensional model, the most recent edition of the test manual

defines the high scoring pole of the three dimensions in the following ways (Eysenck &

Eysenck, 1991). The person who records high scores on the extraversion scale is described as:

> sociable, likes parties, has many friends, needs to have people to talk to, and does not like reading or studying by himself. He craves excitement, takes chances, often sticks his neck out, acts on the spur of the moment, and is generally an impulsive individual. He is fond of practical jokes, always has a ready answer, and generally likes change; he is carefree, easy-going, optimistic, and likes to 'laugh and be merry'. He prefers to keep moving and doing things. (p. 4)

The person who records high scores on the neuroticism scale is described as:

> an anxious, worrying individual, moody and frequently depressed. He is likely to sleep badly, and to suffer from various psychosomatic disorders. He is overly emotional, reacting too strongly to all sorts of stimuli, and finds it difficult to get back on an even keel after each emotionally arousing experience. His strong emotional reactions interfere with his proper adjustment, making him react in irrational, sometimes rigid ways. (p. 4)

The person who records high scores on the psychoticism scale is described as someone who:

> may be cruel and inhumane, lacking in feeling and empathy, and altogether insensitive. He is hostile to others, even his own kith and kin, and aggressive, even to loved ones. He has a liking for odd and unusual things, and a disregard for danger; he likes to make fools of other people, and to upset them. Socialisation is a concept which is relatively alien to high P scorers; empathy, feelings of guilt, and sensitivity to other people are notions which are strange and unfamiliar to them. (p. 6)

> While the conceptualisation and operationalisation of Eysenck's two original dimensions of personality (extraversion and neuroticism) have remained supported and relatively unchallenged across a series of refinements, the third dimension (psychoticism) has

been challenged on both conceptual and empirical grounds. The conceptual challenge concerns the perceived overlap between the definition of psychoticism and psychopathy (see Hare, 1982; Heym et al., 2013). The empirical challenge concerns the unsatisfactory internal consistency reliability often reported by the psychoticism scale (see Francis et al., 1992).

Handedness and the major two or three dimensions of personality

Mascie-Taylor (1981) employed the Eysenck Personality Inventory (Eysenck & Eysenck, 1964) among a sample of 386 adults (193 husband and wife pairs). This study reported no significant differences between right-hand and left-hand writers in terms either of neuroticism scores or extraversion scores.

Furnham (1983) employed the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) among a sample of 210 sixth-form students, 15.7% of whom reported being left-handed. This study reported no significant connection between handedness and either neuroticism or psychoticism. However, left-handed students recorded significantly higher extraversion scores than right-handed students.

Lester (1987) employed the Maudsley Personality Inventory (Jensen, 1958) among a sample of 182 students, 18.7% of whom reported being left-handed. This study reported no significant connection between handedness and neuroticism. However, left-handed female students recorded significantly lower extraversion scores than right-handed female students.

Camposano et al. (1991) employed the Eysenck Personality Questionnaire Revised (Eysenck et al., 1985) among 27 right-handers (13 men and 14 women) and 25 left-handers (13 men and 12 women). Comparing scores for men and for women separately this study reported no significant connection between handedness and neuroticism, extraversion, or psychoticism.

Kalodner et al. (1994) employed the Eysenck Personality Questionnaire Revised (Eysenck et al., 1985) among 22 left-handed and 57 right-handed men and 19 left-handed and

87 right-handed women. This study reported lower psychoticism scores among left-handed men compared with right-handed men.

Beratis et al. (2011) employed the Eysenck Personality Questionnaire (Eysenck & Eysenck, 1975) among 43 left-handers (20 males) and 41 right-handers (21 male). This study displayed lower neuroticism scores and higher psychoticism scores among left-handers, although the statistical significance of the differences is not reported.

Wright et al. (2013) employed the neuroticism scale and the extraversion scale from the short-form Eysenck Personality Questionnaire Revised (Eysenck et al., 1985) among 28 male (12 left-handed) and 57 female (21 left-handed) university students. This study displayed significantly lower neuroticism scores among left-handers but no significant differences in extraversion scores between left-handers and right-handers.

The studies that have explored the connection between handedness and the two or three major dimensions of personality have drawn on a variety of measures for handedness. Mascie-Taylor (1981) determined hand preference in relation to seven activities: writing, throwing, playing games with a racket or bat, cutting with scissors, brushing teeth, striking a match, and either hammering (for men) or threading a needle (for women). Furnham (1983) determined handedness by inviting participants to specify whether they were predominantly left-handed, right-handed, or mixed-handed. Lester (1987) asked participants with which hand they wrote. Camposano et al. (1991) determined handedness by concordant manual preference for writing, eating with a spoon, holding a hammer to hit a nail, and throwing a ball (participants who showed mixed preferences were not included in the study). Kalodner et al. (1994) employed a 13-item measure of handedness proposed by Raczkowski et al. (1974). Beratis et al (2011) identified handedness by concordant manual preferences for hand-writing, hand-throwing, and hand-holding a knife without a fork. Additional information was provided by the Edinburgh Handedness Inventory (Oldfield, 1971). Wright et al. (2013)

employed the Hand, Eye and Ear Preference questionnaire proposed by Jackson (2008). This instrument included ten hand preference questions; handedness was determined by consistent preference across all ten questions.

No clear consensus emerges from the findings of this disparate set of studies exploring the connection between handedness and the Eysenckian dimensional model of personality. For this reason specific hypotheses cannot be safely drawn from previous research to shape the enquiry. This body of research has been generally frustrated by small sample sizes and by the complex interaction between sex differences and scores recorded on the Eysenckian personality measures, whereby women routinely record higher neuroticism scores than men (see Francis, 1993) and men routinely record higher psychoticism scores than women (see Eysenck & Eysenck, 1976). What is needed to clarify this problem is a larger sample and the ability to control for sex differences in personality before exploring the impact of personality on handedness.

Research aim

Against this background, the present study revisited the Teenage Religion and Values Survey conducted among 33,982 young people between the ages of 13 and 15 years during the 1990s. The Teenage Religion and Values Survey was designed to examine the complex associations between religion, values, personality, and external factors like school type. An initial overview of these data was published by Francis (2001). This initial study was followed by a series of focused analyses drawn together and summarised by Robbins and Francis (2010). Many of the surveys completed by these young people included both an Eysenckian measure of personality and a question concerning handedness. In this context the research aim was to explore the connection between handedness and the three major dimensions of personality, controlling for sex differences in personality in the analyses.

Method

Procedure

The Teenage Religion and Values Survey was presented as a 16-page A5 booklet in which all items were presented in a fixed order. Schools that agreed to participate in the project were asked to follow a standard procedure. The 16-page booklets were administered in normal class groups to all year nine (13- to 14-year-old) and year ten (14- to 15-year-old) students throughout the school. Students were asked not to write their names on the booklet and to complete the inventory under examination-like conditions. Although the students were given the choice not to participate, very few declined to do so. They were assured of confidentiality and anonymity. A total of 163 schools participated in the project, with thoroughly completed responses from 26,730 students who provided full data on the measure of personality and information on handedness.

Instrument

The Teenage Religion and Values Survey (Francis, 2001; Robbins & Francis, 2010) contained a range of questions modelled in the tradition of the Attitude Survey developed for the London Central YMCA (CYMCA; Francis, 1982a, 1982b). The present study drew on the following components included within the Teenage Religion and Values Survey.

Personality was assessed by the abbreviated form of the Junior Eysenck Personality Questionnaire (Francis & Pearson, 1988). This instrument proposes three six-item scales to measure extraversion, neuroticism, and psychoticism, together with a six-item lie scale. Each item is rated on a two-point scale: no (0) and yes (1), with negatively-phrased items recoded. Among the present sample the three personality scales recorded the following alpha coefficients: neuroticism, $\alpha = .73$; extraversion, $\alpha = .74$; psychoticism, $\alpha = .57$. The lower reliability of the psychoticism scale is consistent with the problematic nature of operationalising this construct (see further, Francis et al., 1992).

Sex and school year were both treated as dichotomous variables: male (1) and female (2); year nine (1) and year ten (2).

Handedness was assessed by the item, 'Are you generally right-handed?' rated on a two-point scale: no (0) and yes (1).

Participants

Of the 26,730 participants, 13,078 were female and 13,652 male; 14,097 were in year nine and 12,633 year ten; 89.6% of the females and 87.6% of the males were right-handed, while 10.4% of the females and 12.4% of the males were non-right-handed.

Analysis

The data were analysed by SPSS employing the frequency, correlation, and regression routines. The large sample allowed the analysis to progress in six sequential steps. Step one was designed to test if there was a *prima facie* case to assume a connection between handedness and personality by testing mean personality scores between non-right-handed and right-handed participants. Step two was designed to take a fine-grained approach by examining the proportions of non-right-handed participants reporting each of the seven scores on the three personality scales. Step three was designed to test the connection between sex and the mean scores recorded on the three personality scales. In order to clarify the interaction among sex, personality and handedness, step four was designed to examine the bivariate correlations before progressing to logistic regression in step five. Step six was designed to calculate the predicted probabilities for non-right-handedness over right-handedness. While large datasets, such as the one examined in this study provide more precision, they also require a cautious interpretation of statistical significance as determined by *p*-values (see Gómez de Mariscal et al., 2021; Lin et al., 2013). Investigations need, therefore, to include examination of effect sizes and practical comparisons of the fitted model with the data, rather than solely relying on *p*-value.

Results and discussion

- insert table 1 about here -

The first step in data analyses explored the association between mean scores recorded on the three Eysenckian dimensions of personality and handedness. The data presented in table 1 demonstrated that non-right-handed participants recorded significantly higher scores on the psychoticism scale and significantly lower scores on the extraversion scale. The difference in mean scores recorded by non-right-handed and right-handed participants on the neuroticism scale was trivial, with the slightly lower scores on the neuroticism scale recorded by non-right-handed participants only reaching the five percent level of probability.

- insert table 2 about here -

The second step in data analysis took a closer look at the association between the three Eysenckian dimensions of personality and handedness by examining the proportions of non-right-handed participants recording each of the seven scores reported by each of the three dimensions. The data presented in table 2 confirm the following features. In terms of extraversion, the proportion of non-right-handed participants decreased consistently with each of the seven steps on the scale, from 20.3% of those recording a zero score to 10.0% of those recording the top score of six. In terms of psychoticism, the proportion of non-right-handed participants increased consistently with each of the seven steps on the scale, from 10.8% of those recording a zero score to 18.0% of those recording a top score of six. In terms of neuroticism, there was a small drop from 12.1% of those recording a zero score to 10.7% of those recording the top score of six, but here the decline was not linear across the seven points of the scale. Pearson Chi-Square implied that the classifications of handedness both by extraversion and by psychoticism score are statistically dependent classifications ($p < .001$), whereas the classification by neuroticism scores has no clear evidence that it is a dependent classification.

- insert table 3 about here -

While tables 1 and 2 have demonstrated significant associations between handedness and both extraversion scores and psychoticism scores, these analyses have not taken potential sex differences into account. Therefore, the third step in data analysis explored the connection between sex and mean scores recorded on the three Eysenckian dimensions of personality. The data presented in table 3 confirm the expected sex differences in these measures. Males recorded significantly higher scores on the psychoticism scale (see Eysenck & Eysenck, 1976). Females recorded significantly higher scores on the neuroticism scale (see Eysenck & Eysenck, 1975). Females also recorded significantly higher scores on the extraversion scale (see Eysenck & Eysenck, 1991). It is for this reason that analysis of the connection between personality and handedness needs to take sex differences in personality into account.

- insert table 4 about here -

In order to clarify the interaction among sex, personality and handedness, the fourth step in data analysis examined the bivariate correlations before progressing to logistic regression. The Pearson correlations presented in table 4 confirm the pattern of associations identified between handedness and personality (table 1) and between handedness and sex (table 3), and additionally point to the significant correlations among the three personality scales. These findings demonstrate the importance of moving to logistic regression.

- insert table 5 about here -

The fifth step in data analysis presents three regression models in table 5. Model 1 demonstrates the significance of sex differences when only sex is entered into the equation. Model 2 demonstrates that when the three personality variables are entered into the equation, sex is no longer significant. Since sex has lost significance, model three excludes sex and concentrates on the cumulative impact of the three personality variables. In this case all three

personality variables are significant predictors of non-right-handedness, with non-right-handedness being associated with toughmindedness (high P), stability (low N), introversion (low E).

The fitted logistic Model 3 implied by table 5 (now refined to three decimal places) is:

p = prob(non-right-handedness) = 1/(1-exp(-y))

y = ln(p/(1-p)) = logit(p)

y = - 1.547 - 0.120*Ext - 0.032*Neu + 0.083*Psy

This provides a concise summary of the effects of the three major dimensions of personality on left-handedness, for the data provided by the 26,730 survey participants. Plus, a means of predicting characteristics of future samples from similar populations. This mathematically simple model summarises with remarkable accuracy much of the detail in this very large and complex data set.

- insert table 6 about here -

However, in light of continuing controversies concerning the use and usages of significance testing in many scientific disciplines, especially when large datasets are involved, the sixth step in data analysis examines the detailed fit of the model to the dataset. This will demonstrate the practical usefulness, or otherwise, of the fitted model. The data presented in table 6 demonstrates that this model predicts that future sampled individuals from similar populations having these particular (average) values of 4.55, 3.36 and 1.60 – for extraversion, neuroticism, and psychoticism respectively – will have an average 11% for non-right-handedness and 89% for right-handedness. And indeed, these handedness predictions from this model exactly match the values observed in this particular sample dataset. This prediction is displayed in the first row of table 6. The following six rows display predicted values from this model of handedness for the two possible extremes (0 and 6 respectively) of each psychological measure in turn, whilst holding the other two measures at their observed

average values in this dataset. The predicted values from this model for handedness, as displayed in table 6, can be seen to match very closely the observed mean values for those individuals in this sample who match these selected prediction criteria. Finally, the last two rows in table 6 display predicted values of handedness for the two extreme points in the model (noting that extraversion and neuroticism are negatively correlated to non-right-handedness whilst psychoticism is positively correlated to non-right-handedness). For the first extreme there were just two individuals in this very large sample returning these particular extreme psychological scores. They were both non-right-handed, whilst the fitted model predicts a 26% chance of this occurring for each one. This particular small discrepancy is clearly of no statistical significance. For the second extreme there were 265 individuals in the sample returning these particular extreme psychological scores and their observed proportion for non-right-handedness was 9%, closely matching the model prediction of 8%. Note that, for this model and with these data, the probability of non-right-handedness never exceeds 50%. This has been demonstrated in table 6 for the mid-point and the extremes of the model, which can predict for all $7^3 = 343$ possible combinations of levels for the three psychological measures. The selected predictions for non-righthandedness in Table 6 range from 8% through 11% to a maximum of 26%, whilst those for righthandedness range from 74% through 89% to a maximum of 92%. Our comparisons with the corresponding observed percentages suggest a markedly good fit of our model to the observed data. The significance tests were a necessary precursor to this close inspection, but in themselves do not on their own imply this overall close fit of our model to the data.

Conclusion

Located within the broader literatures concerned with connections between handedness and individual differences in personality characteristics (broadly conceived), the present study focused specifically on the connections between handedness and the Eysenckian dimensional

model of personality. The literature review had identified seven previously published studies that had addressed this research question. No clear consensus had emerged from the findings of this disparate set of studies. The theory was advanced that this small body of research had been generally frustrated by small sample sizes and by the complex interaction between sex difference and scores recorded on the Eysenckian personality measure. Against this background, the present study revisited a database collected among 13- to 15-year-old students during the 1990s that contained data from 26,730 students who had completed both the measure of personality and information on handedness.

These new data were amenable to analysis from a range of perspectives. These perspectives led to the same basic conclusion as clearly expressed by the binary logistic regression model that demonstrated, after sex differences had been taken into account, that non-right-handedness was significantly associated with toughmindedness (higher psychoticism score), introversion (lower extraversion score), and emotional stability (lower neuroticism score). Among these three dimensions of personality, the predictive power of higher psychoticism scores and of lower extraversion scores was stronger than for lower neuroticism scores.

There are a number of limitations with the present study that could be addressed by future research. The Eysenckian measure employed was the abbreviated form of the Junior Eysenck Personality Questionnaire (Francis & Pearson, 1988) in which each of the three dimensions was measured by only six items and in which the psychoticism scale recorded low internal consistency reliability ($\alpha = .57$). The measure of handedness relied on a single item focused on right handedness. Both of these limitations are associated with constraints imposed by broader surveys covering a range of issues, and such limitations may be offset by the sample sizes obtained by such surveys. The population sampled was highly specific to 13- to 15-year-old students in England and Wales. Future studies addressing the same research

question are needed among other age groups and within other cultures. As the reviewers

properly mentioned, a third limitation of the present study is that it opted to use one model of

personality and thus could not discuss the factors operationalised by the more popular big

five factor model. Again, future studies can address this limitation.

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No potential conflict of interest was reported by the authors.

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Author contribution (CRediT)

Leslie J. Francis: Conceptualisation, Investigation, Writing original draft. Patrick Laycock:

Methodology, Software, Formal analysis. Ursula McKenna: Data curation, Writing review

and editing, Project administration. All authors agreed the final text.

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Table 1

Means and standard deviations for personality scores by handedness

Psychological scores	Left-handed		Right-handed		t	d
	Mean	SD	Mean	SD		
Extraversion	4.31	1.69	4.58	1.52	-9.11***	-0.17
Neuroticism	3.29	1.84	3.37	1.83	-2.19*	-0.04
Psychoticism	1.73	1.73	1.58	1.43	5.37***	0.10

Note: *$p < .05$, ***$p < .001$

Table 2

Proportion of non-right-handed participants by scores recorded on the three personality scales

Score	Extraversion		Psychoticism		Neuroticism	
	N	% NRH	N	% NRH	N	% NRH
0	561	20.3	7087	10.8	2153	12.1
1	958	15.6	7566	10.9	2830	12.0
2	1725	13.3	5634	11.0	3791	12.3
3	2669	13.0	3425	11.7	4693	11.0
4	4257	11.5	1745	13.8	5050	11.0
5	7126	10.9	928	14.9	4124	11.6
6	9434	10.0	345	18.0	4090	10.7
Total	26730	100.0	26730	100.0	26730	100.0

Note: NRH = non-right-handed

Table 3

Means and standard deviations for personality scores by sex

Psychological scores	Male		Female		t	d
	Mean	SD	Mean	SD		
Extraversion	4.41	1.61	4.70	1.46	-15.86***	-0.19
Neuroticism	2.93	1.81	3.81	1.73	-40.77***	-0.50
Psychoticism	2.06	1.52	1.13	1.19	55.40***	0.68

Note: *** $p < .001$

Table 4

Correlations between the variates

	Sex	E	N	P
Non-right-handed	-.03***	-.06***	-.01*	.03***
Psychoticism (P)	-.32***	.12***	-.06***	
Neuroticism (N)	.24***	-.12***		
Extraversion (E)	.10***			

Note: *$p < .05$, ***$p < .001$

Table 5

Binary logistic regression of non-right-handedness on sex and psychological variables

	Model 1 β	Model 2 β	Model 3 β
Personal factors			
Sex	-.20***	-.06	
Psychological factors			
Extraversion		-.12***	-.12***
Neuroticism		-.03*	-.03**
Psychoticism		.08***	.08***
Constant	-1.76***	-1.47***	-1.55***

Note: * *p* < .05, ** *p* < .01, *** *p* < .001

Statistical significance tested by the Wald statistic

Table 6

Predicted and observed probabilities for handedness

Fixed extreme averages			Logit	Righthand		Non-righthand	
EXT	NEU	PSY [1]	y	Pre	Obs	Pre	Obs
4.55	3.36	1.60	2.07	89%	89%	11%	11%
0.00	3.99	1.27	1.57	83%	80%	17%	20%
6.00	3.10	1.79	2.22	90%	90%	10%	10%
4.91	**0.00**	1.79	1.99	88%	88%	12%	12%
4.26	**6.00**	1.44	2.13	89%	89%	11%	11%
4.90	2.94	**6.00**	1.73	85%	82%	15%	18%
4.23	3.48	**0.00**	2.16	90%	89%	10%	11%
0.00	**0.00**	**6.00**	1.05	74%	0% [2]	26%	100% [2]
6.00	**6.00**	**6.00**	2.46	92%	91%	8%	9%

Note: Bold print is used for the mean and selected extremes of the fitted logistic regression

model

Pre = predicted values

Obs = observed values

[1] = Psychoticism is negatively correlated with righthandedness

[2] = based on just 2 individuals from our sample of 26,730