



## The relevance of analogue studies for understanding obsessions and compulsions



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### HIGHLIGHTS

- We reviewed evidence for utility of analogue samples in understanding OC symptoms.
- OC symptoms are sufficiently prevalent in non-clinical samples.
- OC symptoms are dimensional rather than categorical in frequency and severity.
- Qualitative aspects of OC symptoms are similar in clinical and nonclinical samples.
- Similar causal and maintenance factors occur in clinical and nonclinical samples.

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### ABSTRACT

Analogue samples are often used to study obsessive–compulsive (OC) symptoms and related phenomena. This approach is based on the hypothesis that results derived from such samples are relevant to understanding OC symptoms in individuals with a diagnosis of obsessive–compulsive disorder (OCD). Two decades ago, Gibbs (1996) reviewed the available literature and found initial support for this hypothesis. Since then there have been many important advances addressing this issue. The purpose of the present review was to synthesize various lines of research examining the assumptions of using analogue samples to draw inferences about people with OCD. We reviewed research on the prevalence of OC symptoms in non-clinical populations, the dimensional (vs. categorical) nature of these symptoms, phenomenology, etiology, and studies on developmental and maintenance factors in clinical and analogue samples. We also considered the relevance of analogue samples in OCD treatment research. The available evidence suggests research with analogue samples is highly relevant for understanding OC symptoms. Guidelines for the appropriate use of analogue designs and samples are suggested.

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## 1. Introduction

Obsessive compulsive disorder (OCD) is a complex clinical condition affecting 2–3% of the population (Kessler et al., 2005). It is characterized by (a) intrusive and unwanted thoughts or images or urges (obsessions) and/or (b) repetitive, intentional rituals to neutralize obsessional distress (compulsions) (American Psychiatric Association [APA], 2013). The disorder is associated with considerable suffering, functional impairment, and economic burden to both the individual and the health-care system (Markarian et al., 2010). Obsessive-compulsive (OC) symptoms are phenomenologically heterogeneous (i.e., they take many different forms) and etiologically complex (Taylor, 2011).

Investigators have used many different types of research designs to study OC phenomena. A common method is to study clinical samples of convenience, namely individuals with OCD who are attending a clinic in which research is being conducted. This type of design can be useful, especially for treatment studies, but has limitations. For example, studies of clinic patients are based on the untested assumption that the results generalize to OCD in the population at large. Those seeking treatment for OCD represent a minority of the OCD population (Grabe et al., 2000), and likely differ from non-help seekers on social, economic, attitudinal, and personality factors. Confounding factors such as treatment types and treatment effects, duration of prior treatment, and comorbidity also pose challenges for studies of OC phenomena in clinical populations. This is one reason researchers have pursued various forms of analogue research in order to study OC phenomena. The two most commonly used analogue designs include (a) studies of animals, typically rodents, in which particular behaviors (e.g., excessive grooming or the burying of objects) are used as analogues of compulsions, and (b) studies of human non-clinical samples, such as college students, in which subclinical OC phenomena are regarded as analogues of OC symptoms observed in people diagnosed with OCD.

Both animal and human analogue designs have their strengths and limitations. In recent years, however, it has become increasingly difficult to publish human analogue research, particularly studies based on correlational, factor analytic, or structural equation designs. Indeed, an increasing number of journals indicate in their aims and scope that studies using analogue and non-clinical samples will be given low priority (or in some instances not considered for publication). Perhaps this is because of the often unquestioned assumption that such studies are less relevant than studies of clinical patients to understanding the psychopathology or treatment of OCD (indeed, reviewers of journal submissions often ask authors to provide a justification for using analogue samples, as well as to cite their use as a limitation of the study). In

comparison, animal analogue research (often involving rodents) has been rarely criticized in the literature despite the significant limitations of this type of design. We have discussed the limitations of such animal studies of OC phenomena elsewhere (Abramowitz, Taylor, McKay, & Deacon, 2011). To summarize, the major problems are: (a) it is difficult to determine whether a repetitive behavior in animals such as rodents is a bona fide compulsion (as defined in DSM) or some other form of repetitive behavior<sup>1</sup>; (b) compulsions in humans often arise as a consequence of obsessions—it is unclear whether rodents experience intrusive obsessional thoughts of any kind; and (c) there is no evidence that rodents possess the cognitive capacity (or the frontal lobe development, which is an integral part of neuroanatomical models of OCD) to experience common obsessions, such as those pertaining to taboo acts concerning aggression, sex, or morality.

The motivation for the present article arose from our interest in clarifying the utility of human analogue research in OCD. Since OCD occurs in only 2–3% of the population, it can be time intensive and costly to recruit clinical samples of an adequate size. OC symptoms, however, occur in the general population (Adam, Meinschmidt, Gloster, & Lieb, 2012; de Bruijn, Beun, de Graaf, ten Have, & Denys, 2010; Grabe et al., 2000; Rachman & de Silva, 1978), allowing researchers to recruit larger samples with relative convenience. It is likely that using human analogue samples thus allows for more research to be conducted and may make some projects feasible that would otherwise be impractical. For example, analogue samples provide an opportunity to examine subgroups of obsessions and compulsions (e.g., scrupulosity, checking)—which has become an emphasis in recent years with the conceptualization of OCD as a dimensional condition (e.g., Abramowitz, McKay, & Taylor, 2008). Two decades ago, Gibbs (1996) argued for the relevance of human analogue research for understanding OC phenomena. Since that time there have been many important research developments that further support the value of human analogue research. The purpose of this article is to review the evidence regarding the value of human analogue samples. We also consider the use of non-clinical samples in research on the treatment of OCD. As a shorthand, in the following text we will refer to studies of students or community samples as “analogue samples,” maintaining a focus on human rather than animal analogues.

<sup>1</sup> We have highlighted elsewhere the corollary problem of animal research, namely theories of OCD that emphasize or exclusively conceptualize the disorder based on compulsions are insufficiently relevant to the clinical manifestation in humans, and fail to predict the efficacy of current efficacious interventions (Taylor, McKay, & Abramowitz, 2005). Despite these critiques, research reliant on a primarily compulsion-based conceptualization of the disorder persists in the literature.

## 2. Assumptions underlying human OC analogue research

Analogue designs are based on the notion that the sample or research design is relevant to a particular target disorder. If studies of student or community samples are to be relevant for understanding OCD, then the following assumptions would optimally be met:

- (a) It should be demonstrated that OC symptoms in student or community samples are sufficiently prevalent so that correlational studies of OC symptoms in students would be relevant to correlational studies in patients diagnosed with OCD. If OC symptoms in students or community samples were extremely rare, then analyses of these non-clinical samples might not generalize to clinical samples because of problems of range restriction.
- (b) It should be demonstrated that OC symptoms are dimensional rather than categorical in their frequency/severity distributions. If OC symptoms are categorical, then one would expect that there are two groups of people; those with OCD and those without. In such a circumstance it would not make sense to study OC symptoms in non-clinical samples. However, if OC symptoms were dimensional phenomena, ranging from absent to mild, moderate, and severe, then analogue samples would be highly relevant. Such samples would provide information on portions of the dimension linking subclinical to clinically severe OC symptoms.
- (c) It should be demonstrated that despite expected differences in the quantity (i.e., frequency, intensity) of OC symptoms between clinical and analogue samples, the qualitative features of these symptoms (e.g., thematic content, factorial structure) are similar across types of samples.
- (d) If analogue research is relevant to OCD, there should be evidence of etiological continuity. That is, etiological factors associated with OC symptoms among samples meeting diagnostic criteria for OCD should also be associated with subclinical OC symptoms among people who do not meet diagnostic criteria.
- (e) It should be demonstrated that psychological processes (e.g., cognitive biases) thought to play a role in the development and maintenance of OC symptoms in clinical samples are similarly associated with such symptoms among non-clinical analogue samples.

## 3. Prevalence of OC symptoms in non-clinical samples

Studies of analogue samples (i.e., student and community participants) highlight the prevalence of subclinical OC symptoms. According to surveys, up to 90% of people report that they at least occasionally experience intrusive thoughts that are similar in form and content to clinical obsessions (Clark, 1992; Clark & de Silva, 1985; Freeston, Ladouceur, Thibodeau, & Gagnon, 1991; Freeston, Ladouceur, Thibodeau, & Gagnon, 1992; Purdon & Clark, 1993, 1994; Rachman & de Silva, 1978; Salkovskis & Harrison, 1984). To further illustrate the prevalence of OC symptoms, consider that the Obsessive Compulsive Inventory-Revised (OCI-R; Foa et al., 2002) provides cutoff scores that have been empirically derived from ROC analysis (i.e., to optimally balance false positives and negatives and best distinguish people likely to meet criteria for OCD from those who are not). Several studies of student or community samples have reported the prevalence of “caseness” as assessed by the OCI-R (Cuttler & Taylor, 2012; Jennings, Nedeljkovic, & Moulding, 2011; Kaczurkin, 2013; O’Kearney & Nicholson, 2008; Siev, Huppert, & Chambless, 2010; Sparrow, 2009; Taylor et al., 2010; Taylor, Jang, & Asmundson, 2010; Taylor et al., in press). For these studies, the mean percentage of people scoring above the cutoff, weighted by sample size, was 26%. Although it is likely that this figure represents a high rate of false positives (indeed it is substantially larger than the estimated prevalence of OCD in the general population), this finding is

not entirely surprising given the high proportion of respondents from student and community samples who report having experienced sub-clinical OC symptoms (Clark, 2004; Muris, Merckelbach, & Clavan, 1997; Rachman & de Silva, 1978; Salkovskis & Harrison, 1984). Moreover, based on our meta-analysis of 55 studies using the OCI-R (as described in the appendices of supplemental materials), the SD for non-clinical samples (mean SD = 11.3) is essentially the same as that obtained for OCD samples (mean SD = 12.9), even though non-clinical and OCD samples differ in their weighted mean scores on the OCI-R (14.9 and 27.8, respectively). In other words, there was no evidence of severe range restriction in non-clinical samples, as compared to clinical OCD samples.

## 4. Categories versus dimensions

The question of whether a given psychopathic phenomenon is dimensional or categorical has important implications for the way in which the phenomenon is studied. If OCD is categorical it would mean that people either do or do not have the disorder, with no intermediate. In such a case there is little point in studying non-clinical samples because most people will not have the disorder. But if OCD is dimensional, ranging from no symptoms through to subclinical OC symptoms and finally to symptoms severe enough to meet diagnostic criteria for OCD, then the study of non-clinical samples is highly relevant because insights into the causes of their OC symptoms can shed light on the etiology of “full-blown” OCD.

Numerous studies have compared non-clinical and clinical samples on measures of OC symptom severity. Research consistently shows that people with a diagnosis of OCD report significantly more frequent and intense OC symptoms than do non-clinical individuals (Abramowitz et al., 2010; Foa et al., 2002; Garcia-Soriano, Belloch, Morillo, & Clark, 2011; Thordarson et al., 2004; Watson & Wu, 2005). Nevertheless, in all studies, OC symptoms were present to some degree in the non-clinical samples, providing initial evidence for a continuum of severity (i.e., dimensionality). Distress, impairment, and reduced quality of life are also part of the diagnostic criteria for OCD (American Psychiatric Association, 2013). Accordingly, it is also not surprising that in most studies, clinically diagnosed OCD samples experience greater distress, impairment, and are more likely to seek treatment relative to non-clinical samples (Adam et al., 2012; de Bruijn et al., 2010; Grabe et al., 2000). Yet these studies also reveal some degree of impairment and treatment-seeking even among non-clinical groups, and thus support the dimensional model of OC symptoms.

Meehl and colleagues (Meehl, 1995; Waller & Meehl, 1998) developed taxometric procedures to examine the latent structure of psychological phenomena and determine the extent to which the nature of this structure is categorical or dimensional. Since conclusions drawn from research on non-clinical analogue samples have more merit if psychopathology truly exists on a continuum, findings from taxometric studies of OC symptoms are highly pertinent to the question of whether analogue samples are relevant and useful for understanding OC phenomena in clinically diagnosed samples.

To date, two taxometric studies have examined the latent structure of OC symptoms. In the first, Haslam, Williams, Kyrios, McKay, and Taylor (2005) found strong support for dimensional models of contamination and checking symptoms. There was mixed support for a dimensional model of obsessionality: one indicator of taxonicity (MAXEIG) supported a taxonic model, whereas another (MAMBAC) did not. In the second study, Olatunji, Williams, Haslam, Abramowitz, and Tolin (2008) also found evidence that supported a dimensional latent structure for OC symptoms globally. In concert, these studies generally suggest a dimensional model of OCD in which the symptoms are conceptualized as occurring on a continuum of severity, rather than in discrete categories. This dimensional nature provides an important measure of

support for studies using non-clinical analogue samples to better understand the nature and treatment of clinically severe OC symptoms.

## 5. Phenomenology of OC symptoms

### 5.1. Presence of obsessions and compulsions

The vast majority of individuals diagnosed with OCD experience both obsessions and compulsions (Foa et al., 1995; Rasmussen & Tsuang, 1986). Two early studies, however, found that non-clinical participants tended to report *either* obsessions or compulsions (Karno, Golding, Sorenson, & Burnam, 1988; Weissman, Bland, Canino, & Greenwald, 1994). One explanation for this discrepancy is that the functional relationship between obsessions (which trigger anxiety) and compulsions (which aim to reduce anxiety) may not exist in non-clinical individuals. More recent studies (e.g., Ladouceur et al., 2000), however, provide a more probable explanation: in response to their intrusive obsession-like thoughts, non-clinical individuals (similar to those with OCD) use a broad range of covert neutralizing behaviors which were not assessed in the early studies by Karno et al. and Weissman et al. Indeed, more recent interview and experimental studies have found that non-clinical individuals commonly use covert “rituals” and behaviors such as mental checking, focused distraction, reassurance-seeking, thought replacement, and thought suppression as responses to intrusive thoughts (e.g., Berman, Abramowitz, Pardue, & Wheaton, 2010; Freeston, Ladouceur, Provencher, & Blais, 1995; Ladouceur et al., 2000; Marcks & Woods, 2007). These “neutralizing behaviors” are functionally similar to overt compulsive rituals: both are deliberate and serve an anxiety/distress-reducing function.

In an analogue laboratory study, Rachman, Shafran, Mitchell, Trant, and Teachman (1996) induced obsession-like thoughts by instructing non-clinical participants to write the sentence “*I hope \_\_\_\_\_ is in a car accident*” and insert the name of a friend or relative in the blank. Participants were then instructed either to immediately neutralize (i.e., do whatever they wanted to “cancel” the effects of the sentence) or delay neutralization for 20 minutes. Rachman et al. found that neutralization resulted in a reduction of (a) anxiety and guilt, (b) feelings of responsibility for the accident, (c) judgment of the immorality of writing the sentence, and (d) the subsequent urge to neutralize. This empirically demonstrates the functional similarities between neutralization and overt compulsions as observed in clinically diagnosed OCD patients. Thus, as in clinically severe OCD, anxiety-inducing thoughts and anxiety-reducing behaviors (which can be overt or covert/mental) occur in non-clinical individuals and are similarly functionally related.

### 5.2. Thematic content

#### 5.2.1. Obsessions

A large body of research indicates that for the most part, the themes, content, and form of intrusive distressing (obsession-like) thoughts are the same among non-clinical (analogue) and clinically diagnosed OCD samples (Belloch, Morillo, Lucero, Cabedo, & Carrió, 2004; Garcia-Soriano et al., 2011; Julien, O'Connor, & Aardema, 2009; Khanna, Kaliaperumal, & Channabasavanna, 1990; Purdon & Clark, 1993; Rachman & de Silva, 1978; Rasmussen & Eisen, 1989; Salkovskis & Harrison, 1984). Moreover, Rachman and de Silva (1978) found that even trained clinicians could not distinguish between the content of obsession-like intrusive thoughts reported by people with and without a diagnosis of OCD. In both groups, unwanted thoughts relating to contamination, fears of harming oneself or others, sex, and aggression/violence were commonly reported. Rassin, Cougle, and Muris (2007), however, did report content differences and found that students were more likely to endorse a lifetime history of putative “non-clinical obsessions” than “clinical obsessions.” Yet the absence of an OCD patient control group makes it difficult to interpret these findings; and when Julien

et al. (2009) conducted a similar study with both students and OCD patients, the groups did not differ in the prevalence of “clinical” and “non-clinical” obsessions. Thus, the more rigorous study by Julien et al. supports the view that clinical obsessions and non-clinical obsessions (i.e., intrusive thoughts) are similar in content.

#### 5.2.2. Compulsions

Most types of compulsions observed in clinical OCD samples (e.g., checking, counting, repeating, washing) are also observed in non-clinical samples (Flament et al., 1988; Henderson & Pollard, 1988). Similarly, the covert neutralizing strategies described previously appear frequently in both types of samples (e.g., Ladouceur et al., 2000). Washing and cleaning compulsions, however, while common among clinical samples (Khanna et al., 1990), are reported less commonly among non-clinical individuals (Degonda, Wyss, & Angst, 1993; Valleni-Basile et al., 1994). Perhaps, as Gibbs (1996) suggested, washing compulsions are readily identified as “classic” OCD symptoms and (more often than other types of compulsions) lead to seeking treatment and receiving a clinical diagnosis of OCD. Alternatively, it may be more challenging to recognize non-clinical levels of washing and cleaning compulsions since these are behaviors that most people engage in on a daily basis and/or may not be viewed as problematic. It might also be difficult to ascertain when washing behavior in non-clinical individuals is performed in response to obsessions. For example, someone who works in a hospital or a restaurant might wash her hands multiple times per day as part of normal protocol, but not in response to the fear of contamination.

### 5.3. Thematic structure

Numerous studies have used factor and cluster analysis of OC symptom measures to elucidate the thematic structure of OC symptoms in non-clinical and clinical samples. In general, findings indicate structural invariance between clinical and non-clinical samples across different measures of OC symptoms. The Maudsley Obsessional–Compulsive Inventory (MOCI; Hodgson & Rachman, 1977), for example, was developed from a factor analysis of data from diagnosed OCD patients and includes four theme-based factors: (a) washing, (b) checking, (c) doubting, and (d) slowness. Factor analytic studies also indicate that data from non-clinical samples fit this four-factor model well (Sanavio & Vidotto, 1985; Sternberger & Burns, 1990). Likewise, the Padua Inventory (PI; Sanavio, 1988; van Oppen, Hoekstra, & Emmelkamp, 1995) shows a similar five factor structure in both clinical and non-clinical samples, consisting of (a) washing, (b) checking, (c) impulses, (d) rumination, and (e) precision.

The Obsessive–Compulsive Inventory (Foa, Kozak, Salkovskis, Coles, & Amir, 1998) and its revision (OCI-R; Foa et al., 2002) were developed to measure a broader array of OC symptoms than is assessed by the MOCI or PI. The OCI-R (which is more widely used than its predecessor) contains six factors that were empirically derived using data from a large clinical OCD sample: (a) washing, (b) checking, (c) ordering, (d) neutralizing, (e) obsessing, and (f) hoarding. This identical factor structure has subsequently been replicated in more than 10 studies using exploratory and confirmatory factor analysis in both clinical and non-clinical samples (for a review see Overduin & Furnham, 2012). Likewise, in developing the Schedule of Obsessions Compulsions and Pathological Impulses (SCOPI), Watson and Wu (2005) found that this measure's five factor structure—(a) checking, (b) cleaning, (c) rituals, (d) hoarding, and (e) pathological impulses—was invariant across one clinical OCD and two non-clinical samples.

Numerous studies have also reported factor analyses of the Yale–Brown Obsessive Compulsive Scale's (YBOCS; Goodman, Price, Rasmussen, & Mazure, 1989a, 1989b) symptom checklist, which contains 58 items (although some revisions contain up to 102 items) assessing specific types of obsessions (e.g., concerns about dirt and germs) and compulsions (e.g., ritualized toilet routine) (e.g., Leckman, Grice, Boardman, & Zhang, 1997). Although not

identical (investigators have used slightly different statistical methods and versions of the checklist), results from across studies of clinical samples are generally consistent (for reviews see Katerberg et al., 2010 [p. 507, Table 1] and Wu, Watson, & Clark, 2007). Wu et al. (2007) also conducted a series of factor analyses of the YBOCS checklist using data from a large non-clinical sample, reporting a similar factor structure to previous studies with clinical samples.

Using another self-report measure of OC symptoms, the Dimensional Obsessive–Compulsive Scale, Abramowitz et al. (2010) reported identical results in separate confirmatory factor analyses with a clinical and a non-clinical sample. Both samples' data fit the following four factor solution very well: (a) contamination, (b) responsibility for harm, (c) unacceptable thoughts, and (d) symmetry/incompleteness. Moreover, the identical factor structure was replicated in Spanish OCD and non-clinical samples (López-Solà et al., 2014). Garcia-Soriano et al. (2011) confirmed a similar factor structure in a large non-clinical sample using the Obsessional Intrusive Thoughts Inventory, a self-report measure of obsessional content and severity.

Lee and Kwon (2003) proposed that obsessions could be divided into two types. The first type, *autogenous obsessions*, intrude into consciousness with or without identifiable triggers, are experienced as repugnant and highly distressing, are strongly resisted, and typically take the form of unacceptable sexual, aggressive, or immoral ideas, images, or impulses. The second type, *reactive obsessions*, are evoked by identifiable situations and stimuli (e.g., driving, bathrooms), are perceived as rational enough to provoke compensatory behaviors (e.g., checking, washing), and typically concern contamination, illness, mistakes, accidents, symmetry, and loss. In three studies with non-clinical analogue samples, these authors found that participants' intrusive thoughts could indeed be categorized as autogenous or reactive on the basis of how the thoughts were experienced (e.g., unacceptability, need to control). Subsequent studies with both non-clinical (e.g., Belloch, Morillo, & García-Soriano, 2007; Moulding, Kyrios, Doron, & Nedeljkovic, 2007) and clinically diagnosed OCD samples (e.g., Besiroglu, Agargun, Ozbebit, & Aydin, 2006; Besiroglu et al., 2007; Lee, Kwon, Kwon, & Telch, 2005; Lee & Telch, 2010) have consistently replicated the autogenous–reactive distinction, demonstrating the predictive validity (e.g., of treatment response) of this typology in clinical samples (e.g., Besiroglu et al., 2006, 2007; Lee & Telch, 2010).

#### 5.4. Summary and conclusions: phenomenology

Taken together, despite *quantitative* differences in the frequency, intensity, and associated features of obsessions and compulsions between clinical and non-clinical samples, research clearly indicates that the *qualitative* features of these symptoms, such as thematic content and factorial structure, are highly comparable across samples. This, again, presents a strong case for the dimensional nature of OC symptoms and for the assertion that findings with non-clinical analogue samples are relevant and generalizable to individuals given a clinical diagnosis of OCD.

### 6. Etiology: behavioral and genetic factors

The use of non-clinical analogue samples in OC research is based on the assumption that non-clinical and clinical samples are comparable with regard to certain characteristics. One important characteristic is etiology. Twin studies can provide evidence of whether such an etiological overlap exists between clinical and non-clinical samples because twin studies use biometric structural equation modeling to determine, among other things, the proportion of variance in psychological symptoms (or diagnostic status) due to genetic or environmental etiologic factors. Four types of causal influence are assessed: (a) additive genetic effects (i.e., effects due to the aggregate effects of multiple genes), (b) non-additive genetic effects, such as effects of genetic dominance or epistasis, (c) shared environmental effects (i.e., effects shared by a

given pair of twins, such as family environment), and (d) non-shared genetic effects (i.e., environmental events experienced by one twin and not her or his co-twin; childhood illness, trauma exposure).

A recent meta-analysis compared the pattern of results from twin studies in which one or both twins were diagnosed with OCD versus twin studies of non-clinical samples in which twins completed measures of OC symptom severity (Taylor, 2011). Results indicated that all the findings from clinical samples were replicated in non-clinical samples. In both types of samples the major etiologic factors were additive genetic factors and non-shared environment. The heritability of OC symptoms did not significantly differ from the heritability of OCD diagnoses (i.e., 37–41% of variance was due to genetic factors). In another study, the results of a participant stratification analysis based on a community sample of twins (Taylor, Jang, & Asmundson, 2010) were also consistent with this finding. The effect sizes for additive genetic factors and non-shared environment did not differ when results for the overall non-clinical twin sample were compared with results from participants with relatively high scores on measures of OC symptoms (i.e., OC symptom severity scores above the 50th percentile of the sample; Taylor, Jang, et al., 2010). These findings suggest that OC symptoms, as assessed in analogue samples, are etiologically related to the diagnosis of OCD.

### 7. Development and maintenance processes

Also central to the question of whether the findings from non-clinical analogue samples are useful for understanding the nature of OC symptoms as they occur in clinical samples is the degree to which the psychological processes and mechanisms hypothesized to govern the development and maintenance of OC symptoms overlap across types of samples. Cognitive–behavioral models are the most well-articulated and well-researched psychological models of OC symptoms. These models posit that obsessions arise from dysfunctional beliefs and are maintained by maladaptive escape and avoidance behaviors (e.g., rituals, neutralizing) performed to reduce or control obsessional distress (e.g., Rachman, 1997; Salkovskis, 1999).

#### 7.1. Obsessive beliefs and OC symptoms

Researchers have identified six domains of dysfunctional beliefs (i.e., “obsessive beliefs”) thought to give rise to OC phenomena, including: (a) overestimates of threat, (b) an inflated sense of responsibility, (c) the over-importance of thoughts, (d) the need to control thoughts, (e) the need for perfection, and (f) intolerance of uncertainty (Obsessive Compulsive Cognitions Working Group [OCCWG], 1997). Subsequent structural analyses of measures of these six domains revealed three factors, including: (a) overestimates of threat and responsibility, (b) the importance of and need to control thoughts, and (c) perfectionism and need for certainty (OCCWG, 2003, 2005). Numerous correlational, prospective, and experimental studies demonstrate that obsessive beliefs are present and associated with OC symptom severity in both clinical and non-clinical analogue samples (Abramowitz, Khandker, Nelson, Deacon, & Rygwall, 2006; Abramowitz & Deacon, 2006; Lopatka & Rachman, 1995; OCCWG, 2003, 2005; Steketee, Frost, & Cohen, 1998; Tolin, Woods, & Abramowitz, 2003; for a review see Frost & Steketee, 2002).

#### 7.2. Models of OC symptom dimensions

In addition to the associations between obsessive beliefs and OC symptoms more generally, some theorists have developed “mini models” focusing on particular cognitive–behavioral factors to explain the development and maintenance of particular OC symptom dimensions (e.g., contamination, symmetry). These models have been examined in both clinical and non-clinical samples using correlational and experimental research designs. In the following sections we review the findings of this body of literature.

### 7.2.1. Contamination fear and washing compulsions

Rachman (2004) proposed two presentations of contamination fear: contact contamination and mental contamination. Contact contamination refers to when an individual comes into (or fears they have come into) contact with an item that they believe could cause a possible threat to their mental or physical health (e.g., touching a doorknob). Various authors (e.g., Jones & Menzies, 1997; Rachman, 2004) have proposed that this type of contamination fear is maintained by overestimates of threat and heightened responsibility. Accordingly, research with clinical OCD samples has found that inflated responsibility and threat estimation is predictive of contamination fear and washing rituals (Jones & Menzies, 1997; Taylor, Abramowitz, & McKay, 2005; Tolin, Brady, & Hannan, 2008; Wheaton, Abramowitz, Berman, Riemann, & Hale, 2010). Jones and Menzies (1997), for example, found that high expectations of danger were the main predictor of washing behaviors in OCD patients with contamination obsessions. Similarly, many studies with non-clinical participants have found that overestimates of threat and responsibility are predictive of increased contamination fear and avoidance (e.g., Deacon & Olatunji, 2007; Menzies, Harris, Cumming, & Einstein, 2000; Myers, Fisher, & Wells, 2008; Taylor, Coles, et al., 2010; Thorpe, Barnett, Friend, & Nottingham, 2010; Tolin, Abramowitz, Brigidi, & Foa, 2003). In one exception, Fitch and Coughle (2013) found that perfectionism/certainty beliefs, rather than threat/responsibility beliefs, predicted performance on a washing-related behavioral assessment.

Mental contamination refers to feelings of “internal uncleanness,” shame, guilt, or impurity that occur in the absence of actual (or feared) physical contact with a contaminant; but which nonetheless provoke an urge to wash or clean (Caugherty, Shafraan, Knibbs, & Rachman, 2012; Rachman, 1994). For example, one might have a blasphemous thought or recollection of an unethical deed that leads to ritualistic hand washing (e.g., to “wash away” their sins). Some authors have proposed that mental contamination is associated with cognitions related to disgust and immorality (e.g., Rachman, 1994), and empirical studies with diagnosed OCD samples have supported this hypothesis (e.g., Caugherty et al., 2012; Reuven, Liberman, & Dar, in press). For example, in an experimental study, Reuven et al. (in press) had participants with a diagnosis of OCD (as well as a non-OCD control group) write about an immoral deed they had committed, after which half were instructed to clean their hands. All participants were then offered an opportunity to help a fictitious student by taking part in her experiment. These authors found that physical cleaning relieved moral distress and reduced willingness to help with the experiment; an effect which was pronounced in the OCD group. A similar effect has been found in multiple investigations with analogue samples. For example, several studies have found that the *imagined* occurrence of a non-consensual kiss or other “dirty” or unethical event is sufficient to evoke subjective reports of mental contamination (i.e., feelings of dirtiness and urges to wash), as well as actual washing behavior, in the absence of any physical contact with a contaminant (Elliott & Radomsky, 2009, 2012; Fairbrother, Newth, & Rachman, 2005; Herba & Rachman, 2007; Rachman, Radomsky, Elliott, & Zysk, 2011; Radomsky & Elliott, 2009).

### 7.2.2. Checking compulsions

Various models implicating different domains of obsessive beliefs—primarily inflated responsibility, threat overestimation, and intolerance of uncertainty—have been proposed to explain compulsive checking behavior (e.g., Rachman, 2002). Consistent with these hypotheses, studies with clinical samples have found that the need for certainty is a predictor of checking behavior (Calleo, Hart, Björgvinsson, & Stanley, 2010; Holaway, Heimberg, & Coles, 2006; Julien, O'Connor, Aardema, & Todorov, 2006; OCCWG, 2005; Overton & Menzies, 2002; Steketee et al., 1998; Tolin, Abramowitz, et al., 2003; Tolin, Worhunsky, & Maltby, 2006). Others have found that overestimates of threat and inflated responsibility beliefs are key cognitive factors in checking (e.g., Abramowitz & Deacon, 2006; Lopatka & Rachman, 1995; Taylor,

Abramowitz, & McKay, 2005; Taylor, McKay, & Abramowitz, 2005; Wheaton et al., 2010).

Consistent with findings in clinical samples, a number of correlational and experimental studies using non-clinical samples have shown checking behavior to be related to heightened responsibility and overestimation of threat (e.g., Ladouceur et al., 1995; Myers et al., 2008; Taylor, Coles, et al., 2010; Tolin, Abramowitz, et al., 2003; Tolin, Woods, et al., 2003). In a number of laboratory studies, for example, investigators experimentally manipulated perceived responsibility (e.g., by leading participants to believe that they were sorting colored pill capsules either to identify the correct pills for sufferers of a serious disease [high responsibility] or for a test of color perception [low responsibility]; Ladouceur, Rhéaume, & Aublet, 1997) and examined its effects on various aspects of participants' checking behavior (e.g., hesitations). Other studies using similar experimental methods suggest a key role for perfectionism and intolerance of uncertainty (Fitch & Coughle, 2013; Myers et al., 2008). Thus, while checking might be associated with multiple domains of obsessive beliefs, the same belief domains emerge as predictors of checking in both clinical and non-clinical samples.

### 7.2.3. Symmetry/ordering symptoms

Models of symmetry obsessions and ordering/arranging compulsions propose that these symptoms arise from beliefs about the need for completeness, perfection, and for feeling “just right” (e.g., Summerfeldt, 2004). Correspondingly, research consistently shows that these sorts of obsessive beliefs are predictive of symmetry and ordering symptoms in both clinical (Chik, Calamari, Rector, & Riemann, 2010; Ghisi, Chiri, Marchetti, Sanavio, & Sica, 2010; Tolin et al., 2008; Viar, Bilsky, Armstrong, & Olatunji, 2011; Wheaton et al., 2010) and non-clinical samples (Coles, Frost, Heimberg, & Rhéaume, 2003; Coles, Heimberg, Frost, & Steketee, 2005; Ghisi et al., 2010; Moretz & McKay, 2009; Myers et al., 2008; Pietrafesa & Coles, 2009; Taylor, Coles, et al., 2010; Tolin, Woods, et al., 2003; Viar et al., 2011). For example, Fitch and Coughle (2013) found that beliefs about the need for perfection uniquely predicted ordering urges and behaviors, and associated distress, during exposure to a disorganized and cluttered room designed to elicit the feeling of “not just right.”

### 7.2.4. Obsessions

Several authors have proposed that misinterpretations of the presence and meaning of intrusive thoughts, and beliefs about the need to control such thoughts, lead to the escalation of everyday unwanted cognitive intrusions (e.g., regarding violence, sex, or religion) into clinically severe obsessions (e.g., Clark, 2004; Purdon, 2008; Rachman, 1997, 1998; Salkovskis, 1999). Numerous studies with clinical samples consistently demonstrate that these sorts of beliefs are associated with the severity of OC symptoms (e.g., Abramowitz, Whiteside, Lynam, & Kalsy, 2003; OCCWG, 2003; Shafraan, Thordarson, & Rachman, 1996; Rassin, Diepstraten, Merckelbach, & Muris, 2001; Yorulmaz, Karanci, Bastug, Kisa, & Goka, 2008), and in particular with the intensity of repugnant obsessions (i.e., concerning taboo topics such as religion, immorality, sex, and violence; e.g., Rowa, Purdon, Summerfeldt, & Antony, 2005; Wheaton et al., 2010). Rowa et al. (2005), for example, found that among individuals with OCD, exaggerated negative appraisals of the meaning of obsessional thoughts were positively correlated with ratings of distress.

These findings have also been replicated with non-clinical intrusions in analogue samples (Gwilliam, Wells, & Cartwright-Hatton, 2004; Myers et al., 2008; Rassin & Koster, 2003; Rassin, Merckelbach, Muris, & Schmidt, 2001; Rassin, Muris, Schmidt, & Merckelbach, 2000; Rowa & Purdon, 2003; Viar et al., 2011). For example, in an experimental study, Rassin, Merckelbach, Muris, and Spaan (1999) induced thought-action fusion (TAF; the belief that one's thoughts can produce harmful and preventable consequences) by attaching electrodes to naïve participants and telling the experimental group that thinking the word

“apple” would automatically cause a mild electric shock to another person (whom participants had seen attached to shock equipment in a separate room). Subjects in the control group were told that their thoughts would merely be monitored. Results indicated that the experimental group reported more intrusive “apple” thoughts, more guilt, greater subjective discomfort, more intense resistance to thoughts about apples, and more neutralizing responses compared to the control group. Thus, experimentally inducing TAF in non-clinical individuals evoked experiences that were qualitatively similar to clinical OCD symptoms.

### 7.3. Attentional bias

It is well known that increased state anxiety is associated with the preferential processing of threat-relevant (as opposed to irrelevant) information, and that this attentional bias contributes to the maintenance of fear by causing the person to become highly vigilant to (and have difficulty ignoring) the presence of possible fear triggers (e.g., Barlow, 2002). Various experimental paradigms have been used to examine such attentional biases in individuals with OCD and in analogue samples. In studies of OCD patients, generally consistent evidence of attentional bias has been found using dichotic listening (e.g., Foa & McNally, 1986), modified Stroop (e.g., Foa, Ilai, McCarthy, Shoyer, & Murdock, 1993; Lavy, van Oppen, & van den Hout, 1994), and dot-probe paradigms (e.g., Tata, Leibowitz, Pmnty, Cameron, & Pickering, 1996). In a meta-analytic study, Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, and van Ijzendoorn (2007) found a moderate effect size ( $d = 0.45$ ) across six studies in which attention bias was examined in OCD patients. Bar-Haim et al. also examined 50 studies using samples of non-clinical individuals with elevated anxiety symptoms. Across these studies, they found a similar effect size of  $d = 0.46$ , indicating that threat-related attentional bias is an overlapping feature of individuals with clinical and non-clinical levels of OC symptoms.

### 7.4. Memory distrust

Although checking rituals are performed with the aim of increasing certainty, research shows that checking paradoxically reduces memory confidence, which in turn induces more checking as one continues to strive for certainty in a self-perpetuating cycle. In one study, Tolin et al. (2001) repeatedly exposed OCD patients, non-anxious controls, and non-clinical students to sets of objects rated as “safe” (e.g., new bar of soap), unsafe (e.g., feces specimen), or neutral (e.g., coffee mug). When asked to recall the objects, memory accuracy was the same across groups, but the OCD patients showed a decline in *confidence* in their memory for the unsafe objects as the number of trials increased. Using a task developed by van den Hout and Kindt (2003), Boschen and Vuksanovic (2007) asked OCD patients to repeatedly check a virtual stovetop and observed that the act of repeatedly checking led to reductions in memory vividness, detail, and confidence, without accompanying reductions in memory accuracy. Studies with non-clinical analogue samples (i.e., students) have consistently found the same patterns of results—reduced memory *confidence*, but not accuracy, following repeated checking of virtual (Dek, van den Hout, Giele, & Engelhard, 2010; van den Hout & Kindt, 2003) and actual threat-relevant stimuli (Coles, Radomsky, & Horng, 2006; Radomsky, Gilchrist, & Dussault, 2006; Radomsky et al., 2006). Thus, the paradoxical and deleterious effects of compulsive checking behavior appear to be the same regardless of OCD diagnostic status.

### 7.5. Summary and conclusions: development and maintenance processes

The strands of correlational and experimental research evidence discussed above are consistent with the idea that the cognitive and behavioral processes hypothesized to be involved in the development and persistence of clinically severe OCD symptoms are also involved in the manifestation of OC phenomena among non-treatment seeking

analogue samples (i.e., so-called “normal” obsessions and compulsions). These findings provide additional support for the idea that data from analogue research is relevant to understanding presentations of OC symptoms in individuals with a clinical diagnosis of OCD.

## 8. Use of analogue samples in OCD treatment research

The field of cognitive-behavioral therapy (CBT) has a rich history of conceptualizing and developing treatment methods using analogue samples. In fact, the very procedures that would come to form the heart of CBT for OCD – exposure and response prevention – were initially studied with dogs that had been conditioned to fear the sudden illumination of their shuttle box which signaled the onset of electric shock (Solomon, Kamin, & Wynne, 1953). The dogs learned to avoid the shock by jumping (escaping) to another part of their shuttle box that was not electrified, and continued this “compulsive” jumping behavior long after illumination no longer signaled that a shock was coming. In this way, the dogs' behavior represented an animal learning model of OCD. Solomon and colleagues later extinguished the dogs' fear of the illumination, and the compulsive jumping behavior, by repeatedly illuminating the shuttle box in the absence of shock and preventing the dog from jumping (using a barrier) to the “safe” side (i.e., exposure and response prevention). Following an initial visible increase in distress, the dogs learned that they did not need to jump (escape) to avoid the shock (and indeed they stopped jumping in response to illumination even after the barrier was removed). Some years later, behaviorally-oriented clinicians such as Meyer (1966) and others began applying these procedures with humans with OCD (see Houts, 2005 for a review).

Contemporary treatment development continues to rely on (human) analogue samples for the initial evaluation of potentially effective interventions. For example, based on research demonstrating that individuals with subclinical and clinical levels of OC symptoms exhibit preferential attention toward threat-relevant information (e.g., Amir, Najmi, & Morrison, 2009; Lavy et al., 1994), clinical scientists have developed computerized attention modification programs designed to train fearful individuals to selectively attend away from OC-related threats. This treatment approach has shown promise in reducing attentional bias and promoting approach behavior in an analogue sample of individuals with elevated contamination fear (Najmi & Amir, 2010). At the time of this writing, we are aware of at least one funded research project evaluating the efficacy of attention modification training among patients with OCD (Chang, 2013). It is unlikely that such investment would be possible in the absence of analogue research on the nature and modification of attentional biases in individuals with subclinical OCD symptoms.

Analogue treatment research is also useful for answering important scientific questions that are rarely addressed in traditional clinical trials. Randomized controlled trials (RCTs) typically investigate the comparative efficacy of treatment packages (e.g., exposure and response prevention, cognitive therapy) in heterogeneous samples of OCD patients (e.g., McLean et al., 2001). Although RCTs are useful for characterizing the overall therapeutic benefit of treatment protocols, they are limited in their ability to address other essential aspects of treatment such as the process of change, the specific efficacy of different treatment components, and the manner in which treatments might be modified to optimally target different OCD symptom presentations. To illustrate, although RCTs conducted with OCD patients have clearly established the efficacy of exposure and response prevention (Abramowitz, Taylor, & McKay, 2009), less is known about how exposure should be delivered to ensure its acceptability and optimal effectiveness. Because analogue treatment studies require fewer resources to conduct than RCTs, they are particularly well-suited for the investigation of important aspects of OCD treatment beyond the overall efficacy of treatment protocols.

Treatment studies conducted with analogue OCD samples have provided valuable insights into the mechanisms and effects of exposure therapy. For example, [Coughe, Wolitzky-Taylor, Lee, and Telch \(2007\)](#) found that the process and outcome of exposure to a feared contaminant differed according to whether non-clinical analogue OC participants were concerned with illness or other threats. In contrast to participants with illness-related concerns, those with non-illness concerns (e.g., loss of control) did not experience a reduction in the urge to wash following a single session of exposure therapy, suggesting the possibility that standard exposure treatment may be suboptimal for this subgroup of compulsive washers. An additional treatment analogue study conducted with non-clinical contamination-fearful participants demonstrated that disgust was slower to habituate than was fear during exposure to feared contaminants ([Olatunji, Wolitzky-Taylor, Willems, Lohr, & Armstrong, 2009](#)). Given that disgust is particularly elevated among individuals with contamination-based OCD symptoms ([Olatunji et al., 2010](#)), these findings suggest that treatment of contamination concerns may require more intense and frequent exposure trials to elicit habituation of disgust.

Lastly, researchers have conducted OC analogue treatment studies to test the theory that the “judicious use” of safety behaviors during initial exposure trials will enhance treatment acceptability and tolerability without compromising symptom reduction or cognitive change ([Rachman, Radomsky, & Shafraan, 2008](#)). Single-session exposure treatment studies with high contamination-fearful participants have provided support for this notion ([Rachman, Shafraan, Radomsky, & Zysk, 2011](#); [van den Hout, Engelhard, Toffolo, & van Uijen, 2011](#)) and question the longstanding conventional wisdom that complete safety behavior elimination should be the immediate goal in exposure therapy. Although the generalizability of findings from these analogue studies should eventually be put to the test in RCTs conducted with treatment-seeking OCD patients, treatment research conducted with OC analogue samples is useful in highlighting potentially beneficial modifications to existing “gold standard” treatments for OCD.

## 9. Guidelines for using analogue designs and samples

On the basis of the findings reviewed in this article, we provide recommendations and criteria for the use of analogue designs and samples that allow for understanding the psychological processes involved in OCD, as well as for generalization to clinically severe populations. The suitability of analogue designs and samples depends on the nature of the investigator's research question, and on the associated assumptions underlying the use of analogue samples.

### 9.1. Correlational studies

One common research question concerns the correlates of OC phenomena; for example, the question of how particular types of dysfunctional beliefs are related to different types of OC symptoms. Ideally, for such a correlational or regression design using non-clinical participants, the investigator should justify the assumption of dimensionality, which in this example is the assumption that both OC symptoms and dysfunctional beliefs are dimensional rather than categorical in nature (as reviewed earlier in this article, such an assumption is justified). For other variables, however, the assumption of dimensionality might not have been previously investigated and the researcher might need to test this assumption when conducting correlational or regression analyses. The test of this assumption is important for determining whether the findings from analogue samples are likely to generalize to samples with clinically severe symptoms (i.e., warranting a diagnosis of OCD).

In correlational or regression studies using analogue samples, it is also important to investigate whether range restriction of scores is likely to be a problem. As we have reviewed in this article, it seems unlikely that range restriction would be a problem for OC symptoms in analogue samples. Nevertheless, range might be severely restricted for other

variables under investigation. Range restriction is a relative concept; for a given sample (e.g., a student sample or clinical sample), range might be restricted relative to the range of scores obtained from a sample representative of the general population. However, if a researcher is seeking to understand whether correlational or regression findings from an analogue sample are generalizable to a clinical sample, then it would be useful to determine whether the standard deviation (SD) of scores in the analogue sample is significantly different (e.g., smaller) than the SD of the same scores for clinical samples. This can be readily determined by statistical tests such as the  $F_{\max}$  test. The onus is on the researcher to demonstrate that findings from her or his analogue sample are likely to generalize to clinical samples. If range is restricted, for analogue compared to clinical samples, on one or more variables in a correlational or regression study, then the analogue findings might not generalize to clinical samples.

### 9.2. Between-group designs

Between-group designs commonly involve the comparison of groups of participants scoring high or low on some OC-related measure. This is analogous to studies comparing a group of people with OCD to a control group. Both are quasi-experimental designs rather than true experiments, because group allocation (e.g., diagnosis of OCD vs. control) cannot be randomly assigned. Nevertheless, such studies have their value. In studies of analogue samples, a common practice is to split participants into groups, based on the percentile rank or SD range of their scores. For example, an investigator might collect self-report data on a large pool of undergraduate students and use scores on a measure of checking to create two groups, such as “checkers” and “non-checkers.” In this example, non-checkers might be classified as those participants with scores at least one SD below the mean of all student participants, and checkers classified as those scoring at least one SD above the mean. This is a common practice in analogue research. However, the use of an empirically derived cut-off for OCD caseness (e.g., those obtained by [Foa et al., 2002](#)) is a superior approach for two reasons. First, the use of caseness criteria is based on previous research (e.g., a score of 4 or higher on the OCI-R Obsessions subscale has been found to optimally discriminate people meeting criteria for OCD from those who do not; [Foa et al., 2002](#)), whereas high versus low SD-based cutoffs on some OC symptom scales might not optimally identify people who do or do not meet criteria for OCD caseness. Second, empirically derived caseness cutoffs are likely to be more generalizable than an arbitrary score based on a one SD cutoff for a single non-clinical sample.

## 10. Summary and conclusions

Researchers use analogue samples to study OC-related phenomena based on the assumption that the results derived from such samples are relevant and generalizable to understanding these phenomena in individuals with a diagnosis of OCD. The present review synthesizes research pertaining to five specific assumptions underlying the use of analogue samples: that OC symptoms (a) are prevalent in non-clinical populations, (b) are dimensional as opposed to categorical, (c) have similar etiologies in clinical and analogue samples, (d) are phenomenologically similar across clinical and non-clinical individuals, and (e) are associated with the same developmental and maintenance factors in clinical and analogue samples. The findings from studies addressing these assumptions strongly indicate that analogue research is indeed relevant to understanding OC-related phenomena in individuals diagnosed with OCD, and indeed across the continuum of severity. Despite quantitative differences in severity, OC symptoms in non-clinical individuals appear for the most part to be largely qualitatively indistinguishable from those in clinically diagnosed samples of OCD patients. Put another way, the research reviewed in this article supports the idea that OC-related phenomena among non-clinical analogue samples



are milder variants of those observed among individuals with symptoms severe enough to meet the criteria for a diagnosis of OCD.

Although studies using clinical samples often have immediate implications for understanding, assessing, and treating patients with OCD, especially in practical settings, there are a number of advantages to using analogue samples in research on OC-related psychopathology. First, depending on the setting where data are being collected, analogue samples can be more convenient to accrue than clinical samples; this efficiency is especially beneficial in the present era of tight extramural funding and in light of the fact that studies using larger samples can be more reliable than those using smaller samples. Second, given the costs of recruiting large clinical samples, analogue samples are useful for conducting preliminary studies to determine whether a given line of research is fruitful. If the results of such studies appear encouraging, replications can subsequently be attempted using clinical samples. Third, analogue samples are useful for investigating the developmental progression of OC symptoms. That is, such samples provide an opportunity for conducting longitudinal research to determine why OC symptoms are common in the general population, but only a fraction of people go on to develop OCD. Analogue samples are also advantageous in experimental research that tests hypotheses regarding the effects of putative developmental and maintenance factors on OC symptoms (e.g., Deacon & Maack, 2008; Rassin et al., 1999). Indeed, analogue samples afford more precise experimental control (and internal validity) as compared to clinical samples.

It is also important to consider limitations of analogue research. As we have discussed, aside from being of use in the initial development of psychological treatment procedures, analogue studies have limited use in the empirical validation of treatment programs for problems such as OCD. Indeed, the high internal validity that is a strength in psychopathology research using analogue samples serves to limit the utility of analogue treatment studies. Participants in analogue studies, for example, might systematically differ from clinical populations in ways that can affect the outcome of treatment, such as age, socioeconomic status, general functioning, disability, and educational level. Recruitment methods and the contexts in which assessment and treatment take place might also differ in important ways from general clinical settings (Reynolds & Steiner, 1998). Some authors have speculated that such sampling differences also limit the utility of analogue samples in scale development (Reynolds & Steiner, 1998). However, there is evidence that measures of OC symptoms developed using non-clinical samples have similar psychometric properties when used with clinical OCD samples (e.g., Watson & Wu, 2005).

Because there are currently so few studies directly comparing clinical and analogue groups on variables of interest, in this review we relied on indirect methods of comparison across different studies using more or less varied methodology. Although the similarities between clinical and analogue samples appear to be robust to such method variance, future studies could be conducted to more precisely address the utility of analogue samples in OCD research. Researchers, for example, might include both clinical and analogue groups, and compare the effects of induced state anxiety (or induced dysfunctional cognitions) on variables such as attention bias, memory confidence, and urges to perform compulsions. The field would also benefit from closer examinations of whether certain features or dimensions of OC symptoms (e.g., concerns with incompleteness and the need for symmetry) are more common in analogue versus clinical samples.

More generally, there is a need for prospective studies to examine the course of OC symptoms in analogue samples, and predictors of escalation (if any) to clinically severe levels. Understanding such factors would have important implications for the prevention and treatment of OC symptoms (e.g., Timpano, Abramowitz, Mahaffey, Mitchell, & Schmidt, 2011), as well as for clarifying the continuity of OC symptoms as observed in analogue

and clinical samples. Finally, because of the scarcity of analogue research focusing on conceptual models other than the cognitive-behavioral approach, we focused on this theoretical model in our review of developmental and maintenance factors. It would be valuable, however, to also directly compare associations between OC symptoms and processes of other theoretical models (e.g., neurobiology) in clinical and analogue samples.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.cpr.2014.01.004>.

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