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Magical ideation is related to questionnaire but not behavioural measures of handedness

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Magical ideation has repeatedly been shown to be related to handedness, with mixed-handers exhibiting higher levels of magical thinking. However, most previous research has assessed hand preference with a questionnaire measure, leaving open the possibility that the correlation reflects some aspect of questionnaire-taking behaviour and not an underlying neuropsychological relationship. The present study addressed this issue by administering the Magical Ideation Scale (Eckblad & Chapman, 1983), the Waterloo Handedness Questionnaire-Revised (Elias, Bryden, & Bulman-Fleming, 1998), and a manual dot-filling task (Tapley & Bryden, 1985) as a behavioural measure of handedness to an undergraduate student sample. The expected relationship between magical ideation and handedness as assessed by the questionnaire was observed. However, magical ideation was not related to the behavioural measure of handedness. Results cast doubt on a neuropsychological interpretation of the relationship between handedness and magical ideation in sub-clinical populations.

Magical ideation, or a belief in nonvalid forms of causation, is a hallmark of schizophrenia and schizotypal personality disorder (DSM-IV, American Psychiatric Association, 1994). Relatively high levels of magical ideation are also observed in the sub-clinical population (Eckblad & Chapman, 1983; Raine, 1991). Although magical ideation is often associated with educational, cultural, personality, or psychopathological factors (Ross, Lutz, & Bailley, 2002; Subotsky & Quinteros, 2002), recent research has focused on its neuropsychological correlates. Specifically, magical ideation has repeatedly been found to be related to hand preference, such that mixed-handers have higher rates of magical ideation than either strong left-handers or strong right-handers. That is, a negative correlation is observed between

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magical ideation and the *degree* of hand preference (either right or left). This effect appears to be robust, and is observed across multiple measures of both hand preference and magical or schizotypal thinking (Annett & Moran, 2006; Barnett & Corballis, 2002; Chen & Su, 2006; Claridge, Clark, Davis, & Mason, 1998; Nicholls, Orr, & Lindell, 2005; Richardson, 1994; Shaw, Claridge, & Clark, 2001; Stefanis et al., 2006), although some studies have failed to find such a relationship (Dragovic, Hammond, & Jablensky, 2005; Jaspers-Fayer & Peters, 2005).

One concern with all these studies (with the exception of Nicholls et al., 2005) is that both hand preference and magical ideation were assessed with questionnaire measures. It is therefore possible that the common variance in magical ideation and hand preference reflects some aspect of questionnaire behaviour and not an underlying neuropsychological relationship. For example, individuals with high rates of magical ideation might like to remain open to the idea that they *could* use their nondominant hand for an activity some of the time, when in fact they would not actually do so. Such an individual would appear to be weakly handed or mixed-handed on the questionnaire, but would not in fact be so were their handedness determined behaviourally.

One solution to this problem is to use a behavioural measure of handedness instead of a questionnaire. Nicholls et al. (2005) recently used just this approach, and found that magical ideation was related to hand preference as assessed by questionnaire (mixed-handers had higher rates of magical ideation as expected), but it was not related to asymmetry in hand skill, as assessed with a tapping task. Nicholls et al. interpret their findings as reflecting a flaw in their behavioural measure of handedness (as opposed to a flaw in the self-report measure). They note specifically that the finger-tapping task they used typically produces a unimodal distribution of hand asymmetry, instead of the bimodal distribution associated with handedness, and may therefore not be an adequate indicator of mixed handedness.

The present study assessed magical ideation and handedness using both a questionnaire and a behavioural measure. In the behavioural task, participants were required to place a dot in as many small circles as possible within a specific time interval, with both the left and right hands. Tapley and Bryden (1985) found that this task produced two overlapping normal distributions, one for left-handers and one for right-handers. Using a laterality index, they found that right-handers had a mean index of $+.25$, while left-handers had a mean index of $-.19$ (based on the laterality index of $R–L/R+L$). This performance task may therefore distinguish strong- from mixed-handers more adequately than the finger-tapping task used by Nicholls et al. If magical ideation is related to handedness per se, then a negative correlation should be observed between magical ideation and degree of handedness as assessed by both measures.

STUDY 1

The first study examined relations between magical ideation and hand preference (as assessed by questionnaire) in an undergraduate student population to confirm that we replicated this basic finding in our population.

Method

Participants. Participants were 207 undergraduate students (71 men and 136 women; 24 left-handers and 183 right-handers, classified according to writing hand) registered in either introductory psychology or cognitive psychology classes at a university in Southern California.

Measures. The Magical Ideation scale (MI), developed by Eckblad and Chapman (1983), was used to assess magical thinking in each participant (we called this the Student Belief Scale). This 30-item self-report questionnaire makes various statements of belief with which participants either agreed or disagreed. Examples are: "Some people can make me aware of them just by thinking about me" and "Horoscopes are right too often to be a coincidence". We modified the scale slightly to reflect current culture (e.g., we changed "record albums" to "CDs"). Possible scores range from 0 (*very low magical ideation*) to 30 (*very high magical ideation*).

The Waterloo Handedness Questionnaire – Revised (WHQ-R; Elias et al., 1998) was used to indicate how often participants used each hand for a series of different activities. The questionnaire comprises 36 questions assessed on a 5-point scale (LA = left always, LU = left usually, EQ = equally, RU = right usually, RA = right always). Questions address both skilled and unskilled activities. Items were scored with values of -2 for Left Always, -1 for Left Usually, 0 for Equally, $+1$ for Right Usually, and $+2$ for Right Always. Total scores were transformed to produce a Handedness Index that ranged from -100 (*exclusively left-handed*) to $+100$ (*exclusively right-handed*). Taking the absolute value of the Handedness Index produced a measure of Degree of Handedness, with values between 0 (not handed) and 100 (strongly handed).

Procedure. Participants completed questionnaire packets in a large group setting. Approximately half completed the WHQ-R first and half completed the MI first. They were given no special instructions beyond those on the questionnaires themselves. At the end of the study, they answered demographic questions about their age, sex, number of college units completed, and number of psychology units completed. The study took approximately 15 minutes to complete.

Results and discussion

Demographic information and mean hand preference and magical ideation values are presented in Table 1, and correlations between magical ideation and handedness are presented in Table 2. Consistent with other studies, magical ideation was negatively correlated with degree of hand preference, $r(207) = -.15$, $p = .03$; individuals with lesser degrees of handedness had higher rates of magical ideation.

STUDY 2

Study 1 replicated the basic finding of a negative correlation between magical ideation and degree of handedness as measured with a handedness questionnaire. Participants with higher levels of magical ideation had lesser degrees of handedness. Study 2 used the same questionnaire measures of handedness and magical ideation in the same student population. In addition, participants completed a manual dot-filling task with the left and right hands. If magical ideation is related to handedness (and not some other factor that contributes to responses on the handedness questionnaire), then it should be similarly related to both the questionnaire and the behavioural measures of handedness.

Method

Participants. A total of 170 participants (127 women and 43 men; 25 left-handers and 145 right-handers, as assessed by writing hand) were

TABLE 1
Sample characteristics and handedness measures for Study 1 and Study 2

	Study 1			*Study 2*		
	N	*Mean*	*SD*	*N*	*Mean*	*SD*
Age	207	20.34*	4.53	170	21.60*	4.56
College units	195	37.44*	32.09	162	50.96*	40.83
Psyc units	200	4.46*	10.85	155	7.53*	10.72
Handedness Index (Q)	207	58.30*	37.94	170	64.26*	32.91
Degree of handedness (Q)	207	66.30	20.93	170	69.51	19.42
Magical ideation	207	8.04*	4.78	169	9.61*	5.30
Handedness Index (B)				170	15.95	11.62
Degree of handedness (B)				170	18.23	7.54

(Q) indicates questionnaire measure. (B) indicates behavioural measure. *N*s vary slightly as not all participants answered the demographic questions.

*Indicates a significant difference between samples, $p < .01$.

TABLE 2
Correlations between magical ideation and handedness measures

	Magical ideation	
	Study 1 (N = 207)	*Study 2 (N = 170)*
Handedness index (Q)	−.044	−.105
Degree handedness (Q)	−.150*	−.150*
Handedness index (B)		.020
Degree handedness (B)		.023

(Q) indicates questionnaire measure; (B) indicates behavioural measure.
*$p < .05$.

recruited from the same population sampled in Study 1. None had participated in the previous study.

Measures. Participants completed three assessments: a manual dot-filling task (Tapley & Bryden 1985), the WHQ-R used in Study 1 (Elias et al., 1998), and the MI used in Study 1 (Eckblad & Chapman, 1983). For the dot-filling task, participants were given a sheet of paper printed with a series of circles (3 mm in diameter) arranged in an alternating descending and ascending pattern that snaked across the page. The participant was required to place a dot (•) in the middle of each circle, working as quickly but as accurately as possible. They completed four trials of 20 seconds each with alternating hands (L/R/R/L or R/L/L/R). Dots were counted only if they fell entirely within the circle and did not touch any edges. All participants completed the dot-filling task with a fine-point black felt-tip marker. An asymmetry index of manual skill was calculated as (R–L/R + L). Values ranged from −1 (*left dominant*) to +1 (*right dominant*). Absolute value of manual skill asymmetry ranged from 0 (*hands equivalent*) to +1 (*one hand completely dominant*).

Procedure. Participants took part in either a classroom or a small group session (1–4 participants). They were told that they were participating in two separate studies, the first to examine motor skills and the second to study student beliefs. All participants completed the tasks in the same order: the dot-filling task, followed by the WHQ-R, followed by the Magical Ideation Scale (which we again called the Student Beliefs Scale). Given that measures of magical ideation are likely susceptible to demand characteristics (Mohr & Leonards, 2005), we wished to encourage participants to admit their magical beliefs. This should increase both the validity and the variability in the magical ideation scale, which should increase the likelihood of observing correlations with our handedness measures, should they exist. The following

example was provided with the instructions: "I know that black cats are not really bad luck, but I still feel something odd when one crosses my path." Participants were told to answer based on whether they believed the statements provided and not on whether they thought they were truly right or wrong. Lastly the participants answered demographic questions.

Results and discussion

Demographic information and mean scores on the handedness measures are presented in Tables 1 and 2. Note that the sample characteristics differ considerably from those in Study 1; participants in this study were older and had more education, both in terms of general college units and psychology units. Notably, they were also higher in magical ideation, $t(374) = 3.029$, $p = .003$. Given that the demographic differences would seem to bias this sample towards lower rates of magical ideation (assuming that magical ideation decreases with age and education), we attribute this increase to our instructions, which were designed to make participants comfortable admitting their magical beliefs. Although the samples differed in their rates of magical ideation, the relationship between magical ideation and hand preference as assessed with the questionnaire was unchanged: the correlation between degree of handedness and magical ideation was again $r(170) = -.15$, $p = .05$. Most importantly, there was no correlation between magical ideation and the degree of asymmetry on the manual dot-filling task, $r(170) = .02$, *ns*. Our results are strongly concordant with those of Nicholls et al. (2005), who found a similar significant correlation between magical ideation and degree of hand preference (as assessed with the 31-item questionnaire of Provins & Cunliffe, 1972) of $r(933) = -.138$, and a similar nonsignificant correlation between magical ideation and degree of asymmetry on their finger-tapping task of $r(933) = .009$.

Supplementary analyses were performed to further explore the relationship between the hand preference questionnaire and magical ideation. Given that the same relationship was observed in both studies, the samples were combined wherever possible to increase statistical power. First, individuals were classified into handedness categories using the cut-points used by both Barnett and Corballis (2002) and by Nicholls et al. (2005). Using the cut-point system, individuals with a hand preference index between -100 and -28 were classified as left-handed, those between -28 and $+28$ were classified as mixed-handed, those from $+28$ to $+46$ were classified as weak right-handers, those from $+46$ to $+64$ as medium right-handers, those from $+64$ to $+82$ as strong right-handers, and those from $+82$ to $+100$ as extreme right-handers. Although the pattern of results is identical to that in both Barnett and Corballis and in Nicholls et al., a one-way ANOVA on

magical ideation scores failed to reach significance, $F(5, 370) = 1.362$, $p = .238$ (see Figure 1). However, the quadratic component did approach significance, $F(1, 370) = 3.092$, $p = .08$, as did a planned contrast comparing mixed-handers to all other categories, $t(370) = 1.66$, $p = .098$. Consistent with previous studies, mixed-handers had higher rates of magical ideation than other handedness groups.

A second analysis was performed using a more empirically driven cluster analysis to obtain three handedness groups. Cluster analysis based on handedness questionnaire items revealed three clusters: consistent right-handers ($N = 337$), consistent left-handers ($N = 24$), and mixed-handers ($N = 16$). The mixed-handers primarily (75%) performed writing and other skilled fine-motor activities with the left hand and less skilled activities like throwing or using a light switch with the right hand or both hands equally. A one-way ANOVA failed to show a significant difference between handedness clusters in magical ideation, $F(2, 373) = 2.089$, $p = .125$, but a planned comparison between mixed-handers and other handedness clusters revealed that the mixed-handers had higher rates of magical ideation ($M = 11.25$, $SD = 5.58$) than the combined group of consistent left-handers and consistent right-handers ($M = 8.64$, $SD = 5.08$), $t(373) = 2.\ 005$, $p = .046$.

Finally, given that magical ideation was related to the questionnaire measure of hand preference but not the behavioural measure of asymmetry in hand skill, the relationship between the two handedness measures was examined. In contrast to the finger-tapping task used by

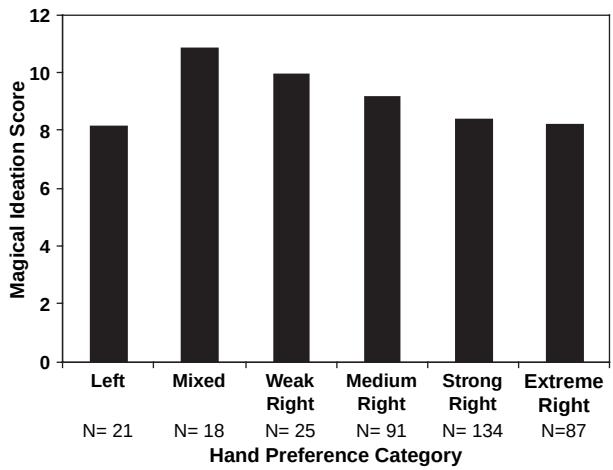

Figure 1. Magical ideation score as a function of handedness, using the cut-off scores in Barnett and Corballis (2002) and in Nicholls et al. (2005). Note that the pattern of results is identical across all three studies.

TABLE 3
Performance on the manual dot-filling task as a function of handedness cluster

	Left-handers ($N = 9$)	*Mixed-handers* ($N = 5$)	*Right-handers* ($N = 156$)
Left hand dots	100.78	90.80	68.04
Right hand dots	72.44	96.40	97.69
Asymmetry index	−.16	.04	.18

Mixed-handers filled as many dots with the left hand as left-handers, and as many dots with the right hand as right-handers.

Nicholls et al. (2005), the dot-filling task produced a bimodal distribution of asymmetry, with left-handers (based on the cluster analysis) producing a mean index of −.16 and a mode at −.10, and right-handers producing a mean of +.18 with a mode at +.10. Although the behavioural assessment of handedness index was moderately correlated with the questionnaire measure, $r(170) = .668$, $p < .001$, degree of handedness on the two measures was only weakly correlated, $r(170) = .186$, $p = .015$. This poor relationship between degrees of handedness on the two measures is largely driven by the right-handers. Among right-handers, there was no relationship between handedness index on the two measures, $r(156) = .095$, $p = .228$, or between degree of handedness on the two measures, $r(156) = .113$, $p = .159$, suggesting that, in right-handers, degree of hand preference indicated on the questionnaire is not driven by degree of asymmetry in hand skill. A final analysis examined the numbers of dots filled with both the left and right hands (see Table 3). This analysis demonstrated that the mixed-handers were highly skilled with both hands. Post-hoc tests revealed that their left-hand performance does not differ from that of left-handers, $p = .455$, and their right-hand performance does not differ from that of right-handers, $p = .970$. Thus, even though there is a weak relationship between the two handedness measures in the sample as a whole, the mixed-handers (as assessed by questionnaire) do differ from the other groups in their asymmetry for hand skill.

GENERAL DISCUSSION

The present study examined the relationship between magical ideation and handedness as assessed with both the Waterloo Handedness Questionnaire–Revised (Elias et al., 1998) and a behavioural dot-filling task (Tapley & Bryden, 1985). Consistent with most previous research in this area, we found a negative relationship between magical ideation and degree of hand preference on the questionnaire; that is, higher rates of magical ideation were associated with weaker hand preference. However, we found that

magical ideation was not correlated with the behavioural measure of asymmetry in hand skill. This lack of association is consistent with that observed by Nicholls et al. (2005), who found that magical ideation was not related to asymmetry in hand skill assessed with a finger-tapping task. It is also consistent with findings from DeLisi et al. (2002), who found that individuals with schizophrenia or schizoaffective disorder were more weakly handed than their non-affected relatives on a questionnaire measure of handedness but not on the Tapley and Bryden dot-filling task.

We have argued that if magical ideation is related to degree of handedness per se, then it should be related to both questionnaire and behavioural measures of handedness. There are a number of possible explanations for why magical ideation was related to the questionnaire measure but not the behavioural measure in this study. Nicholls et al. (2005) suggest that they failed to find a correlation between magical ideation and degree of hand asymmetry on their tapping task because the task was not a valid measure of ambidexterity as it produces a unimodal distribution of asymmetry scores. However, the dot-filling task used in the present study produced a bimodal distribution, and therefore bears a stronger relationship to questionnaire preference measures (Tapley & Bryden, 1985). The present study used only one behavioural measure of handedness, and so our results must be interpreted cautiously. However, given the consistency across the Nicholls et al. (2005) study and the present findings, we suggest that magical ideation is related to questionnaire measures but not behavioural measures of handedness.

Questionnaire measures of handedness typically measure asymmetry in hand preference, whereas behavioural tasks measure asymmetry in hand skill. Although these two dimensions of handedness are highly correlated, they have been shown to dissociate from each other (McManus, Murray, Doyle, & Baron-Cohen, 1992). It is therefore possible that magical ideation is related to hand preference but not asymmetry in hand skill. However, we are not aware of any theoretical neuropsychological reason why magical ideation might be related to one but not the other.

The most parsimonious explanation for the dissociation between the questionnaire and the behavioural measures is that both the handedness questionnaires and the magical ideation questionnaires tap some aspect of questionnaire-taking behaviour that accounts for a small amount of variance on both. Nicholls et al. (2005) suggested that participants who responded randomly on both questionnaires would inflate their scores on the magical ideation questionnaire and decrease their degree of handedness on the handedness questionnaire, producing a small subset of participants who appeared to be mixed-handed and high in magical ideation. Alternatively (and perhaps less cynically), it is possible that some aspect of personality affects both measures. For example, magical ideation has been shown to be

positively correlated with the personality factor of openness (Ross et al., 2002; Wiggins & Pincus, 1989). If openness also contributed to some small amount of variance on the handedness questionnaire (because individuals high in openness like to remain open to the possibility of using their nondominant hand, particularly for less skilled activities), then an association between magical ideation and handedness might reflect common variance due to the personality factor of openness and not an underlying neuropsychological relationship. Unfortunately, there are very few data available on personality correlates of handedness questionnaires, and so this hypothesis remains untested.

The present finding does not invalidate studies that have found relationships between magical thinking and more direct measures of neuropsychological function. For example, considerable evidence has accumulated to suggest that schizotypal thinking is related to leftward attentional and turning biases suggestive of increased right hemisphere activity (Brugger & Graves, 1997; Mohr, Bracha, & Brugger, 2003; Mohr, Landis, Bracha, Fathi, & Brugger, 2005b; Taylor, Zach, & Brugger, 2002, but see Mason & Claridge, 1999) and to increases in right hemisphere language processing (Leonard & Brugger, 1998; Mohr et al., 2005a). However, the relationship between right hemisphere activity and mixed handedness is unknown, and so the right hemisphere interpretation of schizotypy does not necessarily predict relations between handedness and magical ideation. It is entirely possible for relations between magical ideation and handedness to reflect personality variables and the relationship between magical ideation and direct measures of hemispheric asymmetry to reflect neuropsychological variables. If this were the case, it would suggest that we should use caution in using hand preference as a proxy for cerebral organisation, and instead test hypotheses about the neuropsychological basis of schizotypy using more direct measures.

The results of this study do not indicate that the relationship between hand preference questionnaires and magical ideation is not *real*—indeed, the effect appears to be very robust. Furthermore, as the study was conducted in a sub-clinical population, the results say nothing about the relationship that may exist between magical thinking and handedness or neuropsychological organisation in clinical populations. However, the results should lead us to question the nature of the relationship between hand preference and magical ideation in the general population and to question whether this relationship really informs neuropsychological theory.

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