

Predictors of Non-Response to a Questionnaire Survey of a Volunteer Twin Panel: Findings from the Australian 1989 Twin Cohort

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Questionnaire surveys, while more economical, typically achieve poorer response rates than interview surveys. We used data from a national volunteer cohort of young adult twins, who were scheduled for assessment by questionnaire in 1989 and by interview in 1996–2000, to identify predictors of questionnaire non-response. Out of a total of 8536 twins, 5058 completed the questionnaire survey (59% response rate), and 6255 completed a telephone interview survey conducted a decade later (73% response rate). Multinomial logit models were fitted to the interview data to identify socioeconomic, psychiatric and health behavior correlates of non-response in the earlier questionnaire survey. Male gender, education below University level, and being a dizygotic rather than monozygotic twin, all predicted reduced likelihood of participating in the questionnaire survey. Associations between questionnaire response status and psychiatric history and health behavior variables were modest, with history of alcohol dependence and childhood conduct disorder predicting decreased probability of returning a questionnaire, and history of smoking and heavy drinking more weakly associated with non-response. Body-mass index showed no association with questionnaire non-response. Despite a poor response rate to the self-report questionnaire survey, we found only limited sampling biases for most variables. While not appropriate for studies where socioeconomic variables are critical, it appears that survey by questionnaire, with questionnaire administration by telephone to non-responders, will represent a viable strategy for gene-mapping studies requiring that large numbers of relatives be screened.

The past 25 years has seen a shift in twin research from large questionnaire based studies (e.g., Eaves et al., 1989), that are limited to the assessment of a relatively small number of variables which, however, can be achieved at relatively low cost with sample sizes sufficiently large to ensure adequate power for resolving genetic and shared environmental effects on human variation (Martin et al., 1978), to the use of more intensive and comprehensive but expensive interview-based assessments (e.g., Kendler et al., 1992; Heath et al., 1997). The use of interview-based assessments has allowed better documentation of causes of non-response, and led to greater attention to potential sampling

biases (e.g., Heath et al., 1997, 1998). However, as genetic research moves into the phase of finding genes that contribute to human variation, rather than merely documenting that they must exist, there is a need to move beyond the sample sizes that are economically feasible with interview-based research. Because of their larger than average sibship size, and high rates of cooperation in research studies, twin pairs and their siblings can play an important role in gene-mapping, not least variance components linkage studies (e.g., Martin et al., 1997). Typically, however, such studies may require screening 10,000 or more families (Eaves & Meyer, 1994; Risch & Zhang, 1995) in order to identify the much smaller number of families that will be most informative for gene-mapping.

In this paper, we explore the issue of sampling biases that may arise with reliance on questionnaire rather than interview assessments. We present the results of analyses of data from a large national twin cohort, a volunteer panel of Australian twins born between 1964 and 1971 who were first targeted for assessment by questionnaire in 1989–1992, and then, regardless of whether either twin participated in the questionnaire survey, were again targeted for telephone interview in 1996–2000. As is typical in survey research, a much higher response rate was achieved using the interview assessment than using the questionnaire survey, despite the 10 year interval. Here we examine the extent to which important differences exist between interview responders who did versus did not participate in the earlier questionnaire-based study, with a major focus on sociodemographic, psychiatric (depression,

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childhood conduct disorder, and alcohol dependence), and health behavior (smoking, drinking, obesity) measures.

Method

Sample

A total of 8536 twins (4268 pairs) born 1964–1971 were registered with the Australian twin panel as children, over the period 1980–1982, in response to media appeals and systematic appeals through the Australian school systems. These individuals formed the target sample both for the questionnaire survey, and for the telephone diagnostic interview survey, and are identified here as the '1989 cohort', based on the target date for the initial questionnaire survey. Based on the provisional zygosity assignment made at the time the twins volunteered, or were volunteered by their parents, this total comprised 907 monozygotic (MZ) female, 770 MZ male, 747 dizygotic (DZ) male like-sex, 704 DZ female like-sex and 1092 DZ unlike-sex pairs, as well as 48 like-sex pairs for whom zygosity could not be assigned. In total, there were 4450 female twins, 4083 male twins, and 3 twins for whom gender was originally unknown. In the original volunteer panel there was thus a slight underrepresentation of male twins, and of unlike-sex DZ twins, but little evidence for an excess of monozygotic compared to same-sex dizygotic pairs. Based on more detailed questionnaire zygosity assessments for those twins who completed the diagnostic interview assessment, we can project an initial zygosity misassignment rate of less than 2% for those originally designated as MZ pairs, but of 4.3% for those originally designated as female DZ pairs, and 5.6% for those designated as male DZ pairs. There was no misassignment of gender, and hence of zygosity, for unlike-sex pairs.

Assessments

In 1989–1992, when the panel were aged 18 to 25 years, the first survey by mailed questionnaire was conducted. A self-report questionnaire was mailed to the twins which was in most respects identical to the follow-up questionnaire that had been administered, beginning in 1988, to an older cohort of twins born 1890–1964 and first surveyed by questionnaire in 1980–1982 ('1981 cohort': for further details, see: Heath et al., 1994, 1995). Included in the questionnaire assessment were measures of personality (Eysenck Personality Questionnaire, Revised: Eysenck et al., 1985; and the short-form Tridimensional Personality Questionnaire: Cloninger et al., 1991), social attitudes (Martin et al., 1986), alcohol problems and current alcohol consumption patterns (Heath & Martin, 1994), other measures of smoking (Madden et al., 1999), body-mass index, and other health-related behaviors, and standard sociodemographic measures including educational level, religious affiliation, and religious involvement (indexed by frequency of attendance at religious services) (Heath et al., 1997). Wherever possible, the questionnaire items retained the same format as the earlier 1980–1982 questionnaire survey of the 1981 cohort, in order to permit comparison of individuals from the two cohorts who were assessed at similar age (18–25) but approximately 8–9 years apart (in 1980–1982 versus 1989–1991), allowing analysis of secular

changes in patterns of alcohol consumption, smoking and other risk-factors. In cases where twins did not respond to the original questionnaire mailing and a follow-up mailing, an abbreviated questionnaire was administered by telephone whenever possible. This comprised measures of sociodemographic and lifestyle variables, including measures of alcohol consumption but not alcohol problems. No assessment of personality or social attitudes was attempted using the telephone-administered questionnaire.

In 1996–2000, the '1989' cohort were targeted for diagnostic interview assessment by telephone. Interviewing had to be stretched over a 4-year period because of competition with other research projects for access to the 1989 twin panel. Because of the poor response rate to the earlier questionnaire survey, the decision was made to attempt to locate and interview all pairs, regardless of whether either twin had participated in the 1989 questionnaire survey. The interview was based upon, but more extensive than, that used in a previous interview survey of the older 1981 twin cohort (Heath et al., 1997). It included diagnostic assessments of alcohol dependence, smoking history and nicotine dependence, and history of major depression, and childhood conduct disorder, all updated to be compatible with the latest psychiatric diagnostic criteria (DSM-IV) of the American Psychiatric Association (APA, 1994) as well as non-diagnostic measures of social anxiety, illicit drug use and abuse/dependence, suicidality, and a screen for history of bipolar disorder. For the purposes of the present paper, we use a variant of the DSM-IV diagnostic criteria for conduct disorder, which relaxes the requirement for clustering of 3 or more symptoms over the same 6 month period, because of concerns about the accuracy of retrospective reporting of our adult respondents (median age 30) about these childhood symptoms. The interview also included non-diagnostic measures of drinking history and current alcohol consumption (two measures of heavy drinking were analysed here: maximum self-report consumption in any 24-hour period, measured in standard drinks; and maximum self-report tolerance to the intoxicating effects of alcohol, assessed as the maximum number of standard drinks the respondent could consume before getting drunk), as well as standard measures of sociodemographic variables and rearing history, an assessment of height and weight from which body-mass index could be derived, and standard questions for twin pair zygosity assignment.

Statistical Analyses

Frequency distributions were computed for sociodemographic, psychiatric and health behavior variables assessed in the interview survey, stratified by gender and by whether the interviewee (i) had previously mailed back the self-report questionnaire survey conducted in 1989, or (ii) had not returned the mailed questionnaire survey, but had completed the abbreviated questionnaire when it was administered by telephone, or (iii) had not completed either assessment. Included in this latter group were twins who were never successfully located, as well as those who either actively or passively refused to participate in the research. Multinomial logit models were fitted to these data using STATA (StataCorp, 1999), using a Huber-White

robust variance estimator to obtain 95% confidence intervals that were adjusted for the statistical non-independence of observations on twin pairs. The estimated Odds Ratios compared odds of returning the mailed questionnaire, or completing only the brief telephone-administered questionnaire, using interviewees who had not completed either questionnaire measure as the comparison group.

RESULTS

Table 1 cross-tabulates numbers of individuals responding to the 1989 questionnaire survey and the 1998 diagnostic interview survey. Out of a total of 8536 twins (4268 twin pairs) born 1964–1971 registered with the Australian twin panel and forming the target sample for the '1989 cohort', completed self-report questionnaires were mailed back by 3740 respondents, that is, only 43.8% of the target sample (50.9% of women, 36.1% of men). An additional 1318 individuals, while not returning a self-report questionnaire, did complete an abbreviated questionnaire administered by telephone, giving a still disappointing overall individual response rate for the 1989 questionnaire survey of 59.3% (64.5% for women, 53.6% for men). In contrast, response rates for the telephone diagnostic interview survey were considerably better. Despite the fact that the interview survey was conducted approximately 10 years later, a fact that would have increased the likelihood that a family would be lost, a total of 6255 individuals were successfully interviewed (73.3% response rate), including 3456 women (77.7%) and 2799 men (68.6%). The small number of individuals who terminated their interview prematurely (7 women and 17 men) are included as interview respondents in these figures. Interview respondents included 87.7% of those who had previously mailed back the self-report questionnaire, 77.6% of those who had previously completed an abbreviated questionnaire by phone, and 56.1% of those who had not responded during the 1989 questionnaire survey. By the time of the diagnostic interview survey, a total of 252 pairs were identified as 'lost', that is, no leads could be found after extensive efforts to retrace either twin or other family members — including 235 pairs where neither twin had responded to the prior questionnaire surveys, and an additional 17 pairs where at least one twin had previously participated in the questionnaire survey. Taking into account these lost pairs, response rates are

increased to 46.4% for returning a full self-report questionnaire in the 1989 survey, or 62.7% for either returning the questionnaire or completing the abbreviated questionnaire administered by telephone; and to 77.9% for the diagnostic interview survey. While the response rates for the questionnaire mailing were rather low, for the diagnostic interview phase the response rate was at the high end of the range for contemporary survey research.

Sociodemographic Predictors

In the following tables, we use information obtained at the time of the diagnostic interview survey to identify characteristics of individuals who either did not participate in the questionnaire survey, or completed the brief telephone administered questionnaire but did not return the full self-report questionnaire. Table 2 summarises sociodemographic correlates — educational level, twin pair zygosity type, religious affiliation, religious involvement — of completing only the brief telephone, or of non-response to the questionnaire survey. The first six columns summarise, separately for males and females, the frequency distribution of these variables as a function of questionnaire response status. For example, 30% of women and 33% of men interviewees who had previously returned the mailed self-report questionnaire had a University education; but this was true of only 23% of women and 19% of men who had only completed a brief questionnaire, and for 19% of women and men who had not responded at all to the questionnaire survey. The next four columns, headed 'Univariate association with non-response', summarise Odds Ratios, and their 95% confidence intervals, estimated under a multinomial logit model, separately for each sociodemographic variable. This confirms, for example, that those with a University education were significantly less likely to fall into the 'no-response' (Odds Ratio 0.37) or 'Brief Questionnaire' (Odds Ratio 0.51), compared to those with only 8–10 years of education — in other words, that reporting a University education was associated with increased probability of response in the questionnaire survey. The final four columns, headed 'Multivariate association with non-response', summarise Odds ratios estimated under a multivariate multinomial logit model, when all sociodemographic predictors are used jointly to predict questionnaire non-response or partial (brief questionnaire) response. The odds ratios for

Table 1

Australian 1989 Twin Cohort: Individual Response Rates for 1989 Questionnaire and 1998 Interview Surveys

		Questionnaire Response		
		No response	Abbreviated Questionnaire	Full Questionnaire
Women				
Interview	— no response	637 (14.3%)	113 (2.5%)	245 (5.5%)
	— response	944 (21.2%)	491 (11.0%)	2020 (45.4%)
Men				
Interview	— no response	887 (21.7%)	184 (4.5%)	218 (5.3%)
	— response	1007 (24.7%)	530 (13.0%)	1257 (30.8%)

Table 2
Sociodemographic Correlates of Questionnaire Non-response

	Sociodemographic status as a function of questionnaire response status							Univariate association with non-response				Multivariate association with non-response					
	Full Q're			Brief Q're.			No response		Brief Q're. only		No response		Brief Q're. only		No response		
	F	M	%	F	M	%	F	M	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	
Educational Level																	
University	30.4	33.2	23.1	18.5	18.6	19.2	18.6		0.51	0.38–0.69	0.37	0.29–0.46	0.48	0.36–0.65	0.36	0.28–0.45	
Some post-high school	29.2	28.2	25.2	32.1	29.0	27.5	29.0		0.78	0.59–1.03	0.60	0.48–0.75	0.73	0.55–0.96	0.59	0.47–0.73	
8–10 years with diploma or 11–12 years	31.7	31.8	40.8	39.9	40.3	40.2	40.3		0.99	0.75–1.28	0.77	0.62–0.95	0.94	0.72–1.22	0.76	0.61–0.94	
8–10 years or fewer	8.7	6.9	10.9	9.5	12.1	13.1	12.1		1.00	—	1.00	—	1.0	—	1.0	—	
Twin pair zygosity & gender																	
MZ	45.9	41.7	39.4	38.8	37.4	37.4	37.4	MZF	1.00	—	1.00	—	1.00	—	1.00	—	
DZ same sex	32.6	31.1	35.1	36.1	38.0	34.3	38.0	MZM	1.89	1.43–2.49	1.91	1.51–2.43	1.45	1.01–2.08	1.69	1.27–2.24	
DZ unlike sex	21.4	27.2	25.6	25.1	24.6	28.3	24.6	DZF	1.25	0.95–1.64	1.30	1.03–1.65	1.22 ^{NS}	0.93–1.61	1.25	0.99–1.59	
								DZM	2.35	1.78–3.11	2.60	2.04–3.31	1.75	1.22–2.52	2.24	1.68–2.98	
								DZFM	1.62	1.26–2.08	1.76	1.42–2.19	1.41	1.07–1.87	1.65	1.32–2.07	
							Male	1.74	1.49–2.04	1.71	1.49–1.95	1.36	1.08–1.71	1.15	0.99–1.34		
Religious affiliation & involvement																	
Weekly church attendance	11.8	8.7	9.7	8.5	6.5	10.3	6.5		0.84 ^{NS}	0.64–1.10	0.76	0.61–0.95	0.95 ^{NS}	0.72–1.25	0.8 ^{NS}	0.62–1.20	
Roman Catholic	30.4	25.5	34.0	29.9	29.0	36.2	29.0		1.27	1.05–1.55	1.24	1.05–1.46	1.27	1.06–1.53	1.28	1.10–1.51	
Orthodox	1.3	1.4	3.5	2.5	1.5	1.1	1.5		2.48	1.44–4.29	1.24	0.71–2.17	2.45	1.43–4.23	1.09 ^{NS}	0.63–1.40	
Other religion									1.0	—	1.0	—	1.0	—	1.0	—	
Birth cohort																	
1964–66	44.8	44.4	47.8	40.5	41.4	44.2	41.4		1.0	—	1.0	—	1.0	—	1.0	—	
1967–69	41.7	41.0	32.2	40.8	39.0	36.6	39.0		0.91 ^{NS}	0.75–1.09	0.95 ^{NS}	0.81–1.11	0.94 ^{NS}	0.78–1.14	1.01	0.86–1.19	
1970–71	13.5	14.6	20.0	18.7	19.6	19.2	19.6		1.41	1.11–1.80	1.44	1.17–1.77	1.48	1.16–1.89	1.53	1.24–1.90	

Table 3
Psychiatric Correlates of Questionnaire Non-response

	Full Q're				Brief Q're.				No response				Univariate association with non-response				Multivariate association with non-response			
	F		M		F		M		F		M		Brief Q're. only		No response		Brief Q're. only		No response	
	%		%		%		%		%		%		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Major depression	32.3		20.4		29.5		23.2		33.1		23.6		0.93 _{NS}	0.79–1.09	1.09	0.90–1.17	0.8 _{NS}	0.72–1.00	0.94 _{NS}	0.82–1.07
Social anxiety	32.0		29.6		36.4		32.1		27.8		33.5		1.14 _{NS}	0.98–1.33	1.23	1.09–1.40	1.10 _{NS}	0.97–1.32	1.19	1.05–1.35
Conduct disorder	8.8		19.5		7.7		27.6		9.4		27.1		1.49	1.22–1.82	1.55	1.31–1.83	1.38	1.11–1.70	1.40	1.18–1.66
Alcohol dependence	15.3		26.4		16.8		34.4		16.4		34.0		1.46	1.22–1.74	1.40	1.22–1.62	1.36	1.13–1.64	1.30	1.12–1.41

questionnaire completion given a university education are changed hardly at all when other sociodemographic variables are controlled for (ORs 0.36, 0.48 respectively).

Non-response to the questionnaire survey was significantly associated with (i) education below the University level, and especially reporting 10 or fewer years of education; (ii) male gender, (iii) being a dizygotic rather than monozygotic twin, (iv) infrequent (less than weekly) church attendance, (v) reporting a religious affiliation of Roman Catholic, and (vi) belonging to the youngest birth cohort (born 1970–1971). Odds Ratios were essentially unchanged in multivariate compared to univariate analyses. Essentially the same variables predicted completing only the brief telephone administered questionnaire, rather than completing and mailing back the full questionnaire, except that a Greek or Russian Orthodox religious affiliation was one of the most potent predictors of completing only the brief questionnaire.

Psychiatric predictors

Table 3 summarises associations between questionnaire response status and psychiatric history determined at diagnostic interview. Lifetime prevalence of alcohol dependence was lower in males who returned the full questionnaire (26.4%) than in those who either completed only the brief questionnaire (34.4%) or did not respond (34.0%), and there was a similar though weaker trend in women. History of childhood conduct problems was also more rarely reported by males who returned the full questionnaire (19.5%) than by those who completed only the brief questionnaire (27.6%) or who did not respond (27.1%). History of major depression, and history of social anxiety were not associated with returning only a brief questionnaire, and only associated weakly (and only in the case of social anxiety) with non-response.

Health Behavior Predictors

Table 4 summarises health behavior correlates of questionnaire response status. Obesity did not predict questionnaire completion, and while there was significant overrepresentation of individuals with BMIs in the range 25–29 among questionnaire non-responders in univariate analyses, this association was no longer significant when other predictors were controlled for. Meeting criteria for nicotine dependence, or being a non-dependent regular smoker, was also associated in univariate analyses with increased risk of returning only a brief questionnaire, or of questionnaire non-response, but this effect again fell short of statistical significance (with the exception of a marginal association between non-dependent regular smoking and questionnaire non-response) once other variables were controlled for. Finally, heavy drinking was significantly but weakly correlated with both questionnaire non-response (the maximum alcohol tolerance item) and with brief questionnaire response (the maximum one-day alcohol consumption item).

Conclusions

In surveys of the young adult ('1989 cohort') Australian twin panel, a much higher response rate was achieved by diagnostic interview survey (78%) than by an earlier mailed

Table 4
Lifestyle Correlates of Questionnaire Non-response

	Full Q're				Brief Q're.				No response				Univariate association with non-response				Multivariate association with non-response			
	F		M		F		M		F		M		Brief Q're. only		No response		Brief Q're. only		No response	
	%	%	%	%	%	%	%	%	%	%	%	%	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Body Mass Index																				
<20	20.2	3.9	20.5	5.1	20.3	4.1	—	—	1.00	—	1.00	—	—	—	—	—	—	—	—	—
20–24	54.7	51.2	56.2	46.2	52.5	46.4	0.84–1.33	1.05 _{NS}	1.00 _{NS}	0.87–1.27	1.05 _{NS}	0.87–1.27	—	—	—	—	—	—	—	—
25–29	17.2	37.4	16.7	39.0	19.0	40.5	0.95–1.58	1.23 _{NS}	1.37	1.11–1.68	1.37	1.11–1.68	—	—	—	—	—	—	—	—
30+	7.9	7.5	6.6	9.7	8.2	9.0	0.83–1.61	1.16 _{NS}	1.30 _{NS}	0.99–1.70	1.30 _{NS}	0.99–1.70	—	—	—	—	—	—	—	—
Smoking Status																				
Never smoked	12.6	9.4	11.5	8.4	9.6	7.1	—	—	1.00	—	1.00	—	1.00	—	—	—	1.00	—	—	—
Experimented	41.7	44.9	37.8	34.4	34.9	32.0	0.76–1.27	0.98 _{NS}	1.07 _{NS}	0.86–1.34	1.07 _{NS}	0.86–1.34	0.89	0.68–1.16	1.03 _{NS}	0.82–1.30	—	—	—	—
Non-dependent regular smoker	18.6	16.9	21.6	23.7	21.1	22.5	1.08–1.90	1.44	1.72	1.35–2.20	1.72	1.35–2.20	1.12	0.83–1.51	1.38	1.08–1.77	—	—	—	—
Dependent smoker	27.1	28.8	29.1	33.6	34.4	38.4	1.01–1.73	1.32	1.81	1.44–2.29	1.81	1.44–2.29	0.98	0.72–1.33	1.26 _{NS}	0.98–1.62	—	—	—	—
Maximum Alcohol Consumption																				
1st quartile	30.6	27.3	29.9	20.8	30.2	24.2	—	—	1.00	—	1.00	—	1.00	—	1.00	—	—	—	—	—
2nd quartile	28.8	25.7	30.1	26.0	29.3	26.2	0.93–1.39	1.14 _{NS}	1.08 _{NS}	0.93–1.26	1.08 _{NS}	0.93–1.26	1.00 _{NS}	0.80–1.28	1.00 _{NS}	0.79–1.15	—	—	—	—
3rd quartile	22.3	25.3	20.5	28.5	18.9	23.9	0.98–1.49	1.21 _{NS}	1.00	0.84–1.18	1.00	0.84–1.18	1.38	1.08–1.77	1.04 _{NS}	0.84–1.28	—	—	—	—
4th quartile	18.3	21.7	19.4	24.7	21.7	25.7	1.02–1.58	1.27	1.31	1.10–1.56	1.31	1.10–1.56	1.48	1.13–1.95	1.14 _{NS}	0.91–1.44	—	—	—	—
Maximum Alcohol Tolerance																				
1st quartile	38.5	35.3	38.5	29.3	36.9	30.6	—	—	1.00	—	1.00	—	1.00	—	1.00	—	—	—	—	—
2nd quartile	14.0	19.5	11.8	20.0	13.0	19.0	0.88–1.36	1.09 _{NS}	1.09 _{NS}	0.91–1.29	1.09 _{NS}	0.91–1.29	1.03 _{NS}	0.83–1.28	1.03	0.32–1.30	—	—	—	—
3rd quartile	29.7	30.0	32.1	31.8	31.3	29.8	0.99–1.43	1.19 _{NS}	1.13 _{NS}	0.98–1.31	1.13 _{NS}	0.98–1.31	1.06 _{NS}	0.83–1.35	1.38	1.08–1.77	—	—	—	—
4th quartile	17.9	15.2	17.7	18.8	18.9	20.6	0.95–1.47	1.18 _{NS}	1.29	1.08–1.54	1.29	1.08–1.54	1.20	0.90–1.61	1.26	1.08–1.57	—	—	—	—

questionnaire survey (46%, increased to 63% once individuals who completed a brief questionnaire administered by telephone were included). Diagnostic interview surveys however, even when conducted by telephone, are much more costly than questionnaire surveys. Given the need to be able to screen large numbers of families for gene-mapping studies (e.g., Eaves & Meyer, 1994; Risch & Zhang, 1995), we were therefore interested to determine to what extent reliance on questionnaire data alone would lead to significant sampling biases. To our surprise, we found that for most variables sampling biases were relatively modest, particularly when use of a brief questionnaire administered by telephone was taken into account. The most pronounced sampling biases were observed for demographic variables such as educational attainment and twin pair zygosity. History of major depression did not predict questionnaire non-response nor completion of only a brief questionnaire, and social anxiety was only weakly associated with non-response. History of alcohol dependence, and history of childhood conduct disorder, in males, predicted decreased likelihood that a respondent would mail back a self-report questionnaire, but did not predict whether or not the respondent would complete a brief questionnaire administered by telephone. Obesity, as indexed by body-mass index, did not show a differential association with questionnaire response. Smoking, and heavy drinking, were only weakly associated with non response or brief questionnaire response. We may conclude that when our goal is screening large numbers of sibships with respect to quantitative variables, at least with respect to the measurement domains that we have considered here (e.g., body-mass index, alcohol consumption, addictive behaviors), a self-administered questionnaire will be a viable strategy, particularly when combined with telephone administration of the questionnaire to non-respondents.

Several qualifications of this conclusion must of course be borne in mind. First, we do not have information to characterise those pairs where neither twin responded to either the questionnaire or interview assessment. Thus we cannot fully assess the generalisability of findings from the interviewed sample that we have used to characterise differences between questionnaire responders and non-responders. Nonetheless, the fact that we have not observed large differences between twins from cooperative pairs, and singleton twins whose cotwin did not participate in the interview survey (unpublished data) suggests that the interview sample itself is reasonably representative. Since many of the variables that we are assessing are strongly familial, any tendency for these variables to predict non-response in the interview survey should lead to the prediction that they will have elevated values in cotwins of non-responders (e.g., Neale & Cardon, 1992). Second, we did observe quite marked effects on socioeconomic variables (especially educational attainment), so that for studies that are particularly concerned with the effects of socioeconomic disadvantage or its interaction with genetic predisposition, a questionnaire survey would be a difficult strategy to justify. Third, telephone administration of a brief questionnaire, or a mixed strategy of obtaining self-report questionnaires from some respondents and telephone-administered question-

naires from other respondents, may not be a viable strategy for some variables (e.g., personality measures) which were designed to be assessed by self-administered questionnaire and which may behave differently when assessed by telephone. Finally, the questionnaire survey of the young adult Australian twin panel was conducted over a decade ago. We cannot exclude the possibility that more serious sampling biases would be uncovered if that survey were administered to a new cohort today.

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