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Latent class analysis of the Child Behavior Checklist Obsessive-Compulsive Scale

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Abstract

The Obsessive-Compulsive Scale (OCS) of the Child Behavior Checklist (CBCL) predicts obsessive-compulsive disorder and is highly heritable. Latent class analysis (LCA) of the OCS was used to identify profiles within this 8-item scale and to examine heritability of those profiles. The LCA was performed on maternal CBCL reports of their 6- to 18-year–old children from 2 US nationally representative samples from 1989 (n = 2475, 50% male) and 1999 (n = 2029, 53% male) and from Dutch twins in the Netherlands Twin Registry at ages 7 (n = 10 194, 49.3% male), 10 (n = 6448, 48.1% male), and 12 (n = 3674, 48.6% male) years. The heritability of the resultant classes was estimated using odds ratios of twin membership across classes. A 4-class solution fitted all samples best. The resulting classes were a "No or Few Symptoms" class, a "Worries and Has to Be Perfect" class, a "Thought Problems" class, and an "OCS" class. Within-class odds ratios were higher than across-class odds ratios and were higher for monozygotic than dizygotic twins. We conclude that LCA identifies an OCS class and that class is highly heritable using across-twin comparisons.

1. Introduction

Obsessive-compulsive disorder (OCD) in childhood occurs at an estimated rate of 0.13 to 0.25 per 100 children, with most adult cases beginning with symptoms before the age of 18 years [1,2]. Recently, there has been interest in using the Child Behavior Checklist (CBCL) [3,4] to screen for OCD in general population and clinical samples. Nelson and colleagues [5] first demonstrated that an 8-item scale from the CBCL could distinguish OCD clinical controls and the general population. We expanded on that original work, demonstrating that the factor-analytically derived solution could be reliably applied in the clinic using a cut point approach [6]. We also demonstrated the heritability of this Obsessive-Compulsive Scale (OCS) of the CBCL using twin samples [7] and demonstrated the stability of the OCS phenotype [8]. Our group has expanded these findings to demonstrate the heritability in adult samples [9]. Several other groups have tested various adaptations of the CBCL-OCS, including a 6-item version [10]; a 3-item version [11]; and a 2-, 4-, or 10-item version [12]. We sought here to determine whether latent variable modeling could shed light on the question of whether the original 8 items hold together as a scale or whether they represent simply a concatenation of items from the Anxious/Depressed and Thought Problems scales and whether refining the OCS using latent variable modeling would further improve heritability estimation.

Latent variable models have been crucial tools in the study of psychopathology. Latent class analysis (LCA) has been used successfully to advance the phenotypic understanding of attention-deficit/hyperactivity disorder [13-17], eating disorders [18,19], alcohol and drug dependence [20,21], autism [22], temperament [23], tic disorders [24], juvenile bipolar disorder [25], and co-occurring disorders with OCD [26], among others. It offers the clinician and researcher the opportunity to place each individual into a statistically independent class with others who respond or behave in a like manner. This differentiates LCA from factor analysis that is performed at the variable level with items being placed together on the basis of how they load onto

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particular latent factors and has been used in identifying possible subgroups of OCD symptoms in children and adults [27]. These factor-analytically derived groupings of symptoms have enhanced genetic studies of OCD [28].

We performed LCA of the OCS in several samples to see whether classification into discrete classes could be obtained and then to see how this structure informed genetic models of the OCS. Because the OCS is derived from 2 factor-analytically defined subscales of the CBCL, we hypothesized that the latent classes would fall along 2 dimensions that measured those continuous latent constructs. Because of data demonstrating similar genetic structure of the OCS throughout childhood [8], we hypothesized that the same model would fit samples across age. Finally, given the heritability of the OCS, we hypothesized that monozygotic (MZ) twins would have higher odds ratios (ORs) of being placed into the same class than dizygotic (DZ) twins as has been demonstrated in other heritable childhood disorders [25].

2. Methods and materials

2.1. Participants

Data on children and adolescents were derived from 3 sources. First, for determining the model fitting a general population sample, we analyzed data from nonclinically referred participants taken from the CBCL 1989 national sample (CBCL-89) [3]. We verified this in a sample that contained clinically referred and nonclinically referred participants taken from the CBCL 1999 national sample (CBCL-99) [4]. Briefly, in both of these samples, data were obtained from home interview surveys with the parents of participants chosen to be representative of the contiguous 48 states. These surveys included the CBCL and other questions regarding demographics and the participant's mental health. The CBCL-89 consisted of 2475 children aged 6 to 20 years (50% male). The mean age of boys was 13.02 (SD = 3.75) years, and that of girls was 12.97 (SD = 3.75) years. The CBCL-99 consisted of 2029 children aged 6 to 18 years (53% male). The mean age of boys was 11.94 (SD = 3.56) years, and that of girls was 12.02 (SD = 3.50) years. Items from the 8-item version of the CBCL-OCS were selected. Data were analyzed with all participants included, and covariates were included for age and sex.

After running LCA on the CBCL-89 and CBCL-99, we applied the same analysis on maternal reports of twins at ages 7, 10, and 12 years from the Netherlands Twin Registry (NTR7, NTR10, and NTR12, respectively). The characteristics of this sample are described elsewhere [29-31]. The study is part of an ongoing longitudinal twin-family study of health-related characteristics, personality, and behavior in the Netherlands. Mothers returned the CBCL by mail. We used samples from the 1986-1994 period of data collection, including data from 10 194 (49.3% male) twins aged 7 years, 6448 (48.1% male) twins aged 10 years, and 3674 (48.6% male) twins aged 12 years. There was considerable overlap among these 3 samples, as they were taken from a combined cross-sectional/longitudinal study; 5107 (50.0%) of the NTR7 were also in the NTR10, 3029 (47.0%) of the NTR10 were also in the NTR12, and 2926 (28.7%) of the NTR7 were also in the NTR12.

All data collection and analysis were approved by human subjects review boards at the University of Vermont, the VU University Amsterdam, or both. All subjects participated with informed voluntary consent.

2.2. Measures

The CBCL is a standardized questionnaire used for parents to respond to 118 problem behaviors exhibited by their child over the previous 6 months. The parent responds along a 3-point scale, with 0 = "not true," 1 = "somewhat or sometimes true," and 2 = "very true or often true." The characteristics and psychometric stability of the CBCL have been well established in American [3,4] and Dutch [32] samples. The analyses performed here used the 2001 version of the CBCL for the American sample and the 1989 version for the Dutch sample. The items on the OCS are the same across the 2 versions.

The OCS was developed using factor analysis on 11 CBCL items thought to likely predict OCD [5,6]. Using a 1-factor model, 8 items were retained and were shown to have good internal consistency (Cronbach α = .84). The items are shown in Table 1, along with their CBCL item number.

2.3. Latent class analysis

Latent class analysis is a form of categorical data analysis that seeks to identify a number of mutually exclusive respondent classes (*M*) with similar endorsement profiles along a set of nominal- or ordinal-measured items. Latent class analysis presupposes the existence of discrete categories or classes, distinguishing it from factor analysis that assumes continuous latent variables are present [33]. Local independence is assumed, that is, that under an *M*-class solution, the conditional probabilities of endorsing a set of items are statistically independent for a given class [34]. As the number of latent classes estimate increases, it is assumed

Table 1
Items used for the OCS

CBCL item no.	CBCL item	CBCL syndrome on which Item is scored
66	Repeats certain acts over and over; compulsions	Thought problems
84	Strange behavior	Thought problems
85	Strange ideas	Thought problems
9	Cannot get his/her mind off certain thoughts; obsessions	Thought problems
31	Feels he/she might think or do something bad	Anxious/depressed
52	Feels too guilty	Anxious/depressed
112	Worries	Anxious/depressed
32	Feels he/she has to be perfect	Anxious/depressed

that homogenous classes or types will be defined such that individuals within a class will differ in symptom endorsement profiles only because of measurement error or stochastic factors. The resulting parameter estimates are class membership probabilities and symptom endorsement probabilities for each class.

Latent class models were computed using an expectation maximization algorithm [35], using the program Latent Gold 4.0 [36]. Models estimating 1-class through 5-class solutions were compared. To calculate the best fitting model, we compared an M-class solution to an $M + 1$ class solution. We used as a guideline the change in the Bayes information criterion (BIC) and the sample-size–adjusted Bayes information criterion (ABIC) goodness-of-fit indices that consider the rule of parsimony. Models were chosen if moving from the M to the $M + 1$ solution led to a decrease in the BIC while retaining reasonable face validity. The ABIC was used if the differences between 2 models were questionable. For the US samples, analyses were performed using sex and age as covariates; and for the Dutch samples, analyses were initially performed using sex as a covariate (because samples were at ages 7, 10, and 12 years). The covariates were then dropped to determine if the fit worsened substantially. Given that the model was first fitted to unrelated children in the CBCL national samples and that the fits with the Dutch twin data were nearly identical, we did not control for familiality in the NTR models.

2.4. Twin comparisons

Because simultaneously modeling the genetics of the probability of class membership and latent class membership has been demonstrably difficult, we estimated within-twin similarity with ORs using logistic regression in SPSS (version 15.0.1 [37]). The most likely class membership for both twins was calculated, and a series of logistic regressions was run for each class separately with membership in a particular class coded as 1 or 0 for each twin. The OR and 95% confidence interval around each estimate were calculated for twin type (MZ, DZ) and sex separately. Dizygotic twins who were of the opposite sex were not included in this analysis. This approach has been used by others to provide a window on heritability using a latent classes approach [14].

Table 2
Fit statistics for LCA models

Sample	Class solution	NPAR	LL	BIC	ABIC
NTR7	1 Class, sex cov	16	−25123.6494	50394.97	50344.13
	2 Class, sex cov	26	−23716.8184	47673.61	47590.98
	3 Class, sex cov	36	−23586.3521	47504.97	47390.57
	4 Class, sex cov	**46**	**−23473.5711**	**47371.7**	**47225.52**
	5 Class, sex cov	56	−23442.2212	47401.3	47223.34
	4 Class, drop sex cov	43	−23499.7894	47396.45	47259.8
NTR10	1 Class, sex cov	16	−17477.8734	35096.09	35045.25
	2 Class, sex cov	26	−16221.9845	32672.03	32589.41
	3 Class, sex cov	36	−16130.5097	32576.79	32462.4
	4 Class, sex cov	**46**	**−16052.8891**	**32509.27**	**32363.09**
	5 Class, sex cov	56	−16029.2822	32549.77	32371.82
	4 Class, drop sex cov	43	−16069.3853	32515.95	32379.3
NTR12	1 Class, sex cov	16	−9119.9681	18371.28	18320.44
	2 Class, sex cov	26	−8374.781	16963	16880.38
	3 Class, sex cov	36	−8297.1347	16889.79	16775.4
	4 Class, sex cov	**46**	**−8241.1747**	**16859.97**	**16713.8**
	5 Class, sex cov	56	−8215.7246	16891.16	16713.21
	4 Class, drop sex cov	43	−8260.7955	16874.58	16737.95
CBCL-89	1 Class, sex and age cov	16	−9758.7347	19642.49	19588.61
	2 Class, sex and age cov	27	−9141.6874	18494.35	18403.42
	3 Class, sex and age cov	38	−9066.1205	18429.17	18301.19
	4 Class, sex and age cov	49	−9005.713	18394.31	18229.28
	5 Class, sex and age cov	60	−8980.1718	18429.18	18227.11
	4 Class, drop sex cov	46	−9015.4726	18390.39	18235.46
	4 Class drop age cov	**46**	**−9007.2492**	**18373.94**	**18219.02**
CBCL-99	1 Class, sex and age cov	16	−7874.2422	15870.33	15819.5
	2 Class, sex and age cov	27	−7459.1776	15123.97	15038.19
	3 Class, sex and age cov	38	−7410.2618	15109.91	14989.18
	4 Class, sex and age cov	49	−7371.3643	15115.88	14960.2
	5 Class, sex and age cov	60	−7351.3761	15159.67	14969.05
	4 Class, drop sex cov	46	−7425.9735	15202.25	15056.11
	4 Class drop age cov	**46**	**−7372.3365**	**15094.98**	**14948.83**

Best model is indicated in bold. NPAR indicates number of parameters; LL, log-likelihood; cov, covariate.

3. Results

3.1. Model fitting

Five latent class models were fitted to the data, representing a 1-class through a 5-class solution. As the number of classes increased from 1-class through 4-class models, either the BIC and ABIC decreased appreciably or the increase was minimal (Table 2). The 4-class model was considered the accepted model on the basis of the parsimony measures. The graphs for the 4-class solution are presented below. Dropping age as a covariate did not appreciably affect model fitting, but dropping sex as a covariate did. This is consistent with the model fits across the NTR data that showed essentially the same model, regardless of age.

3.2. Class assignments

The latent classes for each sample, including prevalence of assignment of individuals to each class, are presented in Figs. 1-4. The most common class was one with no or few symptoms ("No Symptoms"), with a probability ranging

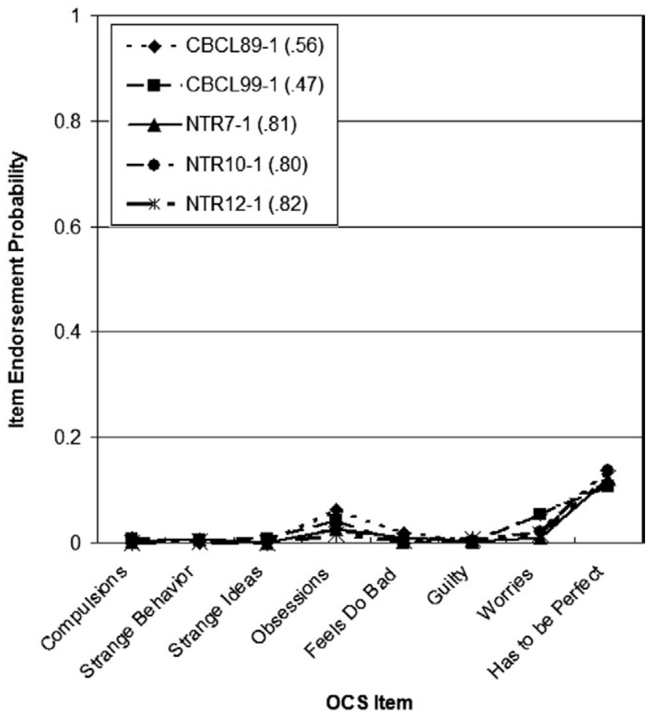

Fig. 1. Class 1: No Symptoms class.

from .47 to .82 and with the differences appearing between US and Dutch samples. The lowest probability was in the CBCL-99 sample that included referred children. The next most common class demonstrated high responding primarily on the items from the Anxious/Depressed scale ("Worries

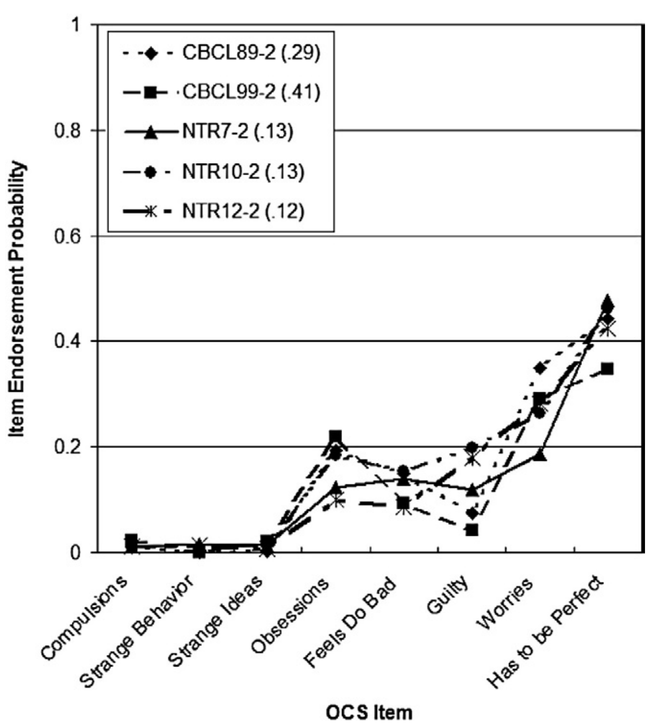

Fig. 2. Class 2: Worries and Has to Be Perfect class.

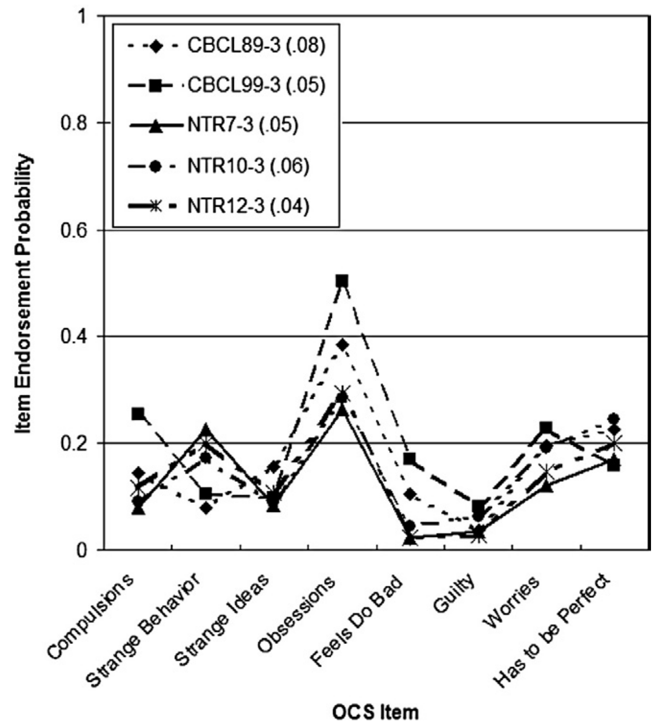

Fig. 3. Class 3: Thought Problems class.

and Has to Be Perfect"), with class membership probabilities ranging from .12 to .41 and with more children in the CBCL-99 placed into this category. For all samples, the third class consisted of relatively higher endorsement on the items from the Thought Problems scale ("Thought Problems"), with

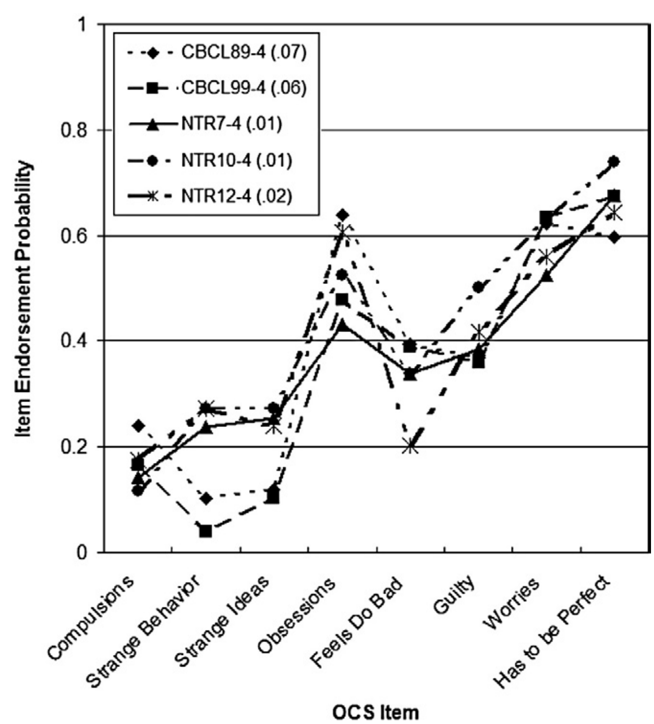

Fig. 4. Class 4: OCS class.

Table 3
Class membership probabilities, average item scores, and average total OCS scores for the 4-class solution across samples

Sample	Sex	Class	Proportion (n) in class	Proportion (n) in class with OCS ≥5	Compulsions	Strange behavior	Strange ideas	Obsessions	Fear do bad	Guilty	Worries	Be perfect	Total OCS
NTR7	♂	1	.83 (4158)	0 (0)	0.01 (0.08)	0.02 (0.12)	0 (0)	0.06 (0.23)	0.01 (0.12)	0.01 (0.1)	0.02 (0.15)	0.24 (0.48)	0.37 (0.57)
		2	.10 (477)	.05 (25)	0.03 (0.16)	0.03 (0.17)	0.02 (0.14)	0.27 (0.55)	0.42 (0.55)	0.34 (0.5)	0.59 (0.53)	1.1 (0.63)	2.8 (0.9)
		3	.07 (339)	.12 (39)	0.24 (0.6)	0.73 (0.78)	0.31 (0.53)	0.80 (0.84)	0.04 (0.21)	0.06 (0.23)	0.3 (0.48)	0.34 (0.52)	2.82 (1.31)
		4	.01 (56)	.98 (55)	0.3 (0.66)	0.73 (0.8)	0.64 (0.7)	0.91 (0.82)	0.79 (0.62)	0.88 (0.69)	1.2 (0.55)	1.46 (0.66)	6.91 (2.03)
	♀	1	.79 (4105)	0 (0)	0 (0.05)	0.01 (0.12)	0 (0)	0.05 (0.22)	0.02 (0.13)	0 (0)	0.02 (0.16)	0.25 (0.44)	0.37 (0.52)
		2	.16 (839)	.06 (47)	0.02 (0.18)	0.03 (0.16)	0.03 (0.18)	0.29 (0.55)	0.35 (0.51)	0.33 (0.48)	0.45 (0.53)	1.22 (0.68)	2.72 (1)
		3	.03 (164)	.11 (18)	0.29 (0.64)	0.68 (0.73)	0.31 (0.48)	0.87 (0.84)	0.03 (0.17)	0.07 (0.26)	0.21 (0.44)	0.22 (0.46)	2.68 (1.21)
		4	.01 (56)	.98 (55)	0.38 (0.73)	0.46 (0.63)	0.71 (0.68)	0.98 (0.8)	0.77 (0.63)	0.91 (0.72)	1.14 (0.55)	1.38 (0.65)	6.73 (1.91)
NTR10	♂	1	.80 (2487)	0 (0)	0 (0.06)	0.02 (0.12)	0 (0)	0.05 (0.22)	0.01 (0.11)	0.01 (0.11)	0.04 (0.19)	0.25 (0.48)	0.38 (0.56)
		2	.11 (330)	.13 (43)	0.02 (0.12)	0 (0.06)	0.01 (0.08)	0.37 (0.61)	0.42 (0.54)	0.41 (0.51)	0.68 (0.52)	1.1 (0.63)	3 (1.09)
		3	.08 (255)	.11 (27)	0.26 (0.59)	0.55 (0.69)	0.29 (0.51)	0.87 (0.84)	0.09 (0.29)	0.11 (0.31)	0.41 (0.52)	0.45 (0.59)	3.03 (1.33)
		4	.01 (32)	1.0 (32)	0.31 (0.69)	0.72 (0.73)	0.69 (0.82)	1.38 (0.79)	0.75 (0.72)	1.06 (0.62)	1.31 (0.59)	1.63 (0.49)	7.84 (1.55)
	♀	1	.80 (2667)	0 (0)	0 (0.05)	0.01 (0.09)	0 (0)	0.05 (0.22)	0.01 (0.12)	0.01 (0.1)	0.04 (0.19)	0.3 (0.51)	0.43 (0.59)
		2	.16 (495)	.11 (56)	0.01 (0.12)	0.01 (0.08)	0.02 (0.13)	0.41 (0.65)	0.37 (0.52)	0.48 (0.55)	0.66 (0.54)	1.03 (0.62)	2.99 (1.1)
		3	.04 (128)	.13 (17)	0.37 (0.69)	0.51 (0.69)	0.4 (0.55)	0.83 (0.86)	0.03 (0.17)	0.13 (0.33)	0.43 (0.53)	0.43 (0.6)	3.12 (1.15)
		4	.02 (54)	.98 (54)	0.24 (0.58)	0.63 (0.76)	0.63 (0.71)	0.96 (0.78)	0.67 (0.58)	1.15 (0.56)	1.35 (0.55)	1.59 (0.57)	7.22 (1.93)
NTR12	♂	1	.81 (1453)	0 (0)	0 (0)	0 (0)	0 (0)	0.04 (0.19)	0.01 (0.09)	0.01 (0.11)	0.04 (0.19)	0.24 (0.48)	0.34 (0.54)
		2	.09 (162)	.04 (7)	0.02 (0.16)	0.04 (0.19)	0.01 (0.08)	0.2 (0.41)	0.22 (0.41)	0.44 (0.53)	0.79 (0.45)	1.02 (0.54)	2.73 (0.83)
		3	.07 (120)	.07 (8)	0.34 (0.65)	0.63 (0.69)	0.28 (0.51)	0.68 (0.73)	0.05 (0.22)	0.05 (0.22)	0.31 (0.48)	0.29 (0.47)	2.64 (1.35)
		4	.03 (52)	1.0 (52)	0.46 (0.8)	0.63 (0.74)	0.5 (0.67)	1.48 (0.73)	0.42 (0.57)	0.88 (0.68)	1.17 (0.68)	1.38 (0.69)	6.94 (1.86)
	♀	1	.82 (1547)	0 (0)	0 (0.03)	0 (0.07)	0 (0)	0.03 (0.18)	0.01 (0.1)	0.02 (0.13)	0.04 (0.19)	0.28 (0.5)	0.38 (0.56)
		2	.15 (279)	.05 (15)	0.03 (0.19)	0.02 (0.15)	0.02 (0.13)	0.27 (0.51)	0.24 (0.44)	0.48 (0.54)	0.75 (0.5)	0.99 (0.53)	2.8 (0.9)
		3	.02 (40)	.20 (8)	0.35 (0.66)	0.6 (0.71)	0.43 (0.64)	0.93 (0.89)	0 (0)	0.03 (0.16)	0.23 (0.42)	0.4 (0.67)	2.95 (1.41)
		4	.01 (21)	1.0 (21)	0.29 (0.64)	0.62 (0.8)	0.67 (0.66)	1.05 (0.8)	0.52 (0.6)	0.95 (0.5)	1.14 (0.65)	1.33 (0.73)	6.57 (0.98)
CBCL-89	♂	1	.58 (723)	0 (0)	0.02 (0.13)	0 (0)	0 (0)	0.13 (0.34)	0.03 (0.17)	0.01 (0.07)	0.09 (0.28)	0.2 (0.4)	0.46 (0.56)
		2	.25 (304)	.03 (9)	0.01 (0.08)	0 (0)	0 (0)	0.41 (0.55)	0.35 (0.5)	0.16 (0.37)	0.8 (0.51)	1.01 (0.68)	2.72 (0.84)
		3	.10 (117)	.14 (16)	0.43 (0.73)	0.15 (0.41)	0.5 (0.58)	0.99 (0.76)	0.18 (0.43)	0.07 (0.25)	0.34 (0.49)	0.38 (0.55)	3.04 (1.26)
		4	.08 (93)	.94 (87)	0.57 (0.76)	0.22 (0.51)	0.26 (0.53)	1.31 (0.67)	0.9 (0.65)	0.81 (0.58)	1.3 (0.55)	1.33 (0.63)	6.68 (1.69)
	♀	1	.54 (664)	0 (0)	0.01 (0.12)	0 (0)	0 (0)	0.09 (0.29)	0.03 (0.18)	0 (0)	0.13 (0.34)	0.18 (0.39)	0.45 (0.51)
		2	.35 (434)	.08 (33)	0.02 (0.13)	0 (0)	0 (0)	0.49 (0.61)	0.33 (0.49)	0.18 (0.38)	0.77 (0.52)	1.05 (0.67)	2.84 (0.97)
		3	.06 (71)	.17 (12)	0.49 (0.63)	0.37 (0.59)	0.51 (0.58)	0.92 (0.79)	0.24 (0.43)	0.03 (0.17)	0.27 (0.45)	0.34 (0.56)	3.15 (1.29)
		4	.06 (69)	.97 (67)	0.57 (0.76)	0.22 (0.51)	0.26 (0.53)	1.31 (0.67)	0.9 (0.65)	0.81 (0.58)	1.3 (0.55)	1.33 (0.63)	6.68 (1.69)
CBCL-99	♂	1	.48 (515)	0 (0)	0.01 (0.12)	0.01 (0.09)	0.01 (0.12)	0.1 (0.31)	0 (0)	0 (0)	0 (0)	0.21 (0.41)	0.35 (0.48)
		2	.38 (409)	.02 (6)	0.03 (0.18)	0 (0)	0.05 (0.23)	0.43 (0.59)	0.2 (0.41)	0.09 (0.29)	0.75 (0.51)	0.76 (0.72)	2.33 (0.98)
		3	.09 (98)	.30 (24)	0.74 (0.79)	0.31 (0.53)	0.26 (0.46)	1.21 (0.69)	0.41 (0.59)	0.15 (0.39)	0.36 (0.5)	0.23 (0.47)	3.67 (1.34)
		4	.05 (51)	.98 (50)	0.39 (0.7)	0.04 (0.2)	0.25 (0.56)	1.06 (0.76)	0.96 (0.66)	0.96 (0.63)	1.33 (0.55)	1.41 (0.61)	6.41 (1.51)
	♀	1	.46 (445)	0 (0)	0.01 (0.09)	0.01 (0.09)	0.01 (0.11)	0.09 (0.29)	0 (0)	0 (0)	0 (0.05)	0.21 (0.41)	0.33 (0.48)
		2	.45 (426)	.02 (10)	0.05 (0.23)	0 (0.05)	0.05 (0.24)	0.5 (0.64)	0.21 (0.42)	0.09 (0.29)	0.75 (0.49)	0.72 (0.71)	2.37 (1)
		3	.01 (7)	.43 (3)	1.14 (0.9)	0.57 (0.79)	0.29 (0.49)	1.57 (0.53)	0.43 (0.79)	0.43 (0.53)	0.29 (0.49)	0 (0)	4.71 (1.8)
		4	.08 (78)	.87 (68)	0.38 (0.69)	0.12 (0.36)	0.21 (0.49)	0.97 (0.81)	0.79 (0.69)	0.76 (0.65)	1.41 (0.61)	1.41 (0.71)	6.05 (1.63)

For class membership probabilities and proportion in class with OCS of at least 5, proportions are given and absolute numbers are in parentheses. For item scores and OCS scores, mean score is given, with SD in parentheses.

Table 4
Odds ratios (and 95% confidence intervals) between classes for MZ and DZ twins across age and sex

Age	Class	MZ				DZ			
		1	2	3	4	1	2	3	4
7									
♂	1	15.54 (9.99-24.19)	0.12 (0.07-0.20)	0.11 (0.06-0.20)	0.03 (0.00-0.29)	6.46 (4.33-9.64)	0.22 (0.14-0.35)	0.17 (0.09-0.31)	0.35 (0.10-1.24)
	2	0.13 (0.08-0.22)	12.34 (7.09-21.49)	0.43 (0.10-1.81)	11.63 (2.30-58.79)	0.31 (0.19-0.51)	4.31 (2.46-7.54)	1.52 (0.62-3.70)	NC
	3	0.08 (0.04-0.15)	1.83 (0.83-4.05)	25.71 (13.09-50.52)	3.22 (0.37-28.12)	0.17 (0.10-0.29)	2.49 (1.32-4.72)	7.68 (3.92-15.05)	5.04 (1.27-19.97)
	4	0.03 (0.00-0.28)	3.65 (0.70-19.11)	11.80 (2.57-54.20)	27.17 (2.75-268.89)	0.13 (0.04-0.40)	3.78 (1.14-12.53)	5.20 (1.38-19.58)	7.21 (0.85-61.50)
♀	1	12.50 (8.58-18.20)	0.11 (0.07-0.15)	0.17 (0.08-0.35)	0.06 (0.01-0.53)	3.79 (2.61-5.49)	0.32 (0.22-0.47)	0.32 (0.15-0.69)	0.35 (0.12-1.01)
	2	0.09 (0.06-0.13)	12.00 (8.01-17.97)	1.69 (0.71-4.00)	3.66 (0.61-22.07)	0.26 (0.17-0.39)	4.00 (2.62-6.12)	1.23 (0.46-3.32)	2.19 (0.68-7.11)
	3	0.23 (0.11-0.50)	0.84 (0.29-2.47)	21.05 (8.48-52.27)	8.66 (0.94-80.23)	0.54 (0.26-1.12)	0.76 (0.29-2.01)	9.60 (3.73-24.71)	NC
	4	0.15 (0.04-0.65)	2.95 (0.70-12.49)	4.41 (0.53-37.01)	32.86 (3.25-332.36)	0.31 (0.08-1.27)	1.45 (0.29-7.24)	NC	20.72 (3.79-113.31)
10									
♂	1	11.16 (6.70-18.58)	0.12 (0.06-0.21)	0.17 (0.10-0.34)	0.10 (0.01-1.15)	4.8 (3.02-7.64)	0.24 (0.14-0.40)	0.32 (0.16-0.65)	0.43 (0.07-2.58)
	2	0.15 (0.08-0.27)	18.56 (9.59-35.93)	0.21 (0.03-1.56)	NC	0.20 (0.11-0.35)	8.45 (4.53-15.78)	0.23 (0.03-1.70)	5.84 (0.95-35.79)
	3	0.15 (0.07-0.30)	0.26 (0.04-1.93)	23.49 (10.67-51.68)	NC	0.43 (0.24-0.80)	1.00 (0.43-2.31)	5.34 (2.48-11.47)	NC
	4	NC	3.14 (0.32-30.68)	4.29 (0.44-42.22)	540 (33.73-8644.34)	0.20 (0.04-0.91)	1.07 (0.13-9.00)	10.52 (2.26-48.99)	NC
♀	1	11.43 (7.44-17.55)	0.13 (0.09-0.21)	0.20 (0.09-0.44)	0.08 (0.02-0.29)	3.97 (2.43-6.50)	0.29 (0.17-0.49)	0.49 (0.17-1.43)	0.28 (0.09-0.91)
	2	0.15 (0.10-0.24)	9.47 (5.86-15.32)	0.51 (0.12-2.18)	0.56 (0.07-4.39)	0.24 (0.14-0.42)	4.46 (2.50-7.93)	0.44 (0.06-3.37)	3.77 (1.10-12.92)
	3	0.11 (0.05-0.25)	1.22 (0.49-3.06)	30.20 (12.25-74.42)	7.89 (2.02-30.80)	0.53 (0.20-1.38)	0.84 (0.24-2.95)	9.40 (2.74-32.24)	NC
	4	0.06 (0.01-0.26)	3.57 (1.11-11.46)	NC	67.25 (17.12-264.13)	0.31 (0.06-1.57)	2.28 (0.41-12.66)	NC	8.6 (0.93-79.88)
12									
♂	1	10.09 (5.23-19.45)	0.32 (0.14-0.72)	0.14 (0.06-0.34)	0.02 (0.00-0.18)	2.59 (1.33-5.06)	0.49 (0.21-1.15)	0.3 (0.11-0.83)	0.81 (0.16-4.00)
	2	0.23 (0.10-0.55)	4.92 (1.85-13.13)	1.31 (0.29-5.96)	3.91 (0.76-19.98)	0.30 (0.13-0.70)	2.83 (1.03-7.72)	3.32 (1.00-11.04)	1.21 (0.15-10.07)
	3	0.22 (0.08-0.57)	0.53 (0.07-4.10)	8.84 (2.94-26.62)	5.21 (1.00-27.15)	1.16 (0.38-3.57)	0.37 (0.05-2.85)	1.59 (0.34-7.47)	1.46 (0.18-12.27)
	4	0.04 (0.01-0.17)	2.96 (0.77-11.38)	7.06 (1.98-25.16)	26.58 (6.10-115.89)	0.08 (0.01-0.79)	8.71 (1.18-64.30)	5.33 (0.53-54.21)	NC
♀	1	10.6 (5.90-19.04)	0.09 (0.05-0.17)	1.47 (0.17-12.40)	0.08 (0.01-0.76)	4.62 (2.26-9.41)	0.32 (0.14-0.70)	0.29 (0.05-1.80)	0.09 (0.02-0.52)
	2	0.08 (0.04-0.14)	15.38 (8.05-29.40)	NC	5.47 (0.76-39.65)	0.32 (0.14-0.70)	3.44 (1.48-7.99)	1.74 (0.19-15.99)	1.38 (0.16-12.19)
	3	1.02 (0.21-4.93)	NC	6.61 (0.72-60.75)	13.33 (1.26-140.91)	0.19 (0.05-0.78)	0.98 (0.12-8.21)	9.39 (0.93-95.23)	21.92 (3.34-143.69)
	4	0.25 (0.04-1.81)	4.86 (0.67-35.13)	NC	NC	0.10 (0.01-1.09)	3.5 (0.31-39.65)	NC	26.70 (2.07-344.80)

NC indicates not calculable.

class membership probabilities ranging from .04 to .08 and with more males than females being placed into this class across all samples (Table 3). The final, and least common, class consisted of responses that endorsed high levels of all items ("OCS"), with class membership probabilities ranging from .01 to .07. The classes were markedly similar, regardless of sample.

3.3. Twin cross-class ORs

The ORs across twins for each of the NTR samples are in Table 4. Significant ORs are defined as those where the 95% confidence interval does not cross 1. Because of low numbers within certain cells, not all ORs were able to be calculated (and are listed as "NC" in Table 4). For the remainder of the comparisons, it is clear that most significant ORs fall along the diagonal—representing within-class similarity across twins. In cases where significant ORs were found between different classes, they tended to be between group 4 (OCS) and either group 2 (Worries and Has to Be Perfect) or group 3 (Thought Problems). It is also clear that the ORs within each class are higher in the MZ twins than in the DZ twins for nearly every comparison. The ORs were verified with Pearson correlations of the probability of class membership across twins, although nonindependence of the measures makes this less acceptable. The pattern of correlation was the same (data available on request).

4. Discussion

Latent class analysis identifies a profile that is consistent with the OCS. This class structure is very highly consistent over the ages from 7 to 12 years and across 2 different countries (American and Dutch samples). The prevalence of individuals placed into a particular class may change by sample, sex, or age; but the general class structure is the same. In families with twins, the odds of a twin falling into the same class as his or her co-twin is higher than the odds that the twins will be in different classes. Moreover, this is more likely in MZ compared with DZ twins, which supports the heritability of these classes. Thus, these data indicate that the classes are statistically and, for the most part, genetically discrete, although with some overlap particularly among the 3 more symptomatic groups. The statistical ability to simultaneously measure class membership and specific heritability estimates is being explored by our group and others [38,39]. As demonstrated in attention-deficit/hyperactivity disorder [17] and mood dysregulation [25] in children, there are clear associations between sharing the same DNA and being in the same latent class for OC behavior. These findings speak to the ongoing issue of how best to characterize both problem and typically occurring behavior in studies that search for their genetic and environmental roots. Todd and colleagues [40,41] have argued persuasively that these latent constructs are useful in gene finding as a complement to "top-down" *Diagnostic and Statistical Manual of Mental Disorders* (*DSM*) constructs.

Of additional import here is the class with few symptoms. This class is always identified in general population studies of problem behavior. The ORs for the Low or No Symptoms class were higher for MZ than for DZ twins, giving some indication of a genetic influence of being in this Low or No Symptoms class. This speaks to the genetics of wellness: an important topic that has been much less discussed or researched [42]. The apparent heritability of the No Symptoms class may be driven by children who are especially nonanxious and nonobsessional. Modeling of scales where both strengths and weaknesses can be assessed is a focus of some of our present and future work [42,43].

Finally, this work speaks to the usefulness of the OCS scale as a whole. Although some revisions of the OCS as a measure of OCD may be warranted [10,11], it continues to garner empirical support as a naturally occurring cluster of behaviors. Storch et al in 2006 showed that a 6-item version of the OCS dropping the Strange Ideas and Has to Be Perfect items was the most robust. In the analyses here, the American samples have the Strange Ideas item endorsed at lower rates than the other items, even in the most severe class. Conversely, in the American samples, the Has to Be Perfect item is frequently endorsed even in the No Symptoms class. However, excluding this item from the OCS would remove a potentially clinically meaningful class (Worries and Has to Be Perfect class), which may represent children with anxiety unrelated to OCD. It is possible that this class is capturing a temperamental trait like neuroticism that has links to more classic OC symptoms. We are exploring temperamental profiles in a sample of children who fall into this class to determine these relations.

The OCS does not contain all items for OCD from the *DSM, Fourth Edition* (*DSM-IV*); thus, use of these scales is not a direct test of *DSM-IV* OCD or of latent classes of obsessive-compulsive behavior. Furthermore, data on maternal reports may not generalize to children using self-reports. However, the OCS was constructed to use maternal reporting to predict clinically significant OCD as defined by the Children's Yale-Brown Obsessive-Compulsive Scale [5]. Finally, we cannot present data on the number of children who fell in to the latent classes who also met *DSM-IV* diagnostic criteria for OCD. Our group is interviewing a subset of this sample and analyzing these data to determine those relations.

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