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Handedness and schizotypy in nonpsychotic relatives of patients with schizophrenia

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Abstract

Existing studies have found the relationship between handedness and schizotypy to be inconsistent and had limited generalizability since only highly homogeneous groups have been investigated. This study aimed to examine the relation between handedness and the four schizotypal factors identified from a previous confirmatory factor analysis in a population of high familial loading for schizophrenia. Study subjects consisted of nonpsychotic first-degree relatives (850 parents and 334 siblings) of sib-pairs who were co-affected with schizophrenia. All participants were interviewed with the Diagnostic Interview for Genetic Studies, which contains a section of the modified Structured Interview for Schizotypy, and the Annett handedness questionnaire. Both categorical and continuous indicators for handedness were examined. Non-right handed siblings of schizophrenia patients displayed more positive schizotypal features than their right handed counterparts when the two-way Annett's handedness classification was adopted. No association was found when handedness was treated as continuous. The relationship between handedness and schizotypy was insignificant for parents probably due to the strong social pressure against left-handedness. We concluded that categorical non-right handedness was associated with positive schizotypy in nonpsychotic siblings of schizophrenia patients. The results indicate that an atypical cerebral lateralization underlying non-right handedness may be also a contributing factor to positive schizotypy.

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Keywords

positive schizotypy; handedness; familial loading; schizophrenia

Introduction

The excess of non-right handedness in patients with schizophrenia compared with normal controls has been reported in many studies (Dragovic & Hammond, 2005; Green, Satz, Smith, & Nelson, 1989; Satz & Green, 1999; Sommer, Ramsey, Kahn, Aleman, & Bouma, 2001). Since handedness has been considered as an index of cerebral hemispheric asymmetries that underlie complex human cognition (Bishop, 2002), atypical cerebral lateralization is suggested to be a risk factor for schizophrenia (Crow, Done, & Sacker, 1996; Satz & Green, 1999). In line with this, schizotypy, which is presumed to reflect a genetically determined disposition to schizophrenia (Meehl, 1962; Rado, 1953), has also been postulated to be related to handedness in non-clinical populations.

However, most of existing studies have been conducted in college students (Annett & Moran, 2006; Asai & Tanno, 2009; Barnett & Corballis, 2002; Chapman & Chapman, 1987; Gregory, Claridge, Clark, & Taylor, 2003; Grimshaw, Yelle, Schoger, & Bright, 2008; Jaspers-Fayer & Peters, 2005; Nicholls, Orr, & Lindell, 2005; Overby, 1993; Poreh, 1994; Shaw, Claridge, & Clark, 2001) and some in general populations (Chen & Su, 2006; Claridge, Clark, Davis, & Mason, 1998; Kim, Raine, Triphon, & Green, 1992; Preti, Sardu, & Piga, 2007; Stefanis et al., 2006). Only one study has been conducted in relatives of patients with schizophrenia (Dragovic, Hammond, & Jablensky, 2005). Among existing studies in non-clinical populations, handedness has been treated as either categorical (separating into right, mixed, and left) (Annett & Moran, 2006; Chapman & Chapman, 1987; Chen & Su, 2006; Dragovic et al., 2005; Preti et al., 2007) or continuous (direction and consistency) (Chen & Su, 2006; Claridge et al., 1998; Dragovic et al., 2005; Grimshaw et al., 2008; Shaw et al., 2001). Positive schizotypy has been shown to be associated with categorical non-right handedness in most studies (Annett & Moran, 2006; Chapman & Chapman, 1987; Kim et al., 1992; Nicholls et al., 2005; Poreh, 1994; Shaw et al., 2001; Stefanis et al., 2006). In contrast, the correlation between positive schizotypy and the direction of handedness (Barnett & Corballis, 2002; Chen & Su, 2006; Jaspers-Fayer & Peters, 2005; Nicholls et al., 2005) was insignificant, whereas positive schizotypy was correlated with the consistency of handedness in some studies (Annett & Moran, 2006; Barnett & Corballis, 2002; Chen & Su, 2006; Nicholls et al., 2005; Shaw et al., 2001) but not others (Gregory et al., 2003; Jaspers-Fayer & Peters, 2005).

Another issue that might also contribute to the inconsistent findings is the varying structure and content of schizotypy (Kendler, McGuire, Gruenberg, & Walsh, 1995; Kendler, Thacker, & Walsh, 1996; Vollema & van den Bosch, 1995). Recently, the multidimensionality of schizotypy was further supported by means of ordered subset linkage analyses in non-psychotic relatives of patients with schizophrenia (Lien et al., 2010). A four-factor model of schizotypy was derived, which consisted of Negative Schizotypy, Positive Schizotypy, Interpersonal Sensitivity, and Social Isolation/Introversion. It is of interest to examine the relationship between handedness and schizotypy with the 4-factor structure.

Most previous studies have been conducted in Western countries (Annett & Moran, 2006; Barnett & Corballis, 2002; Claridge et al., 1998; Grimshaw et al., 2008; Jaspers-Fayer & Peters, 2005; Kim et al., 1992; Nicholls et al., 2005; Shaw et al., 2001) and were therefore limited in their generalizability. Earlier studies of Asian adults either did not show the association between positive schizotypy and non-right handedness (Gregory et al., 2003) or

showed this association only when the consistency of handedness was used (Chen & Su, 2006). A recent study in Japanese students using a modified handedness scale showed for the first time that mixed-handed Japanese participants had the strongest positive schizotypal traits (Asai & Tanno, 2009).

To test if handedness is related to schizotypy in a population of high familial loading for schizophrenia in a non-Western culture, we turned to a sample of nonpsychotic first-degree relatives of sib-pairs who were co-affected with schizophrenia and were recruited throughout Taiwan. Different indicators for handedness were examined to compare their relations to individual schizotypal factors in the relatives. We aimed to examine, in relatives of patients with schizophrenia, if (1) non-right handedness would be related to positive schizotypy; (2) handedness and negative schizotypy would be unrelated; and (3) a categorical approach to handedness would exhibit a stronger association with positive schizotypy than a continuous approach.

Materials and methods

Subjects

The participants of this study were recruited from two family studies on schizophrenia in Taiwan, the Multidimensional Psychopathological Study on Schizophrenia and the Taiwan Schizophrenia Linkage Study. Both studies were designed to recruit sib-pairs who were co-affected with schizophrenia and had at least two living first-degree relatives and have been described in greater detail previously (Hwu et al., 2005; Tsuang et al., 2006). Briefly, affected sib-pair probands, who met the DSM-IV criteria for schizophrenia or schizoaffective disorder, depressed type, were identified from either the inpatient wards or outpatient clinics of the National Taiwan University Hospital and the Provincial Tao-Yuan Psychiatric Center from 1998 to 2001 for the first study and from 78 psychiatric hospitals or health centers throughout Taiwan from 1998 to 2002 for the second study. All first-degree relatives were invited to participate. Written informed consent was obtained from all subjects after a complete description of the study. The first study was approved by the institutional review boards of the participating hospitals, and the second one was approved by both the US Department of Health and Human Services and the National Taiwan University Hospital's Internal Review Board of Human Studies. Both studies were conducted in accordance with the 1964 Declaration of Helsinki.

Among 142 first-degree relatives (from 70 families) in the first study and 1,276 first-degree relatives (from 607 families) in the second study who were directly interviewed, 117 and 1,168 completed a hand preference questionnaire, respectively. For this study, first-degree relatives with schizophrenia, schizophreniform disorder, or mental retardation were excluded from the analysis. Hence, two (with schizophrenia) in the first study and 99 (91 with schizophrenia, 1 with schizophreniform disorder, and 7 with mental retardation) in the second study were excluded. The final study sample included 1,184 nonpsychotic first-degree relatives, including 850 parents and 334 siblings.

Interview Instruments and Diagnostic Procedures

All participating first-degree relatives were interviewed with the Diagnostic Interview for Genetic Studies (DIGS) (Nurnberger et al., 1994), which contains a section of the modified Structured Interview for Schizotypy (SIS) (Kendler, Lieberman, & Walsh, 1989). The establishment of the Chinese version of the DIGS and its reliability has been described previously (Chen et al., 1998). Interviews with the Chinese version of the DIGS were carried out by research assistants who had received standardized psychiatric interviewing training. In addition to the DIGS, interviewers used the Chinese version of the Family Interview for

Genetic Studies (FIGS) (NIMH Genetics Initiative, 1992) to collect relevant information on relatives. Two psychiatrists independently reviewed all available information including the DIGS, the FIGS, hospital records and the interviewer's notes. Best estimate lifetime psychiatric diagnosis according to the DSM-IV criteria were determined independently; if both disagreed about a diagnosis, a third one was sought, and a consensus diagnosis was reached after discussion.

Structured Interview for Schizotypy

The SIS in the DIGS 2.0 contains 13 global ratings on seven-point scales of schizotypal symptoms and 6 global ratings on five-point scales of schizotypal signs. Items relating to symptoms were evaluated by respondents' self-report, while items relating to signs were rated by interviewers based on their observation of respondents' behavior. The consensus rating rules were written in computer algorithms using SAS to perform global ratings. The intraclass correlation coefficient between the SAS algorithm and the consensus rating of the first study ranged from 0.70 to 1.00.

A four-factor model of schizotypy, which was initially derived by conducting exploratory factor analysis on the global ratings of schizotypal symptoms and signs in the nonpsychotic first-degree relatives from simplex schizophrenia families, was confirmed in nonpsychotic first-degree relatives from multiplex schizophrenia families (most of these subjects were included in the current study) (Lien et al., 2010). The factor scores for the four schizotypal factors, Negative Schizotypy, Positive Schizotypy, Interpersonal Sensitivity, and Social Isolation/Introversion, were estimated for subsequent analyses.

Hand Preference Questionnaire

Handedness was assessed using the modified version of Annett's (1967) handedness questionnaire by Briggs and Nebes (1975), a reliable instrument comprising 12-items (Loo & Schneider, 1979). The modification replaced the original 3-point response scale to a 5-point scale to increase the grading of ambidexterity. The 12 items include: (1) writing; (2) throwing a ball; (3) using a racket; (4) sweeping (hand on top); (5) shoveling (hand on top); (6) striking a match; (7) using a scissors; (8) threading a needle; (9) dealing cards; (10) hammering a nail; (11) brushing teeth; and (12) unscrewing a jar lid. On each item, participants indicated if the right hand was always preferred (+2), usually preferred (+1), both hands were used equally often (0), the left hand was usually preferred (-1), or the left hand was always preferred (-2).

The Annett questionnaire was scored in three different ways, one as categorical and two as continuous, so that the results could be compared with existing studies and their influence on the relations of handedness to schizotypal factors could be examined.

1. Three-way classification of handedness based on Annett's category classification: The distinction between "usually" and "always" was ignored and then the Annett's eight-category classification was adopted initially (Annett, 1970; 1985; Annett & Moran, 2006). Therefore, the classification of handedness would be the same as using the original version of Annett's questionnaire. The classification was implemented with a decision tree, starting with writing hand, and yielded eight handedness groups (named preference classes 1-8). Since only 1, 3, 4, and 1 subjects in this study were classified in preference class 3, 4, 6, and 7, respectively, we simplified Annett's eight categories into three categories, with group 1 being "fully right," groups 2-7 being "mixed," and group 8 being "fully left," following the convention of previous studies (Chen & Su, 2006; Claridge et al., 1998; Shaw et al., 2001).

2. Hand Preference Index: The summed score of the 12 items was divided by the maximum possible score of 24, and then multiplied by 100, yielding a directional index ranging from -100 for extremely left hand preference to +100 for extremely right hand preference (Corey, Hurley, & Foundas, 2001).
3. Either hand use score: The number of items for which a subject declared a preference for either hand was treated as a continuous index of mixed-handedness (Shaw et al., 2001).

Data Analysis

To compare the score of schizotypy among different handedness categories, linear mixed effect models with family as the random effect to adjust for within-family correlation was applied using the Proc MIXED procedure in the software package SAS version 9.1 for Windows (SAS Institute, Cary, NC, USA). The three-category approach was adopted first using Annett's classification. Next, the handedness grouping was further simplified into the non-right-handed (NRH) versus the right-handed (RH), following the previous study (Chen & Su, 2006), as well as the mixed-handed (MH) versus the non-mixed-handed (NMH). In addition, to examine the correlation between schizotypy and the two continuous indicators of handedness (i.e., Hand Preference Index and either hand score), partial correlation coefficients with adjustment for sex and age were calculated. Since both indexes were not normally distributed, Spearman's rank correlations were calculated. All tests were two-tailed and a p-value of < 0.05 was considered significant.

In addition, the schizotypal factor scores were plotted against Hand Preference Index raw scores in scattergrams with bubble size indicating the number of participants. The relationship between the schizotypal factor scores and Hand Preference Index raw scores was further explored by the non-parametric method of local fitting using Proc LOESS (Cleveland, Devlin, & Grosse, 1988).

Results

The mean age of parents and siblings of schizophrenia patients in this study was 63.6 and 37.4 years, respectively (Table 1). Mean years of education were about 5 years for parents and 11 years for siblings. Parents and siblings differed significantly in their proportions of Annett's categorization ($\chi^2 = 11.2$, $df = 2$, $p < 0.01$). On the basis of Wilcoxon rank sum test, the Hand Preference Index score appeared to be higher in parents than in siblings ($Z = -2.4$, $p < 0.05$), while the either hand score was higher in siblings than in parents ($Z = -4.1$, $p < 0.0001$).

Because the number of left- and mixed-handed category participants was too small, the two were pooled as NRH. The proportion of NRH tended to be higher in siblings than in parents (11.1% vs. 7.7%; $\chi^2 = 3.6$, $df = 1$, $p = 0.06$). When the comparisons were made between the RH group versus the NRH group, the NRH siblings had higher scores in Positive Schizotypy, i.e. more positive schizotypal features, with an effect size of 0.42 (Table 2). Meanwhile, the comparisons between the MH group versus the NMH group revealed similar results. All the comparisons were insignificant except that the MH siblings had higher scores in Positive Schizotypy using the Annett's classification than the NMH siblings ($p < 0.05$ for the mixed effect model). When handedness was treated as continuous, none of the correlations were statistically significant (Table 3).

Figure 1 (see online supplementary figure 1 for a color image) displays the scattergrams of the Positive Schizotypy scores and Hand Preference Index raw scores for the siblings and parents, respectively. Siblings with greater Hand Preference Index scores tended to have

lower Positive Schizotypy scores. This trend appeared to be supported by non-parametric curve-fitting using Proc LOESS.

Discussion

The current study showed that non-right handed siblings of schizophrenia patients displayed more positive schizotypal features than their right handed counterparts when the two-way Annett's handedness classification was adopted. No association was found when handedness was treated as continuous. In contrast to the results for positive schizotypy, negative schizotypal factors, including Negative Schizotypy and Social Isolation/Introversion, were unrelated to hand preference.

One noteworthy phenomenon of this study is that the prevalence of left-handedness for writing was relatively low in both study samples, i.e., only about 1% of them were fully left-handed according to the Annett's three-way classification. In contrast to the secular trend that younger generations have a higher prevalence of left-handedness for writing than older generations in Taiwan (Chen & Su, 2006), the prevalence in the siblings was even lower than that in the parents (0.3% vs. 1.7%). In addition to mere fluctuation by chance, another possible explanation is due to the lower participation rate among siblings than that among parents (Chang et al., 2002). If those siblings who refused to participate were people who tended to have some schizotypal personality features that were associated with left-handedness, we may end up in a sample of siblings with an extremely low percentage of left-handedness. Furthermore, this overall low rate of left-handedness appears to be similar to previous studies conducted in Asian populations, e.g., 0.6% of Taiwanese adults were categorized as fully left-handed (Chen & Su, 2006) and 2% of Japanese university students as left-handed (Asai & Tanno, 2009). In both Taiwan and Japan, the culture pressure against using left hand for certain activities, such as writing, appears to be high. Those who switched from left hand to right would therefore be pooled with innate right-handers or categorized as mixed-handedness. Nonetheless, we considered this misclassification would underestimate the relations observed between handedness and schizotypy.

A weak, but significant, association between non-right handedness and positive schizotypy was confirmed in this non-western population with a high familial loading for schizophrenia. A recent study also in Asian populations found that the association between non-right handedness and positive schizotypy was significant only when a modified handedness scale was used (Asai & Tanno, 2009). The current study is the first one showing that non-right handedness, as measured by the Annett's handedness questionnaire, associated with positive schizotypy in nonpsychotic relatives of patients with schizophrenia. The only existing study that was conducted in nonpsychotic relatives of schizophrenia patients found a trend, though insignificant, between handedness and the Cognitive Perceptual factor (Dragovic et al., 2005). The participants in this study, the nonpsychotic first-degree relatives of sib-pairs who were co-affected with schizophrenia, presumably had higher familial loading for schizophrenia than those in the previous study (Dragovic et al., 2005). Therefore, our results seemed to suggest the relationship between handedness and schizotypy being related to the familial loading for schizophrenia.

Some researchers proposed that hand preference is a continuous rather than categorical variable (Annett, 1994; Dean & Reynolds, 1997). However, among studies examining the relationship between handedness and schizotypy using both categorical and continuous approaches (Annett & Moran, 2006; Barnett & Corballis, 2002; Chen & Su, 2006; Dragovic et al., 2005; Gregory et al., 2003; Shaw et al., 2001), one found that categorical handedness indicator better identified people with high positive schizotypy (Barnett & Corballis, 2002) and another one found that a continuous indicator better identified the relationship (Chen &

Su, 2006). The other studies either showed significant relationships for both continuous and categorical indicators (Annett & Moran, 2006; Shaw et al., 2001) or reported insignificant for both (Dragovic et al., 2005; Gregory et al., 2003). The current study found that the relationship between handedness and schizotypy was significant only when the categorical handedness was used in the mixed model analysis. The partial correlation analysis that was based on continuous handedness failed to replicate the findings from the mixed model analysis. This discrepancy might be in part accounted for by the correlation analysis' assumption of a linear relationship between handedness and schizotypy, which appears to be not the case as illustrated in the LOESS curve-fitting in scattergrams. Another concern is whether the adjustment for sex and age in the partial correlation might render the results insignificant. Since both variables were considered as potential confounders in the analysis, rather than mediators, the association between schizotypy and handedness were enhanced in the analysis with adjustment as compared with those without adjustment.

The current study seemed to suggest that handedness might be a categorical rather than continuous variable. Besides, Annett's classification took the type of actions, primary (e.g. writing, throwing a ball) or secondary (e.g. threading a needle, shoveling), into consideration, whereas the two continuous indicators included in this study assigned the same weighting for each action in their scoring. Therefore, type of action appeared to be an important issue in handedness.

Handedness and schizotypy were not related in the parents of schizophrenia patients in the current study even when Annett's classification was adopted. Social pressure against using the left-hand was common, particularly for the generation of elders (Ellis, Ellis, Marshall, Windridge, & Jones, 1998; Gilbert & Wysocki, 1992). The comparison of handedness patterns between parents and siblings in our study appeared to be consistent with the secular trend toward greater acceptance of using the left hand, which included a lower proportion of right handedness and higher proportion of mixed handedness according to Annetts' classification, as well as lower Hand Performance Index and higher either hand use score in the younger generation, i.e. the siblings. Therefore, the misclassification of handedness might partially explain the lack of significant difference in Positive Schizotypy between right and non-right handed parents in our study.

The lack of association between handedness and negative schizotypy is consistent with previous studies (Asai & Tanno, 2009; Chapman & Chapman, 1987; Chen & Su, 2006; Dragovic et al., 2005; Kim et al., 1992; Overby, 1993; Poreh, 1994; Stefanis et al., 2006). The differential relationship between individual schizotypal factors, i.e., positive and negative schizotypy, and handedness appeared to reconfirm the multidimensionality of schizotypy, which was also supported by our previous study (Lien et al., 2010).

One caveat about the association between positive schizotypy and non-right handedness is whether the association reflects some aspects of questionnaire-taking behavior rather than an underlying neuropsychological relationship. This possibility is highlighted in a recent study reporting that magical ideation was related to questionnaire but not behavioral measures of handedness (Grimshaw et al., 2008). However, one issue that study did not take into account was that a practice effect might be more likely to confound a behavioral measure of handedness than a questionnaire one. Some by-nature left- or mixed-handers might have higher score in the behavioral measure because they have been forced to use and have more time to practice their right hand. This differential bias would render the association between magical ideation and behavioral measures of handedness underestimated. Further studies are needed so that these issues could be investigated more thoroughly in the future.

Implications of our findings can be gauged by the increasing understanding on the origin of handedness. Recent two meta-analyses of data from twin studies, which defined handedness by self classification or by asking the hand used for writing or drawing, reported that the contribution from additive genes was estimated to be about a quarter with the remainder from non-shared environment (Medland et al., 2009; Medland, Duffy, Wright, Geffen, & Martin, 2006). Similarly, about one-third of the variance in handedness assessed using the Annett's handedness questionnaire was accounted for by additive genetic effects among adolescents in Taiwan when a directional indicator for the categorical handedness was used (Su, Kuo, Lin, & Chen, 2005). Taken together, the small magnitude of heritability in categorical handedness may account for the moderate effect size in the association of non-right handedness with positive schizotypy in this study's sample of high familial loading for schizophrenia. It will be of interest to examine in future studies if the same chromosomal regions related to positive schizotypy (Lien et al., 2010) also affect handedness.

Regarding distinct implications of left-handedness versus mixed-handedness, we only concluded that non-right handedness, instead of mixed-handedness, was associated with positive schizotypy, despite the fact that the study samples contained almost no left-handers. The rationale is that some mixed-handers in the current study might be innate left-handers due to the misclassification of handedness. Despite that atypical cerebral lateralization is considered a risk factor for schizophrenia (Crow et al., 1996; Satz & Green, 1999), it is still unclear if both left and mixed handedness or mixed handedness alone are associated with schizophrenia (Sommer et al., 2001). Hence whether a reversal or reduction of cerebral dominance is associated with schizophrenia remains unknown (Crow, 1997; Gur, 1999). A recent meta-analysis found that mixed-handed subjects, but not strong left-handed subjects, had higher schizotypy levels than right-handed ones, while most of the subjects were college students (Somers, Sommer, Boks, & Kahn, 2009). Given a relatively large total sample size, this study still could not solve the above issue probably due to the following two limitations. First, since fewer siblings participated in this study, it would result in the small number of siblings with left or mixed handedness and render the comparison between the two groups unlikely. Second, although more parents participated in the current study, cultural pressure against left-handedness was presumed to be relatively high in Taiwan, particularly for the elderly (Chen & Su, 2006). A significant association between schizotypy and non-right-handedness was found only after correcting for the effects of early switching of hand usage in Japan (Gregory et al., 2003). Since we did not measure if subjects switched their hand usage earlier, the misclassification of handedness in parents should have reduced the statistical power of detecting the relationship between handedness and schizotypy in our study.

In conclusion, we found that categorical, but not continuous, non-right handedness was associated with positive schizotypy in nonpsychotic siblings of patients with schizophrenia in a non-western population. The results indicate that an atypical cerebral lateralization underlying non-right handedness may be also a contributing factor to positive schizotypy.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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(a)

(b)

Figure 1.

The scattergrams of the Positive Schizotypy scores and Hand Preference Index raw scores in open circles for the (a) siblings (N = 323) and (b) parents (N = 812), respectively, with the bubble size proportional to the number of participants (the scaling factor = 12 and 18, respectively). The predicted scores derived from using the non-parametric local fitting method implemented in SAS PROC LOESS were superimposed on the corresponding scattergram in solid points.

Table 1

Descriptive data of the nonpsychotic relatives of patients with schizophrenia.

Variable	Parents (N = 850)	Siblings (N = 334)
Females, <i>n</i> (%)	440 (51.8)	152 (45.5)
Age, mean (SD)	63.6 (9.4)	37.4 (9.0)
Years of education, mean (SD)	5.2 (4.1)	11.1 (3.7)
Writing with left hand, <i>n</i> (%)	16 (1.9)	2 (0.6)
Annett's categorization, <i>n</i> (%)		
Fully left-handed	14 (1.7)	1 (0.3)
Mixed-handed	51 (6.0)	36 (10.8)
Fully right-handed	785 (92.4)	297 (88.9)
Hand Preference Index		
Mean (SD)	92.1 (31.9)	91.8 (27.2)
Median (10%–90%)	100 (89.6–100)	100 (83.3–100)
Either hand use score		
Mean (SD)	0.1 (0.5)	0.2 (0.9)
Median (10%–90%)	0 (0–0)	0 (0–0)

Comparing the factor scores of schizotypal factors between the NRH and RH on the basis of Annett's (1985) classification

Table 2

Schizotypal personality factor	Parents			Siblings		
	NRH (N = 60)		Group comparison ^a	NRH (N = 37)		Group comparison ^a
	Mean (SD)	RH (N = 752)		Mean (SD)	RH (N = 286)	
			Effect size			Effect size
Negative Schizotypy	0.24 (0.76)	0.15 (0.82)	0.11	-0.03 (0.66)	-0.15 (0.81)	0.15
Positive Schizotypy	-0.05 (0.78)	-0.11 (0.80)	0.08	0.48 (0.68)	0.15 (0.79)	0.42
Interpersonal Sensitivity	-0.09 (0.79)	-0.17 (0.85)	0.09	0.45 (0.69)	0.18 (0.81)	0.33
Social Isolation/Introversi	0.07 (0.78)	0.05 (0.81)	0.03	0.08 (0.50)	-0.11 (0.67)	0.28
			0.85			0.11

^aLinear mixed effect model with family as the random effect to control for intrafamilial correlation

Table 3
Partial correlations (Spearman's r) between schizotypal factors and handedness indexes with adjustment for sex and age

Schizotypal personality factor	Parents (N = 811)			Siblings (N = 323)		
	Hand Preference Index		Either hand use		Hand Preference Index	
	r	p	r	p	r	p
Negative Schizotypy	-0.06	0.09	0.00	0.95	-0.07	0.20
Positive Schizotypy	-0.04	0.26	-0.02	0.59	-0.06	0.29
Interpersonal Sensitivity	-0.04	0.23	-0.03	0.39	-0.04	0.53
Social Isolation/Introversi	-0.04	0.28	-0.01	0.78	-0.10	0.08
					0.04	0.44