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What Drives OCD Symptom Change During CBT Treatment? Temporal Relationships Among Obsessions and Compulsions

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Cognitive behavior therapy (CBT) is an effective treatment for obsessive-compulsive disorder (OCD). However, less is known about how obsessions and compulsions change during treatment, either in tandem, sequentially, or independently. The current study used latent difference score analysis to show path-analytic dynamic modeling of OCD symptom change during CBT. Four competing models of the temporal relationship between obsessions and compulsions were examined: no coupling (obsessions and compulsions are not dynamically related), goal directed (obsessions lead to subsequent changes in compulsions), habit driven (compulsions lead to subsequent changes in obsessions), and reciprocal. Treatment seeking participants ($N = 84$) with a principal diagnosis of OCD completed 12 weeks of CBT group therapy and completed measures assessing obsession and compulsion severity at pretreatment, Sessions 4 and 8, and end of treatment. Bivariate results supported the *goal directed* traditional CBT model, where obsession scores are temporally associated with subsequent changes in compulsion scores. These results have implications for theoretical and treatment modelling of obsessions and compulsions in OCD treatment.

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Obsessive-compulsive disorder (OCD) is a debilitating disorder characterized by distressing obsessive thoughts and/or images and compulsive behaviors (APA, 2013). OCD occurs in approximately 2% of the population, is chronic, leads to a variety of significant functional impairments and decreased quality of life, and is a leading cause of disability (e.g., Cassin, Richter, Zhang, & Rector, 2009; Kessler, Petukhova, Sampson, Zaslavsky, & Wittchen, 2012; Markarian et al., 2010). The presumed temporal sequence of obsessions and compulsions has been pivotal to diagnostic accounts of OCD, including the DSM-5 (APA, 2013) stipulation that compulsions are behaviors that individuals feel "driven to perform *in response to an obsession*" (APA, 2013, p. 237), as well as cognitive behavioral frameworks, where obsessions are interpreted as being particularly meaningful, thus producing distress, and compulsions are then performed to reduce that distress (Purdon, 2008; Rachman, 1997, 1998; Rachman & Hodgson, 1980; Salkovskis, 1985; Taylor, Abramowitz, & McKay, 2007). Notwithstanding this long-held assumption in the psychiatric nomenclature that a functional relationship exists whereby obsessions temporally precede and drive compulsive rituals in OCD, the assumption has been largely untested.

Obsessions and compulsions are not hypothesized to occur simultaneously, but rather sequentially. Given that obsessions and compulsions occur at different points in the sequential unfolding of an obsession-compulsion cycle, formal examination of their time sequencing is of theoretical and clinical importance. In the absence of longitudinal examination of the temporal ordering of obsessions and compulsions, this study aimed to directly test several possible temporal relationships between obsessions and compulsions across the course of group-based cognitive behavior therapy (CBT). Latent difference score analysis (LDS; see McArdle, 2001; McArdle & Hamagami, 2001) can be used to examine these temporal relationships, and within this statistical approach it is standard practice to examine four possible longitudinal relationships between these variables. First, obsessions and compulsions may change independently over time (termed the *no coupling model*). Second, obsessions (measured at time t) may lead to subsequent changes in compulsions over time (between time t and time t + 1), termed the *goal-directed model (*Rachman & Hodgson, 1980; Salkovskis, 1985; Taylor, Abramowitz, & McKay, 2007). Third, compulsions (measured at time t) may lead to subsequent changes in obsessions over time (between time t and time t + 1), termed the *habit-driven model* (Robbins, Gillan, Smith, de Wit, & Ersche, 2012; Voon et al., 2015). Finally, a bidirectional relationship may exist between obsessions and compulsions over time, termed the *reciprocal model;* in other words, both the goal-directed and habit-driven models may co-occur.

To date, there is some empirical evidence for each model. For the *no coupling model*, there are presumed independent changes among obsessions and compulsions. The DSM-5 has embedded the "no coupling" possibility directly in the criteria for the disorder, given that allowance is made for some patients to present only with obsessions, in the apparent absence of any compulsions. The DSM-5 stipulates that a diagnosis of OCD can be given when an individual has obsessions *or* compulsions (APA, 2013). Additionally, some patients with OCD indicate that they experience greater impairment and distress pertaining more to one symptom area than the other (e.g., Masellis, Rector, & Richter, 2003). Additional quantitative support for a possible "no coupling" model of obsessions and compulsions is that factorial examination of OCD symptoms routinely identifies a "pure obsessional" clinical presentation whereby compulsions, if present, are presumed to be of less importance to the clinical presentation (e.g., Abramowitz, Franklin, Schwartz, & Furr, 2003; Baer, 1994; Calamari et al., 2004). However, this work has been criticized for not sufficiently taking into consideration the presence of avoidance, mental rituals, and reassurance seeking, and more recent works suggest that OCD diagnoses should be based on both obsessions and compulsions (Leonard & Riemann, 2012; Williams et al., 2011). Nevertheless, given the DSM-5 diagnostic criteria, for some individuals with OCD, a clear mental or behavioral compulsion is not a necessary condition or outcome to the experience of obsessions.

There is support for the *goal-directed model*, where obsessions temporally occur first, followed by changes in compulsions. Rachman and Hodgson (1980) experimentally demonstrated that exposure to obsession cues led to subsequent anxiety and urges to ritualize. Perreault and O'Connor (2014) reported on a sample of four clients receiving 24 weeks of psychological treatment for OCD. They conceptualize obsessions as always taking the form of obsessional doubt, and found that changes in reported conviction about obsessional doubts were independent of change in daily duration of compulsions. All participants showed significant decreases in conviction about obsessional doubts and increases in perceived ability to resist compulsions; however, only 75% of participants had significant decreases in daily duration of compulsions. The authors concluded that "obsessional doubt is the first step in the OCD sequence" (p. 6).

Across this treatment study, the first changes that occurred were in conviction of obsessional doubt. There was no change in duration of compulsions between pretreatment and Step 1 to 8 of a 10-step treatment. These findings lend support for the possibility that obsessions come first in the unfolding of obsessions and compulsions.

The *habit-driven* model proposes that compulsions "are the result of aberrant dysregulation of stimulus-response habit learning and obsessions are post hoc rationalizations of otherwise unexplained compulsive behaviours" (Kalanthroff, Abramovitch, Steinman, Abramowitz, & Simpson, 2016, p. 9). In this framework, an imbalance between goal-directed and habit formation systems results in OCD, such that compulsions are seen as habits that drive obsessions (Gillan & Sahakian, 2015). This hypothesis stems largely from experimental studies, for example using devaluation tests (e.g., Gillan et al., 2011), and are often conducted with, or in comparison to, non-psychiatric control samples (see Kalanthroff et al., 2016, for review of the habit-driven hypothesis). In a clinical context, Anholt et al. (2008) had participants with OCD complete the Yale Brown Obsessive Compulsive Scale (YBOCS) weekly, during treatment that was either cognitive therapy or exposure and response prevention. While there were no differences between treatments, changes in compulsions were a stronger predictor of overall treatment outcome in both treatments than were changes in obsessions. Moreover, a more micro-examination of temporal sequencing demonstrated that while decreases in compulsions significantly occurred between pretreatment to Session 4, decreases in obsessions significantly occurred from pretreatment to Session 8. Kalanthroff et al.'s (2016) review of the habit-driven model highlights mixed experimental and clinical evidence for this framework (not directly examining longitudinal relationships in obsessions and compulsions), and so further work is required.

The *reciprocal* model assumes a bidirectional relationship. In partial support of this model, Wilson (2002) reported a therapy study where at some points during therapy obsessions and compulsions changed in tandem, while at other points the changes occurred in opposite directions (as cited in Polman et al., 2010). Last, Rhéaume and Ladouceur (2000) reported bidirectional relations between changes in beliefs and obsessive-compulsive behavior. Although this study examined obsessive beliefs (as opposed to obsessions as defined by DSM criteria), it lends indirect support for the possibility of a bidirectional relationship. Thus, each of the four models has some degree of empirical support. However, no study has directly compared these four models to determine which temporal pattern best explains the obsession-compulsion cycle of OCD.

The purpose of the current study was to determine the longitudinal temporal relationship between obsessions and compulsions during group CBT treatment for OCD. The univariate analyses of obsession and compulsion change over time were exploratory, as no *a priori* hypotheses regarding the nature of univariate change were proposed.[1] The bivariate coupling analysis considered how obsessions and compulsions independently change and temporally relate during treatment. Given that several prominent cognitive models of OCD propose a temporal ordering of obsessions driving compulsions, as well as wording of the diagnostic criteria for OCD (APA, 2013), we hypothesized that the bivariate *goal-directed* model would be supported, in which obsessions (measured at time t) would lead to subsequent elevations in compulsion symptoms (measured between time t and time t + 1) throughout treatment.

Method

PARTICIPANTS

Eighty-four treatment-seeking individuals with a primary *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text revision; DSM-IV-TR, American Psychiatric Association, 2000) diagnosis of OCD, who completed a specialized CBT for OCD group, were selected for participation in the study. The Structured Clinical Interview for Axis I Disorders IV (SCID-1/P; First, Spitzer, Gibbon, & Williams, 1996; 2002; 2007) was used to determine diagnostic status.[2] SCID IV interviewers included psychologists, psychometrists, and Ph.D.-level graduate students. All interviewers completed extensive training in the administration of the SCID IV, and graduate-level students were supervised in weekly meetings with a psychologist, where each SCID assessment was discussed individually to ensure accurate diagnoses. After the SCID was administered, participants completed a brief semistructured interview to screen for likely suitability for group-based outpatient CBT. Exclusion criteria for the study were as follows: active psychosis or mania, active suicidal ideation or self-harm, an adequate course of CBT for OCD within

[1] Univariate LDS analyses can establish how a longitudinal variable independently changes over time. Although this is a necessary first step for any LDS analyses, we are not offering any specific hypotheses regarding how obsessions and compulsions independently change over time. Instead, we are interested in determining how these two variables interrelate throughout treatment (i.e., bivariate analysis). For an overview of the steps of LDS analysis, including univariate, bivariate and multi-group analyses using clinical data, please refer to Hawley, Ho, Zuroff, and Blatt (2006, 2007).

[2] One participant was evaluated using the Structured Clinical Interview for DSM-5. All of the same study processes occurred for this individual.

the last 2 years, and current additional CBT for OCD.

Participants were primarily Caucasian (70.1%), single (64.6%), and young adult (29.79 years; *SD* = 8.62).[3] The following comorbid diagnoses were also present in this sample: major depression (27.2%), dysthymia (6.2%), social anxiety disorder (27.7%), generalized anxiety disorder (9.2%), posttraumatic stress disorder (4.6%), panic disorder with/without agoraphobia (3.1%), and substance abuse/dependence (4.7%). The study was approved by the hospital's research ethics board, and participants provided informed consent to participate in the study. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

MEASURES

Yale-Brown Obsessive-Compulsive Scale – Self Report (YBOCS-SR; Baer, Brown-Beasley, Sorce, & Henriques, 1993)

The YBOCS-SR is a 10-item scale that assesses the severity of OCD symptoms. Respondents report the time occupied by obsessions or compulsions, interference and related distress, and perceived control over obsessions or compulsions. The YBOCS-SR yields similar scores to the interviewer-administered version of the YBOCS and demonstrates good internal consistency and validity (Baer et al., 1993; Steketee, Frost, & Bogart, 1996). Internal consistency was good in this study: pretreatment $\alpha = .88$.

PROCEDURE

The study was completed at a large university-affiliated specialized mood, anxiety, and OCD disorders clinic. The clinic is in a tertiary care setting, and tends to service clients with severe and complex mental health difficulties. The specialized CBT for OCD is a publicly funded service with no catchment limitations. Many clients referred for treatment have had some type of mental health service before being referred to the hospital. Participants completed questionnaires in the context of a 12-week manualized CBT group for OCD (treatment manual also used in Vorstenbosch & Laposa, 2015). The CBT program included introduction to the CBT model of OCD, creation of exposure hierarchies, exposures (in vivo and imaginal as indicated), thought records, additional cognitive interventions tailored to OCD appraisal themes (e.g., responsibility pie for inflated responsibility, etc.), and relapse prevention. There were typically 8 to 10 participants per group, and the group was 2 hours/week. Each week clients had homework exercises, and once exposures were started in Session 3, all participants were assigned a total of five exposures per week (typically one or two different exposures that were then repeated). Cognitive interventions were started in Session 5. All groups were co-led with two leaders, where the primary leader was a licensed psychologist or psychometrist. Participants completed the YBOCS at the start of treatment, Week 4, Week 8, and at the end of treatment.

DATA ANALYSIS

Latent difference score analysis (LDS; see McArdle, 2001; McArdle & Hamagami, 2001) was used to examine the longitudinal and temporal dynamics of YBOCS obsessions and compulsions during CBT treatment. LDS models integrate features of latent growth curve models (Meredith & Tisak, 1990) and cross-lagged regression models (Jöreskog & Sörbom, 1979). LDS analysis combines features of both classes of models by considering dynamic longitudinal growth within a time series while also examining multivariate relationships and determinants. Within each longitudinal series, the latent rate of change is used as the outcome variable.

There are several steps involved with any LDS analysis. First, longitudinal measurement invariance was evaluated.[4] Next, a univariate model was established, examining how obsessions and compulsions independently changed during treatment (Hamagami & McArdle, 2001; McArdle, 2001; McArdle & Hamagami, 2001; McArdle & Nesselroade, 2002). It is standard practice (e.g., see Hamagami & McArdle, 2001) to consider four univariate models as a first step whenever examining longitudinal changes within a single variable. The four univariate models were the *no change*, *constant change*, *proportional change*, and *dual change* models, and specifically refer to the type of determinants in the univariate changes that occur over time. Notably, the names of the models are different from what is listed for the bivariate models (no coupling, goal directed, habit driven, and reciprocal) outlined in the introduction, because the bivariate models determine how two univariate series interact. Please refer to the Appendix for the four univariate change equations.

[3] We examined bivariate correlations between age and obsessions and compulsions at each time point, and there were no significant correlations, all *p*s > .05.

[4] Each variable was evaluated for longitudinal measurement invariance. A confirmatory factor analysis (CFA) was first conducted for each measure. Measurement invariance was evaluated, and all items were retained in the CFAs. Weak longitudinal measurement invariance (i.e., equal factor loadings over time) was demonstrated for all measures before proceeding with the LDS analyses.

Next, bivariate LDS analyses were used to evaluate temporal relationships between univariate series by considering *coupled* regressions. Bivariate coupling occurs if two univariate processes demonstrate a temporal relationship in which one univariate process (measured at time t) predicts the subsequent rate of change in the other (measured between time t and time t + 1). Bivariate LDS analyses examine four possible coupling relationships between obsessions and compulsions during CBT treatment when examining longitudinal change over time. It is standard practice (e.g., see Hamagami & McArdle, 2001) to consider all of the four bivariate models described below whenever examining coupling relationships between two repeatedly measured variables. It may be that: (a) the two univariate series are not dynamically related (termed the *no coupling* model), (b) obsessions (measured at time t) lead to subsequent changes in compulsions (measured between time t and time t + 1) over each time period (termed the *goal-directed* model), (c) compulsions (measured at time t) lead to subsequent changes in obsessions (measured between time t and time t + 1) over each time period (termed the *habit-driven* model), or (d) a *reciprocal* model in which both *b* and *c* co-occur. These bivariate models can be written as equations which consider whether dynamic coupling occurs between the YBOCS-O and YBOCS-C, and consider the temporal nature of this coupling relationship. Please refer to the Appendix for the bivariate model equations.

The AMOS 20.0 program (Arbuckle, 2011) was used to evaluate all univariate, bivariate, and multigroup LDS models. Parameters were estimated by the maximum-likelihood method, which compares the fit of a hypothesized structural model to the observed variance-covariance matrix and mean vector. AMOS provides a variety of measures for assessing absolute and relative model fit. The chi-square index is considered a measure of absolute model fit, and a heuristic is typically used in which chi-square to degrees of freedom ratios (χ^2/df) near two represent acceptable model fit (Byrne, 2004). The root mean square error of approximation is provided as a measure of absolute model fit (RMSEA; Steiger & Lind, 1980). RMSEA indicates "model discrepancy per degree of freedom," with values less than .05 indicating a "close fit," whereas RMSEA values larger than .10 suggest a "poor fit" (Browne & Cudeck, 1993). Further, we considered the *p*-value for testing the null hypothesis that the population RMSEA is no greater than 0.05 (MacCallum, Browne, & Sugawara, 1996), reported as "*p* close fit." The Comparative Fit Index (CFI) indicates the relative reduction in model misfit when comparing the target model relative to a baseline (independence) model. CFI values greater than .90 indicate a good fit of the model to the observed data (CFI; Bentler, 1990). Further, the relative fit of competing models is compared using the Akaike Information Criterion (AIC; Akaike, 1973), which considers model complexity in relationship to the number of parameters. The model with smaller AIC is preferred. Finally, certain key parameter estimates are considered, although they are not measures of overall model fit. To evaluate the theoretical cogency of competing models, the bivariate LDS models can be discriminated based on whether the coupling parameter (γ) is significant. If the coupling is not significant, the model postulating that effect may not be supported (Hamagami & McArdle, 2001; McArdle, 2001; McArdle & Hamagami, 2001).

Results

Table 1 presents means, standard deviations, and correlations among study variables at pretreatment, Sessions 4 and 8, and end of treatment. The average YBOCS total score at pretreatment was 22.53, which falls in the high end of the moderate severity range (the severe range starts at 24). The pre-post effect size on the YBOCS was 0.94, taking into account the correlation between scores. The observed YBOCS obsessions (YBOCS-O) and compulsions (YBOCS-C) means decreased monotonically. As expected, measures from consecutive assessments were positively correlated for each measure over time.

UNIVARIATE LDS MODELS

First, LDS univariate analyses considered four longitudinal models for each variable, consisting of the *no change* model, the additive *constant change* model, the *proportional change* model, and the combined *dual change* model for each time series (YBOCS-O and YBOCS-C). The path diagrams for these models are provided in Figure 1. Both time-varying (i.e., $\beta(t)$) and time-invariant proportional effects were considered in all models. Of the four univariate models considered, examination of parameter significance and goodness of fit indices indicated that longitudinal YBOCS-O change was best represented as a dual change process, χ^2 (4, N = 85) = 3.96.; χ^2/df = .99; AIC = 23.96, CFI = 0.99, RMSEA = .01, with time-invariant proportional effects. All parameter estimates were statistically significant ($p < .05$). Next, four univariate YBOCS-C models were considered; longitudinal YBOCS-C change was also best represented by the dual change model, χ^2 (3, N = 84) = 1.96; χ^2/df = 0.65; AIC = 23.41, CFI = 1.00, RMSEA = .01, with time varying proportional effects. All parameter estimates were statistically significant ($p < .05$).

Table 1
Correlations, Means and Standard Deviations for Study Measures

Variable	1	2	3	4	5	6	7	8	9	10
1. YBOCS-O_{t1}	1.00	—	—	—	—	—	—	—	—	—
2. YBOCS-O_{t2}	.57*	1.00	—	—	—	—	—	—	—	—
3. YBOCS-O_{t3}	.43**	.79**	1.00	—	—	—	—	—	—	—
4. YBOCS-O_{t4}	.47**	.72**	.81**	1.00	—	—	—	—	—	—
5. YBOCS-C_{t1}	.65**	.54**	.46**	.43**	1.00	—	—	—	—	—
6. YBOCS-C_{t2}	.40**	. 85**	.71**	.69**	.38**	1.00	—	—	—	—
7. YBOCS-C_{t3}	.41**	.66**	.67**	.75**	.60**	.64**	1.00	—	—	—
8. YBOCS-C_{t4}	.53**	. 70**	.69**	.87**	.53**	.66**	.86**	1.00	—	—
9. YBOCS $_{t1}$	.83**	.62**	.54**	.56**	.85**	.47**	.58**	.62**	1.00	—
10. YBOCS $_{t4}$	.49**	.74**	.71**	.85**	.58**	.63**	.84**	.87**	.59**	1.00
M	11.17	10.13	9.42	8.98	11.36	10.24	8.73	8.48	22.52	17.46
SD	3.12	2.83	3.17	2.89	3.28	2.82	3.55	3.28	5.85	6.01

Note. YBOCS-O = Yale Brown Obsessive Compulsive Symptom Inventory, Obsessions Subscale; YBOCS-C = Yale Brown Obsessive Compulsive Symptom Inventory, Compulsions Subscale; $YBOCS_{t1}$ = Yale Brown Obsessive Compulsive Symptom Inventory, Total Score, Time 1; $YBOCS_{t1}$ = Yale Brown Obsessive Compulsive Symptom Inventory, Total Score, Time 4; t1 = CBT pre-treatment; t2 = CBT session 4; t3 = CBT session 8; t4 = CBT end of treatment. *M* = Mean, *SD* = Standard deviation.
* $p < .05$. ** $p < .01$.

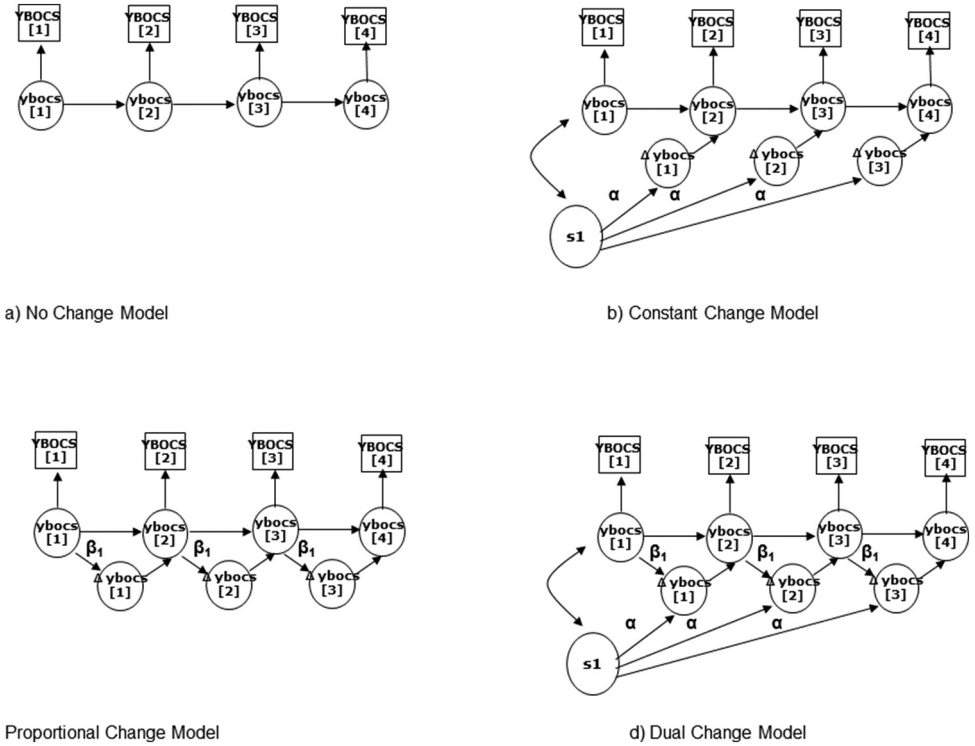

FIGURE 1 Path diagrams for four latent difference score (LDS) models based on observed scores collected across four consecutive time points. Squares represent observed variables, circles represent latent variables, single-headed arrows represent regression coefficients, and double-headed arrows represent a correlation or covariance. *YBOCS*(*t*) represents the observed scores at time *t*, *ybocs*(*t*) represents the latent difference score at time *t*. ($\alpha \times s_n$) represents a fixed slope score. β_1 indicates the proportional effect of a previous latent variable on the subsequent rate of change. e(*t*) represents the error term at time *t*. Each path diagram can be written as an equivalent equation as follows:
No Change Equation : $\Delta ybocs(t)_n = 0$ ($\alpha_{ybocs} = \beta_{ybocs} = 0$).
Constant Change Equation : $\Delta ybocs(t)_n = \alpha_{ybocs} \times s_{ybocs,\,n}$ ($\beta_{ybocs} = 0$).
Proportional Change Equation : $\Delta ybocs(t)_n = \beta_{ybocs} \times ybocs\,(t-1)_n$ ($\alpha_{ybocs} = 0$).
Dual Change Equation : $\Delta ybocs(t)_n = \alpha_{ybocs} \times s_{ybocs,\,n} + \beta_{ybocs} \times ybocs\,(t-1)_n$.

BIVARIATE LDS ANALYSES: TEMPORAL RELATIONSHIP OF YBOCS-O AND YBOCS-C

Summary results for the YBOCS-O and YBOCS-C bivariate analyses are presented in Table 2. Four models were considered, indicating parameter and fit indices for the *no coupling model*, the *goal-directed* unidirectional model in which a latent YBOCS-O value affects the subsequent change in YBOCS-C values, the *habit-driven* unidirectional model in which a latent YBOCS-C value affects the subsequent change in YBOCS-O values, and the *reciprocal* bidirectional model involving coupled linkages between univariate series. The path diagrams for these models are provided in Figure 2. All four bivariate models exhibited adequate model fit indices, and are therefore interpretable. Examination of goodness of fit and parameter estimates demonstrated that *goal-directed model* was the best model among the four candidate models, particularly given that this model had the lowest AIC and RMSEA, the lowest χ^2 /df ratio, and the highest CFI, $\chi^2(19, N = 84) = 33.95$; $\chi^2/df = 1.79$; AIC = 83.95, CFI = .96, RMSEA = .084. Notably, the coupling parameter ($\gamma_{obs/com}$) in which YBOCS-O leads subsequent change in YBOCS-C scores (*goal-directed model*) was significant. However, the coupling parameter in which YBOCS-C leads subsequent change in YBOCS-O scores was non-significant (*habit-driven* and *reciprocal models*). Although the habit-driven and reciprocal models demonstrated adequate overall model fit indices, since the path from Y-BOCS-C to subsequent change in YBOCS-O was not significant, these two models were not supported.

The path diagram for this unidirectional *goal directed model* can be found in Figure 3. All parameter estimates were statistically significant (*p*s ranging from < .001 to < .05). The coupling coefficient (γ_{ybocs}) was of particular importance, as the unidirectional coupling from YBOCS-O to YBOCS-C was significant ($p < .05$), with the unstandardized estimate being $\gamma_{ybocs} = 1.32$. The magnitude of this coefficient can be interpreted as following: for every one unit increase in YBOCS-O at time *t*, there is a subsequent additional 1.32 unit increase in YBOCS-C between time *t* and time *t+1*.

Results from the bivariate *goal-directed* model can be used to establish an equation, indicating the expected subsequent change in YBOCS-C values as related to prior values of YBOCS-C and YBOCS-O.

Table 2
Bivariate Models Involving the Relationship of YBOCS Obsessions (OBS) and YBOCS Compulsions (COM)

Parameters and Fit Indices	No Coupling		Goal Directed		Habit Driven		Reciprocal	
	OBS	COM	OBS → COM		OBS ← COM		OBS ←→ COM	
Additive coefficient								
$E(s_n)$	1.57[c]	3.32 [a]	.79[a]	.42 [a]	1.58[a]	3.13[a]	.19	2.16
σ^2 (s_n)	.96	.86	1.05	1.51	1.17	2.24	1.53	2.46
Proportional coefficients								
β_a	-.72[c]	-1.27[b]	-.20[c]	-.24[b]	-.89[c]	-.32[c]	-.92[c]	-.28[c]
β_b	-.72[c]	-1.27[b]	-.20[c]	-.24[b]	-.89[c]	-.32[c]	-.92[c]	-.28[c]
β_c	-.72[c]	-1.27[b]	-.20[c]	-.24[b]	-.89[c]	-.32[c]	-.92[c]	-.28[c]
Coupling coefficient								
γ_{OBS} / γ_{COM}	0 (=)	0 (=)	1.32[a]	0 (=)	0 (=)	0.11	2.68[a]	.96
Goodness-of-fit indices								
Parameters	61		64		64		67	
Degrees of Freedom	20		19		19		18	
RMSEA (p close fit)	.15(.24)		.08(.36)		.13(.33)		.09(.19)	
CFI	.69		.96		.76		.94	
AIC	182.17		83.95		154.06		84.59	
χ^2	96.17		33.95		54.06		34.76	
χ^2/df	4.81		1.79		2.84		1.87	

Note. OBS = Yale Brown Obsessive Compulsive Symptom Inventory, Obsessions Subscale; COM = Yale Brown Obsessive Compulsive Symptom Inventory, Compulsions Subscale; 0 (=) indicates parameter is not estimated. "*p* close fit" = *p* value for testing the null hypothesis that the population root-mean-square error of approximation (RMSEA) is no greater than .05 (MacCallum et al., 1996); CFI = comparative fit index; AIC = Akaike information criterion; E(*sn*) = additive change coefficient; β = proportional change coefficient. In this model, the β coefficient is time varying; β_a, β_b, and β_c represent three distinct parameter estimates. γ = cross-lag coupling coefficient between two univariate series.

[a] $p < .05$. [b] $p < .01$. [c] $p < .001$.

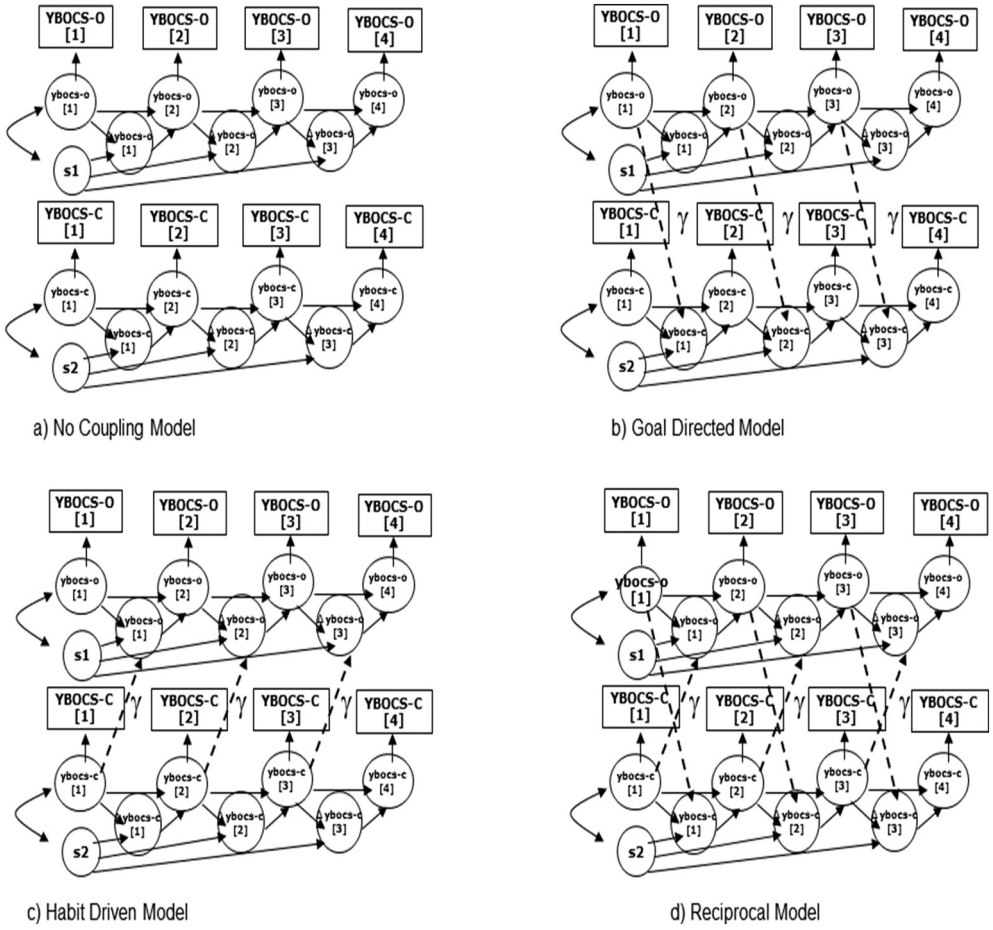

FIGURE 2 Path diagrams for four bivariate latent difference score (LDS) models based on observed scores collected across four consecutive time points. Squares represent observed variables, circles represent latent variables, single-headed arrows represent regression coefficients, and double-headed arrows represent a correlation or covariance. *YBOCS*(*t*) represents the observed score at time *t*, ybocs(*t*) represents the OCD symptoms latent difference score at time *t*. ($\alpha \times s_n$) represents a fixed slope score. β_1 indicates the proportional effect of a previous latent variable on the subsequent rate of change. γ[t] indicates the cross-lagged coupling effect between the two longitudinal series. *e*(*t*) represents the error term at time *t*.

Please refer to the Appendix for this bivariate "goal-directed" model equation.

Discussion

Although there is a longstanding assumption that obsessions precede changes in compulsions, research studies had yet to directly investigate this temporal relationship. After examining four competing models of the relationship between obsessions and compulsions, data from the current study revealed that the *goal-directed* model was the best fit, demonstrating bivariate longitudinal coupling and confirming the directional, functional relationship between obsessions and compulsions. This finding lends support for the long-presumed DSM criteria that individuals with OCD feel driven to perform compulsions *in response to their obsession*, as well as CBT models of OCD, which assert that obsessions increase anxiety, and individuals with OCD manage the anxiety resulting from their obsessions by engaging in compulsions (e.g., APA, 2013; Purdon, 2008; Rachman, 1997, 1998; Rachman & Hodgson, 1980; Salkovskis, 1985; Taylor et al., 2007). Although all four models demonstrated model fit indices within acceptable ranges, the directional relationship in which compulsions (at time t) lead to changes in obsessions (between time t and t+1) was not significant, and therefore these models are not supported. In the participant sample for the current study, exposure and response prevention (ERP) commenced before cognitive therapy strategies were introduced starting in Session 5. Although ERP strategies came first, obsession scores led to subsequent changes in compulsion values. Further, the alternative possibility (explored in the habit driven and reciprocal

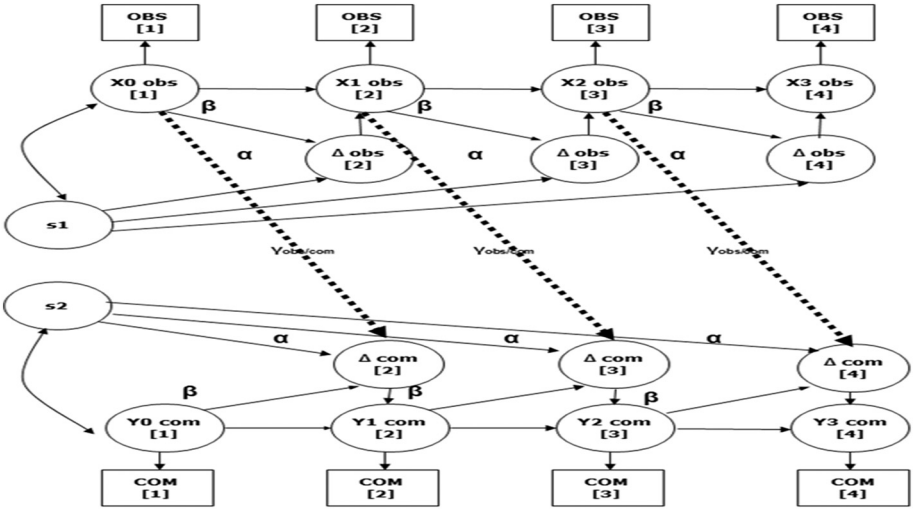

FIGURE 3 Path diagram of the bivariate "goal directed" model, illustrating the longitudinal association of YBOCS obsessions (OBS[t]) as it affects the subsequent change in YBOCS compulsion symptoms (DCOM[t]) through cross-lagged coupling (γ[t]) for each time period. Squares represent observed variables. Circles represent latent variables. Single-headed arrows represent regression coefficients. Double-headed arrows represent a correlation or covariance. OBS[t] and COM[t] represent the obsession and compulsion observed scores at time t. obs[t] and com[t] represent the associated latent scores at time t. e(t) represents the error term at time t. (α × sn) represents a fixed slope score. β(t) indicates the time-varying proportional effect, while γ[t] indicates the coupling effect between the univariate series.

models) did not occur—there were no significant cross-lagged paths in which compulsion scores lead to subsequent changes in obsession scores. Thus, the results are not simply due to cognitive interventions occurring temporally before behavior interventions.

Cross-sectional and experimental research supports a functional relationship between obsessions and compulsions. For example, Rachman and Hodgson (1980) experimentally showed that exposing someone to obsessional cues was related to increased anxiety (subjective report and pulse rate variability) and urges to enact rituals. Further, engaging in the rituals decreased anxiety. Covert neutralization of obsessions also leads to short-term distress reduction (e.g., de Silva, Menzies, & Shafran, 2003; Rachman, Shafran, Mitchell, Trant, & Teachman, 1996; Salkovskis, Thorpe, Wahl, Wroe, & Forrester, 2003). Safety behaviors have shown to produce a similar anxiolytic effect (Abramowitz & Moore, 2007), and similar anxiety reduction effects are seen when safety behaviors are available, but not used (Powers, Smits, & Telch, 2004).

The recently proposed "habit-driven" hypothesis views compulsions as habits that drive obsessions due to an imbalance between goal-directed and habit formation systems results in OCD. The habit-driven model would be expected to show increased brain activity in different areas of the brain than would be expected for the goal-directed model. Research involving both animals and humans shows that action-outcome learning is associated with the ventromedial prefrontal cortex and caudate, whereas habits implicate the putamen (see Robbins, Gillan, Smith, de Wit, & Ersche, 2012). Robbins et al. suggested that "although a propensity to habits may not be the only vulnerability factor for OCD, it is likely the main maintaining factor" (p. 84). The current study did not support the model where compulsions temporally lead to subsequent changes in obsessions, which is consistent with other research not fully supporting this model (Kalanthroff et al., 2016). Research on this hypothesis with clinical treatment populations is in its infancy, and further research is needed.

The reciprocal model, wherein both the goal-directed and habit-driven models coexist, was also not supported. Although the overall model fit was adequate, the path from compulsions to subsequent changes in obsessions was not significant. There is a paucity of data directly testing the temporal sequence of obsessions and compulsions. Some researchers have found that changes in beliefs and compulsions occur in tandem (Storchheim & O'Mahony, 2006; Williams, Salkovskis, Forrester, & Allsopp, 2002), and others have found a bidirectional relationship between beliefs and compulsions, in both CT and ERP for OCD (Rhéaume & Ladouceur, 2000). It is

unclear whether changes in beliefs function the same way as changes in obsessions. Further, the above studies had very small sample sizes (six in each), and Rhéaume and Ladouceur (2000) included only individuals with checking-based OCD. The findings of this larger study incorporating diverse OCD subtypes provide a small step forward in examining time sequences of obsessions and compulsions. More time series analyses are needed to provide greater understanding of the temporal unfolding of obsessions and compulsions.

Another area for further study in change modeling of OCD relates to the fact that a diagnosis of OCD can be given with obsessions only, compulsions only, or both. In the current study, participants reported both obsessions and compulsions, and the results show that obsessions drive the compulsions. However, a small subset of those with OCD do not report both obsessions and compulsions (e.g., Abramowitz et al., 2003; Calamari et al., 2004). Models for the experience of obsessions or compulsions in isolation remain to be determined, although some dispute the category of "pure obsessional" and argue that all OCD diagnoses should be based on both obsessions and compulsions (Leonard & Riemann, 2012; Williams et al., 2011). Further, the order of change in obsessions and compulsions during CBT may or may not be identical to the relationship between obsessions and compulsions more generally. Although our analyses examined the temporal relationship of obsessions and compulsions during CBT treatment, future studies could also examine this process by considering whether this process occurs differently when examining situations involving the onset, maintenance, and longer term course of OCD following treatment.

A main clinical implication of this study's findings is the importance of targeting obsessions, although further research is needed as this study did not directly examine the impact of a specific cognitive or behavioral intervention on the temporal sequence of obsessions and compulsions. Obsessions can be targeted directly with a variety of well-validated cognitive interventions, such as a thought record, responsibility pie, cumulative probabilities, and continuums. Alternatively, it may be that exposure indirectly impacts obsessions. As individuals confront their feared stimuli through planned exposures, they learn that their feared outcome is unlikely to occur, which results in less anxiety-provoking appraisals about their obsession (e.g., Rachman, 1997). From an inhibitory learning standpoint, the most effective exposures have maximum expectancy violation, whereby there is a significant mismatch between the expected and actual outcomes (Craske, 2015; Craske et al., 2014). ERP's targeting of compulsions is thought to be the most effective behavioral component of therapy for OCD. Studies show that changes in beliefs about obsessions occur equally in CBT and ERP for OCD (Belloch, Cabedo, & Carrió, 2008; Whittal, Thordarson, & McLean, 2005), and other studies have reported decreases in dysfunctional beliefs in both CBT and ERP (e.g., Rhéaume & Ladouceur, 2000; Storchheim & O'Mahony, 2006). Thus, even ERP alone results in cognitive shifts.

However, it may be that direct targeting of obsessions over and above the indirect shifts that occur via exposure is most important, although again further research is needed, as that hypothesis was not directly examined in this study. Masellis et al. (2003) reported that among individuals with OCD, obsession severity, but not compulsion severity, significantly predicted poor quality of life. Participants in this study experienced both obsessions and compulsions of moderate to severe intensity, and they found greater life detriment in the intrusive unwanted obsessions that create anxiety, rather than in the time-consuming compulsions, perhaps as obsessions may be especially disruptive, hindering one's ability to carry out activities. Focusing treatment solely on exposures may be insufficient, particularly if an individual has a predominantly obsessional clinical presentation. Given the prevalence of intrusive thoughts in both OCD and in the general public (e.g., Byers et al., 1998; Purdon & Clark, 1993; Rachman, 1998; Rachman & de Silva, 1978; Steketee & Barlow, 2003), the treatment target is less on stopping obsessions from occurring and more on changing one's reaction to the obsessions. Related to this, research has demonstrated that cognitively based CBT for patients without overt compulsions has significant impact on obsessions independently of targeting compulsions (Freeston et al., 1997; Freeston & Ladouceur, 1999). Further, Eddy et al. (2004) showed that cognitive therapy was equivalent to ERP, where the former is mostly aimed at targeting the appraisals and beliefs pertaining to obsessions. In addition, treatment outcome studies show that successful OCD treatment relates to significant improvements in obsessional beliefs (Bouvard, 2002; Emmelkamp, van Oppen, & van Balkom, 2002).

We recognize that the above discussion regarding the possible importance of targeting obsessions more directly is speculative, and requires further research. Although the current findings suggest that obsessions predict subsequent changes in compulsions, this study was not designed as a treatment dismantling study. Theoretically, there are various factors that could change obsessions, including, but not limited to, decreasing compulsions, psychoeducation,

structured assessment, or participating in group therapy processes. Thus, the design of the current study does not illuminate how selected interventions impacted temporal change in obsessions and compulsions. While the findings of the current study stand in contrast to those reporting that cognitive belief domains do not mediate treatment outcome (Olatunji et al., 2013; Su, Carpenter, Zandberg, Simpson, & Foa, 2016), the current study design cannot speak to direct implications for psychotherapy practice guidelines.

Conclusions from this study are tempered by the study's limitations. Although each participant's SCID diagnosis and report was reviewed by the supervising psychologist, formal inter-rater reliability analyses were not conducted. The participants were all treatment seeking, and were largely Caucasian and single, thus the results may not generalize to other groups. The participants in this study attended a large tertiary care hospital that often provides treatment for individuals with treatment-refractory mood and anxiety disorders, and treatment is funded by the government. The effect size reported in this study (.94) is lower than that reported in the meta-analysis by Öst et al. (2015) for group CBT for OCD (Hedges' $g = 1.36$), and the posttreatment YBOCS score of 17.46 is relatively high, indicating that treatment was not as effective in this study in comparison to the studies included in that meta-analysis. This study was not a randomized control trial (RCT), had minimal exclusion criteria, and took place in a tertiary care hospital, with participants experiencing significant diagnostic comorbidity. Although ERP is effective in both non-RCTs and RCTs (e.g., Franklin, Abramowitz, Kozak, Levitt, & Foa, 2000), the current effectiveness study provides generalizability beyond the more narrow scope of RCTs. In this study, the pre-post changes in OCD were statistically significant, and were close to the effect size reported in Rosa-Alcázar, Sánchez-Meca, Gómez-Conesa, and Marín-Martínez (2008) meta-analysis of ERP + CR OCD, $d = 0.998$. Further, other OCD group CBT studies have reported end-of-treatment YBOCS scores of 18 or over (Anderson & Rees, 2007; Belotto-Silva et al., 2012; Jónsson, Hougaard, & Bennedsen, 2011). Thus, the lesser degree of change within this sample is not unique, is unlikely to complicate analyses of changes in obsessions and compulsions, and this naturalistic sample may be more representative of typical clinical outpatient settings.

The results of the current study suggest several areas for future research, in addition to examining the effect of specific therapeutic interventions on the temporal sequence of obsessions and compulsions. Future work could examine whether all indices of obsessions/compulsions change at the same rate, or whether particular items on the YBOCS drive change in obsessions and/or compulsions symptoms. Researchers could investigate whether the format of the YBOCS (self-report vs. clinician administered) alters the pattern of results. Last, although this study focused on the examination of these four models in a first step to investigating temporal changes in obsession and compulsions, we acknowledge that other variables may mediate or moderate the nature of obsession-compulsion change (such as age, duration of illness, anxiety intensity, frequency, etc.), and this may be a fruitful area for further research.

In conclusion, this first study examining the temporal relationships between obsessions and compulsions during CBT demonstrated that obsessions drive compulsions, providing direct support for DSM 5 and CBT models focusing on the functional relationship between obsessions and compulsions. The conclusions and implications of this study will be strengthened by replication with larger and more generalizable samples.

Conflict of Interest Statement

The authors have no competing interests to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.beth.2018.03.012.

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