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Going beyond students: An association between mixed-hand preference and schizotypy subscales in a general population

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ABSTRACT

Research on the sub-clinical condition of schizotypy suggests that it is associated with mixed handedness. To date, however, this research has focussed on undergraduate populations. If the association between schizotypy and mixed-handedness is the result of an underlying neurological trait, it is important to demonstrate that the effect extends to the general population. With this in mind, 699 participants were drawn from a wide community sample. Schizotypy was measured using the Psychosis Proneness Questionnaire and handedness was assessed using the Annett inventory. To avoid the sometimes arbitrary definitions of left-, right- and mixed-handed, regression analyses were used to explore the data. There was no evidence of a difference in schizotypy between individuals with a left- or right-hand preference. People with a mixed-hand preference, however, had higher scores on PER–MAG (Perceptual Aberration and Magical Ideation) and HYP–IMP (Hypomania and Impulsive Non-Conformity) scales (positive traits). No effect was observed for the SAN (Social Anhedonia) and PAN (Physical Anhedonia) scales (negative traits). The nature of the association between schizotypy and handedness observed in the current study is similar to that reported for student populations. The possibility that the association is related to response biases or a biological mechanism is discussed.

1. Introduction

Examination of a person's handedness provides a potentially important insight into the neural mechanisms that underlie schizotypy. Mixed-handedness has been found to be associated with a number of measures or factors of schizotypy including magical ideation (Barnett and Corballis, 2002; Nicholls et al., 2005; Grimshaw et al., 2008), positive schizotypy (Kim et al., 1992; Shaw et al., 2001; Annett and Moran, 2006; Asai and Tanno, 2009) and disorganised traits (Kim et al., 1992; Stefanis et al., 2006).

However, evidence for an association between schizotypy and handedness is not unanimous and a number of researchers have found the effect to be unreliable or idiosyncratic to certain subgroups (e.g.,Gregory et al., 2003; Jaspers-Fayer and Peters, 2005; Dragovic et al., 2005). Two factors that have been proposed to account for the inconsistencies in findings are the reliance on undergraduate student populations (e.g., Dragovic et al., 2005) and the possible role of response biases in producing the association (Jaspers-Fayer and Peters, 2005; Nicholls et al., 2005; Grimshaw et al., 2008; Bryson et al., 2009). The present study examined the relationship between handedness and different dimensions of schizotypy in a large community sample in order to test these hypotheses. Response biases could account for relationships between handedness and schizotypy in a number of ways. Response biases are known to affect responses to schizotypy scales (Mohr and Leonards, 2005) and may affect handedness questionnaires as well. Jaspers-Fayer and Peters (2005) found minimal association between schizotypy and handedness. To explain the discrepancy between their research and other studies, they suggested that participants' questionnaire-related response tactics and predispositions could explain the relationship, rather than an underlying neurological link. Nicholls et al. (2005) made the same point more explicitly. They proposed that random or careless responding by some participants would lead to weak handedness scores on scales such as the Annett Handedness Inventory (Annett, 1970) and the Magical Ideation Inventory (Eckblad and Chapman, 1983). Bryson et al. (2009) were also concerned about response bias, but suggest that it was related to a personality trait, such as intellectual openness or ease of updating belief (Niebauer et al., 2004). In support of the response bias hypothesis, it has been noted that the relationship between handedness and schizotypy is not typically observed when handedness is assessed behaviourally through the performance of skilled motor tasks (Nicholls et al., 2005; Grimshaw et al., 2008; Bryson et al., 2009).

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It should be noted, however, that the preference and performance measures of handedness tap different functions (Steenhuis and Bryden, 1999) and produce different population distributions (Peters and Durding, 1978; Büsch et al., 2010). Differences in the predictive abilities of hand preference and performance measures may therefore reflect these different psychometric properties.

A second issue relates to the selection of participants. Many studies in experimental psychology use undergraduates as participants and the research investigating schizotypy and handedness is no exception. For example, since 2005, the majority of studies have used young adults sourced from undergraduate subject pools (e.g. Jaspers-Fayer and Peters, 2005; Nicholls et al., 2005; Annett and Moran, 2006; Grimshaw et al., 2008; Asai and Tanno, 2009; Bryson et al., 2009). Stefanis et al. (2006) also used a young adult sample, but they were drawn from a group of draft-board conscripts. Studies that have used a broader age range and a more representative sample include the research by Claridge et al. (1998), Kim et al. (1992), Dragovic et al. (2005) and Chen and Su (2006). The two more recent studies by Dragovic et al. (2005) and Chen and Su (2006) have produced mixed results. Chen and Su (2006) administered the Schizotypal Personality Questionnaire (Raine, 1991) and the Perceptual Aberration Scale (Chapman et al., 1978) to 1537 participants drawn from the Taiwanese community with ages ranging between 6 and 65 years. Although some details of the nature of the relationship changed across age groups, the same basic effect was observed whereby non-right handedness was associated with higher schizotypy scores. Dragovic et al. (2005) measured schizotypy in four groups of participants. A sample of 353 people drawn from the general community (age range 18–79 years) showed no association between schizotypy and mixed handedness. No association was also observed for a sample of 131 volunteers (screened for no personal, or first-degree relative, history of mental, physical or drug-abuse disorders) and a group of 97 people who were the siblings of schizophrenic patients. A group of 176 schizophrenic patients did show a moderate to weak effect of handedness on schizotypy scores. Dragovic et al. (2005) concluded that the association between schizotypy and mixed-handedness was plagued by a number of methodological issues and may not generalise beyond undergraduate populations. Indeed, Henrich et al. (2010) have questioned how well results from undergraduate subjects from Western societies generalise to the broader population.

These inconsistencies raise important questions in relation to research purporting to show an association between mixed handedness and schizotypy. If the research does not generalise outside of undergraduate populations, then the relationship might not be that meaningful. The current study addressed this issue by applying some of the techniques used to explore handedness and schizotypy to a large and broad community sample, with a wide age-range. Particular attention was paid to the effect of response biases on questionnaires. Indeed, an individual's predisposition or amenability to the questions in a typical schizotypy questionnaire can be an important factor (Jaspers-Fayer and Peters, 2005; Mohr and Leonards, 2005) and may explain well-known age and sex effects in schizotypy questionnaires (Mata et al., 2005).

Data were obtained from the Brain Resource International Database (Gordon, 2003; Gordon et al., 2005). This database gives access to data collected from a broad community sample, with ages ranging between 11 and 87 years. It is believed that schizotypy can be assessed as early as 11 years of age, but not younger (Cyhlarova and Claridge, 2005). Schizotypal traits were assessed using the short measure of psychosis-proneness developed by Hay et al. (2001). Factor analysis of the questionnaire has revealed four distinct subscales: Perceptual Aberration–Magical Ideation; Hypomania–Impulsivity/Nonconformity; Social Anhedonia; and Physical Anhedonia. These scales measure either an absence or deviance of mental activity known as negative and positive traits respectively. The relationship between schizotypy and non-right-handedness has often been observed for positive schizotypy, but not negative schizotypy. For example, Chen and Su (2006) found that the elevation of schizotypy scores was stronger and more consistent for the Perceptual Aberration Scale (Chapman et al., 1978) and cognitive-perceptual dysfunction items on the Schizotypal Personality Questionnaire (Raine, 1991). Similarly, Asai and Tanno (2009) found that mixed-handers had higher scores for the Oxford Schizotypal Personality Scale (Claridge and Broks, 1984) and the Unusual Experiences scale for the Oxford–Liverpool Inventory of Feelings and Experiences (O-LIFE) (Mason et al., 1995). There was no effect for anxiety, depression or any of the other scales from the O-LIFE. We therefore expect an association for the Perceptual Aberration–Magical Ideation and Hypomania–Impulsivity/Nonconformity scales, which gauge positive schizotypy (Hay et al., 2001). The negative symptoms of Social and Physical Anhedonia were not expected to show an association.

Hand preference was gauged using the Annett (1970) Handedness Inventory and relative (indicating the direction of handedness) and absolute (indicating the strength of handedness) indices were obtained. If a difference in schizotypy exists between left- and right-handers, an effect should be obtained for the relative measure. Alternatively, if there is a difference between individuals with a strong handedness (to the left or right) and mixed-handers, an effect should be observed for the absolute measure.

Previous research has often categorised individuals into handedness groups, such as left-, right- and mixed-handed, and meta-analyses often focus on studies that have used dichotomous or trichotomous descriptions (e.g. Somers et al., 2009). While use of these categories can increase the statistical power of an experiment, the sometimes arbitrary nature of the categories has been identified as a problem in the classification of handedness (Büsch et al., 2010). To avoid the effect of categorisation, the current study will use regression techniques to examine the relationship between handedness and schizotypy. Age and sex are known to be related to schizotypy (Mata et al., 2005) and these will be controlled using the regression model.

2. Method

2.1. Participants

A total of 699 (m = 371, f = 328) participants were selected from the Brain Resource International Database (BRID; Gordon, 2003). The database contains a census-matched representative sample of healthy individuals drawn from a broad cross-section of the community. Samples for the data-base have been accumulated over a number of years. As of June 2009, the sample included data from 5000 normal individuals. For more details on the database, the tests it includes and the publications that have arisen from it, see: www.brainnet.net. From the larger database, cases were selected which reported no neurological disease, psychopathology or history of drug or alcohol addiction. Cases were also selected only if they had completed all of the handedness and schizotypy tests (see below). Ages in the sample ranged from 11 to 87 years, with a mean age of 36.8 years. Years of formal education ranged from 4 to 18 years, with a mean of 11.8 years and a S.D. of 3.7. Participants were screened and tested using standardised protocols of the BRID (Gordon, 2003). Informed consent was provided according to the human research ethical requirements of the University of Technology, Sydney.

2.2. Measurement instruments

Hand preference was gauged using the Annett Handedness Questionnaire (Annett, 1970). The questionnaire contains 12 questions concerning hand preference to which participants responded: 'left', 'right' or 'either' (Annett, 1970). The scores ranged from −12 to +12, indicating left- and right-handedness, respectively. The absolute value of the hand preference index (ranging from 0 to 12) was used as a measure of strength of hand preference.

Schizotypy was assessed using the psychosis proneness questionnaire (Table 1) developed by Hay et al. (2001). Hay's questionnaire is based on the original 264 item questionnaire developed by Chapman and Chapman (1985). Using factor analysis, the original questionnaire was scaled down to 12 items, which load on four distinct factors: Perceptual Aberration–Magical Ideation (PER–MAG), Hypomania–Impulsivity/Non-Conformity (HYP–IMP), social anhedonia (SAN) and physical anhedonia (PAN). The factors were measured using 4, 4, 2 and 2 questions, respectively. Participants responded 'true' or 'false' to each question. This questionnaire is thought to provide a fast and accurate measure of psychosis proneness (Hay et al., 2001). For more details about the norms, reliability and validity, see Hay et al. (2001).

Table 1
Psychosis proneness questionnaire developed by Hay et al. (2001).

Perceptual Aberration (PER)–Magical Ideation (MAG)
- Sometimes part of my body seems smaller than it really is.
- Sometimes I feel like everything around me is tilting.
- I have wondered whether the spirits of the dead can influence the living.
- I have felt that I might cause something to happen just by thinking too much about it.

Hypomania (HYP)–Impulsivity/Non-Conformity (IMP)
- In unfamiliar surroundings, I am sometimes so assertive and sociable, that I surprise myself.
- I often have moods where I feel so energetic and optimistic that I feel I could outperform almost anyone or anything.
- It would embarrass me a lot to have to spend a night in jail.
- I usually find myself doing things "on impulse".

Social Anhedonia (SAN)
- I prefer hobbies and leisure activities that do not involve other people.
- Although there are things that I enjoy doing myself, I usually seem to have more fun when I do things with other people.

Physical Anhedonia (PAN)
- Trying new foods is something I have always enjoyed.
- I seldom care to sing in the shower.

3. Results

3.1. Descriptive analyses and simple correlations

Scores on each of the four factors of schizotypy (PER -MAG, HYP–IMP, PAN, and SAN) were calculated for males and females separately, and are presented in Table 2. Handedness measures were similarly tabulated for relative hand preference (−12 to +12) and absolute hand preference (0 to 12). Examination of sex differences revealed that males had higher scores than females in HYP–IMP, $t(692) = -2.314$, $p = 0.033$ and lower scores in PER–MAG, $t(692) = 2.806$, $p = 0.005$. These sex differences are in line with previous research (Hay et al., 2001). Males had lower values for absolute hand preference $t(697) = 3.823$, $p < 0.001$ and this is also in line with the literature (Oldfield, 1971). Although the schizotypy scores varied from 0 to 4 (for PER–MAG and HYP–IMP) or from 0 to 2 (for PAN and SAN) all measures approximated a normal distribution. Simple correlations were calculated among variables of interest, and are presented in Table 3. Notably, age was positively correlated with SAN, and was negatively correlated with PER–MAG and HYP–IMP.

3.2. Regression analyses

Given that most of the schizotypy measures were related to age and sex, a three-step multiple regression procedure was used to examine the relationship between handedness and schizotypy. First, schizotypy factor scores were regressed on age and sex to control for variance related to these variables. In the second step, the linear and quadratic measures of hand preference were entered. The linear measure assesses differences between left- and right-handers, and the quadratic component assesses differences between strong and mixed-handers. A significant increase in R^2 for the second step indicates that handedness (linear and/or quadratic) accounts for variance in schizotypy over and above that related to age and sex. The beta weights indicate which measure(s) of handedness are individually associated with schizotypy. Finally, in the third step, the four interaction terms of linear and quadratic hand preferences with age and sex were entered. Significant interactions indicate that the relationship between hand preference and schizotypy factor vary as a function of sex and/or age. Again, individual beta weights indicate which interaction terms are significant predictors of schizotypy.

Regression results appear in Table 4. The inclusion of the hand preference measures provided a significant improvement in the prediction of PER–MAG, $F(2, 689) = 3.151$, $p = 0.043$, $\Delta R^2 = 0.009$, and HYP-IMP, $F(2, 689) = 6.822$, $p < 0.001$ $\Delta R^2 = 0.017$. Examination of beta weights indicated that in both cases only the quadratic measure of hand preference was a significant predictor, $\beta = -0.103$, $t(689) = -2.428$, $p = 0.015$ for PER–MAG and $\beta = -0.132$, $t(689) = -3.246$, $p = 0.001$ for HYP–IMP. The inclusion of the interaction terms did not significantly improve prediction of any schizotypy factor, indicating that the relationship between hand preference and schizotypy is constant across age and sex.

3.3. Curve fitting procedures

In order to visualise better the relationship between hand preference and PER–MAG and HYP–IMP, curve fitting procedures were used. First, the schizotypy scores were regressed on age and sex

Table 2
Mean age, handedness and schizotypy scores for female and male participants.

	Females ($N = 371$)		Males ($N = 328$)	
	M	(S.D.)	*M*	(S.D.)
Age	39.27**	(24.44)	34.29	(24.84)
Relative hand preference	9.18	(5.84)	8.46	(5.85)
Absolute hand preference	10.65**	(2.22)	9.94	(2.62)
SAN	0.35	(0.62)	0.40	(0.65)
PAN	0.87	(0.67)	0.94	(0.66)
PER–MAG	0.97*	(1.06)	0.75	(0.96)
HYP–IMP	1.46**	(1.17)	1.65	(1.19)
Total schizotypy	3.64	(2.08)	3.74	(1.82)

Note. SAN and PAN have maximum scores of 2.0. PER–MAG and HYP–IMP have maximum scores of 4.0.
* $p < 0.05$.
** $p < 0.01$.

Table 3
Correlations for the four schizotypy subscales (Social Anhedonia; Physical Anhedonia; Perceptual Abberation–Magical Ideation; and Hypomania Impulsivity) with age and handedness.

	SAN	PAN	PER–MAG	HYP–IMP
Age	0.190**	0.061	−0.141**	−0.313**
Relative hand Preference	0.026	0.040	0.028	−0.069
Absolute hand Preference	0.033	0.023	−0.062	−0.145**

* $p < 0.05$.
** $p < 0.01$.

Table 4
Results of a three-step multiple regression examining the effects of age and sex (Model 1), handedness (Model 2) and the interactions between handedness, age and sex (Model 3) on the four schizotypy subscales.

Factor	Model	d.f.1	d.f.2	R^2	ΔR^2
SAN	1	2	695	0.039**	
	2	2	693	0.040**	0.001
	3	4	689	0.050**	0.011
PAN	1	2	696	0.007	
	2	2	694	0.009	0.002
	3	4	690	0.015	0.006
PER–MAG	1	2	693	0.034**	
	2	2	691	0.043**	0.009*
	3	4	687	0.050**	0.006
HYP–IMP	1	2	693	0.100**	
	2	2	691	0.118**	0.017**
	3	4	687	0.122**	0.004

Model 1: age and sex.
Model 2: adds linear and quadratic hand preference.
Model 3: adds interactions terms linear × age, linear × sex, quadratric × age, quadratic × sex.
* $p < 0.05$.
** $p < 0.01$.

to obtain the standardised residuals. Positive values indicate that a participant has higher than expected schizotypy scores, for their age and sex. Then, linear and quadratic curves were fitted to these data using hand preference as a predictor (see Fig. 1a and b). In addition to telling us goodness of fit, the curve fitting also allows us to determine the hand preference values at which predicted schizotypy scores are maximal. As expected, for PER–MAG the linear equation was not significant, but the quadratic equation was, $R^2 = 0.010$, $F(2, 691) = 3.381$, $p = 0.035$. This equation has its peak PER–MAG score at a hand preference score of 3.0 (out of 12). Similarly, for HYP–IMP, only the quadratic equation was significant, $R^2 = 0.028$, $F(2, 693) = 7.570$, $p = 0.001$. HYP–IMP scores were maximal at a hand preference score of 0.

4. Discussion

Regression analyses using absolute hand preference revealed that scores for the PER–MAG and HYP–IMP scales were higher for individuals with a weaker hand preference. The results of the regression analysis were confirmed with a curve-fitting procedure which showed that PER–MAG and HYP–IMP were maximal around the point of mixed-handedness. The results therefore confirm research (e.g. Barnett and Corballis, 2002; Nicholls et al., 2005; Grimshaw et al., 2008; Asai and Tanno, 2009) and meta-analyses (Somers et al., 2009) showing an increase in measures of schizotypy with mixed-hand preference. There was no indication that the association between schizotypy and mixed-handedness differed between the sexes (cf. Gregory et al., 2003). While the effects observed in the current study are statistically significant, it should be acknowledged that the effect sizes are small (with hand preference accounting for about 1% of the variance in schizotypy) and that similar effects are only likely to be detected in large-scale studies.

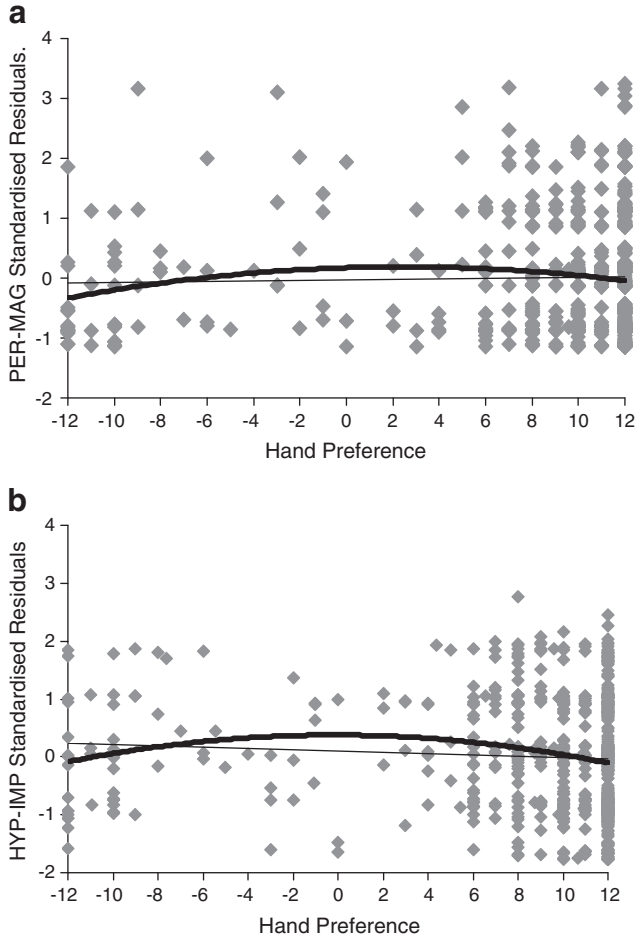

Fig. 1. (a) Relationship between hand preference and PER–MAG, after controlling for age and sex. The quadratic relationship is significant, and has the equation PER–MAG = −0.002 (HAND^2) + 0.012 (HAND) + 0.172. (b) Relationship between hand preference and HYP–IMP, after controlling for age and sex. The quadratic relationship is significant, and has the equation HYP–IMP = −0.003 (HAND^2) + 0.378. In both figures, the thick and thin lines show quadratic and linear models, respectively.

There was no sign of a difference in schizotypy between left- and right-handers. If such an asymmetry did exist, the regression coefficients for relative hand preference should have been significant — or there should have been a linear effect in the curve fitting procedure. The lack of difference between left- and right-handers also confirms the finding of previous studies (Barnett and Corballis, 2002; Nicholls et al., 2005) and the meta-analysis carried out by Somers et al. (2009). Previous studies have often divided their samples into categories of left-, right- and mixed-handers to test for an effect and this has been identified as a problem in this field (Dragovic et al., 2005). By avoiding the use of such categories, and by controlling for the effects of age and sex, the current study was able to provide a more principled analysis of the relationship between handedness and schizotypy.

An effect was observed for the PER–MAG and HYP–IMP scales, but not for the PAN or SAN scales. The difference between the scales is probably related to the fact that the PER–MAG and HYP–IMP scales are most closely related to the positive symptoms of schizotypy, whereas the anhedonias (PAN and SAN) are most closely related to the negative symptoms (Hay et al., 2001). Previous research has reported an association between schizotypy and handedness — but only for the scales that assess positive features, such as the Perceptual Aberration Scale and cognitive–perceptual dysfunction items on the Schizotypal Personality Questionnaire (Chen and Su, 2006) and the Oxford Schizotypal Personality Scale and the Unusual Experiences scale for the O-LIFE (Asai and Tanno, 2009). While the current study confirms previous reports of an association between handedness and positive schizotypy, these data are also relevant to the issue of response tactics proposed by Nicholls et al. (2005). They suggested that the association between magical ideation and mixed handedness could be an artifact of careless or random responding. If this were the case, however, this mode of responding should apply to all of the schizotypy scales and not just the positive scales. That is, random responses of 'yes' or 'no' should lead to elevated scores for all four scales. Random responding, however, is only one way in which scores can be biased (see Bryson et al., 2009). By manipulating the context in which a test was administered, Mohr and Leonards (2005) demonstrated that defensive response biases were more likely to affect positive traits scores than negative traits. If negative and positive traits are differentially susceptible to response biases, it may still explain the effect observed in the current study.

It has been proposed that high levels of schizotypy and mixed-handedness have a common underlying neurological cause related to weak cerebral dominance and 'cerebral indecision' (Crow, 1997; 2000). A lack of a clearly dominant hemisphere, or interference with normal left-hemisphere function, may bring about language difficulties. These language difficulties, in turn, may bring about a susceptibility to psychotic disorders and schizotypy (Stefanis et al., 2006). In support of Crow's model of cerebral indecision, DeLisi et al. (1997) found some evidence of anomalous cerebral dominance from the structural MRI scans of schizophrenia patients' brains — though evidence for a consistent pattern of reduced asymmetry was not clear. Clearer support for Crow's model comes from Leonhard and Brugger (1998), who found that individuals with high schizotypy scores had reduced hemispheric lateralisation for lexical decisions compared to individuals with low schizotypy scores. While there is some support for a neurological model of schizotypy, alternative accounts cannot be dismissed at this point. Foremost among these alternatives is the proposition that the association between schizotypy and mixed-

handedness is related to individual differences in personality traits such as intellectual openness (Bryson et al., 2009) or defensive responding (Mohr and Leonards, 2005).

The present study demonstrates that the association between schizotypy and mixed-handedness, which has often been observed in undergraduate student populations, also occurs in a general community sample. Excessive use of university student populations has been criticised because their behaviour might not generalise to the broader community (Henrich et al., 2010). By demonstrating a relationship between handedness and schizotypy in a broad community sample, who would be expected to have very different responses to schizotypy questionnaires, the findings of the current study argue against the effect of personality traits and response tactics in a specific group. Nevertheless, the contribution of response strategies to the relationship between schizotypy and mixed-handedness cannot be ruled out at this stage.

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