Dysfunctional beliefs in the understanding & treatment of obsessive compulsive disorder
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Processes of change in cognitive-behavioural treatment of obsessive-compulsive disorder; current status and some future directions.
Abstract

The present chapter discusses theoretical and methodological issues involved in the processes of change in cognitive-behavioural treatment (CBT) of obsessive-compulsive disorder (OCD). Treatment outcome studies showed that CBT is effective in reducing obsessive-compulsive symptoms. However, why and how CBT works cannot be corroborated by comparing pre- and post-assessment. Recently, there has been a resurgence of interest in theory-driven process studies. By showing patterns of change over time, process studies can contribute to our insight into the actual mechanisms of change during treatment. We review process research in the field of OCD, and discuss methodological issues involved in process studies for this particular disorder. It is concluded that studying the processes of change harbours promising possibilities for bridging the gap between theory and clinical practice.
Introduction

According to Marks (2002, p. 200) ‘therapy is coming of age regarding efficacy for anxiety and depression, but is only a toddler regarding the scientific principles to explain its effects’. Cognitive-behavioural models are currently the most prominent theories on obsessive-compulsive disorder (OCD), but whether clinical improvement follows the predictions of these models has not been established, yet. To bridge this gap between theory and practice, process oriented research during the actual treatment phase is an important tool. In this chapter, we will review the current status of process studies in OCD, and discuss several methodological issues that seem relevant for process research in this disorder.

Contemporary theories emphasize the role of dysfunctional beliefs in the development and maintenance of OCD (see for example, Clark & Purdon, 1993; Frost & Steketee, 2002; Rachman, 1997, 1998; Salkovskis 1985, 1989). Cognitive-behavioural models postulate intrusive thoughts as cognitive stimuli, and negative automatic thoughts and beliefs (concerning for example responsibility) as cognitive responses to the intrusions. These negative automatic thoughts and beliefs in turn would influence one’s emotions, and affect behaviour (i.e., compulsions). An international group of researchers identified six OCD relevant belief domains; over-importance of thoughts, importance of controlling one’s thoughts, perfectionism, inflated responsibility, overestimation of threat, and intolerance of uncertainty (Obsessive Compulsive Cognitions Working Group (OCCWG), 1997). A therapeutic implication of the cognitive-behavioural model is that automatic thoughts about the meaning of intrusions and the beliefs that give rise to them should be modified. Changing these beliefs (in whichever way) should lead to a decrease in OCD symptoms.

Both exposure with response prevention (ERP), the gold standard in the treatment of OCD, and cognitive treatment (CT) are considered effective treatments for OCD (Cottraux, Note, Yao, Lafont, Note, Mollard et al., 2001; Foa, Franklin & Kozak, 1998; Freeston, Ladouceur, Gagnon, Thibodeau, Rhéaume, Letarte et al., 1997; Van Oppen, De Haan, Van Balkom, Spinthon, Hoogduin & Van Dyck, 1995a; Whittal, Thordarson & McLean, 2005). Some evidence has been emerging for the relationship between successful treatment and significant changes in obsessional beliefs. Two studies involving exposure with response prevention in which cognitive changes were assessed, showed that improvement in OC symptomatology was related to improvement on cognitive measures (Emmelkamp, Van Oppen & Van Balkom, 2002). Furthermore, one of these studies showed that obsessive beliefs hardly changed over the course of treatment in the least improved patients. Cognitive behaviour therapy seems to be associated with cognitive change as well: Different research teams have demonstrated that reductions in OC symptoms correlate with changes in OC beliefs (Bouvard, 2002). However, since the studies covered in these reviews focused on the comparison of pre- and post-treatment measures, it cannot be corroborated whether changes in interpretations and long-standing beliefs precede, follow, or co-vary with changes in symptomatic outcome.
A more critical test of the cognitive-behavioural model would involve process-oriented research to determine whether decreases in dysfunctional beliefs mediate clinical outcome (Tolin, Woods & Abramowitz, 2003).

**Defining process research**

In general, two types of process studies can be distinguished; those that focus on change processes, and those that focus on treatment processes (Orlinsky, Rønnestand & Willutzki, 2004). Change processes occur within the patient and not exclusively or mainly during treatment, whereas treatment processes only take place during treatment sessions and involve the patient, the therapist, and their interaction. When process research concerns the investigation of mechanisms of change of a particular treatment, focus is on changes in overt and covert client behaviour during treatment (which can take place both inside and/or outside treatment sessions) (Orlinsky et al., 2004).

Since process research concerns a different research question compared to traditional treatment outcome research, it also requires a different research methodology. Whereas treatment outcome research aims to establish treatment efficacy, process studies aim to elucidate how phenomena change over time. Therefore, many data-points per participant are required to reveal patterns of change over time. Data analysis concerns both intra- and inter-individual changes (instead of changes in group means, as is common in treatment outcome research). The additional value of process research is that the within-person level data provides information on within-person changes over time, as well as individual differences in such changes (Bolger, Davis, & Rafaeli, 2003). Individual differences might be linked to the extent of improvement (outcome). It may be assumed that the least improved patients show different patterns of change compared to the most improved patients. Moreover, different patterns of change might lead to improvement as well. For instance, in the investigation of processes of change in CBT for depression, both sudden gains and temporary worsening of symptoms (which was considered to be a sign of a learning process, in which old patterns were changed and new behaviours and beliefs emerged) predicted better treatment outcome (Hayes, Feldman, Beevers, Laurenceau & Cardaciotto, 2007). Process research could contribute to our understanding of a particular disorder and can help to optimize treatment methods and their effects (Whisman, 1993). For instance, in case of the temporary worsening in depressed patients which occurred during an exposure phase of the treatment, a therapist might consider a patient’s resources to deal with this temporary worsening before starting with this part of the treatment (Hayes, et al., 2007).
In the following sections we will focus on process studies investigating mechanisms of change in OCD, and the methodological issues involved in such studies.

Process studies in OCD

To obtain an overview of the status of process research focusing on mechanisms and processes of change in OCD, a literature search was conducted, using PSYCHINFO and MEDLINE-Pubmed from 1985 to 2008 (week 52) with keywords ‘process’, ‘treatment’, ‘obsessive’, ‘compulsive’ as well as synonyms and related words, and using the reference lists of various publications. This literature search yielded papers related to different types of processes, e.g., neurological and biological processes not related to treatment, and papers related to general treatment processes like the therapeutic relationship. Selection was based on two criteria. Firstly, the paper should concern cognitive-behavioural treatment for patients suffering from OCD. Secondly, the processes under study should involve processes of change, as described in the previous section. Papers were examined by the first author in consultation with the second author, which eventually yielded eight relevant papers. Table 1 provides a summary of these studies, describing the samples, theoretical backgrounds, provided treatments, assessment points, types of process measures, data-analytical techniques and results. In this section, we will briefly describe the studies and discuss theoretical implications, in the next section we will discuss their methodological strengths and weaknesses and methodological aspects of studying processes of change in OCD in general.

The studies of Kirkby, Berrios, Daniels, Menzies, Clark, and Romano (2000), Kozak, Foa, and Steketee (1988) and Moergen, Maier, Brown and Pollard (1987) mainly concerned exposure with response prevention. Kirkby et al. (2000) studied the efficacy of a computer aided ERP training consisting of 3 sessions. Participants were asked to learn to do exposure and ritual prevention by directing a person pictured on the screen who is stated to have contamination obsessions and washing rituals. An on-screen thermometer provided feedback on the current anxiety of the figure, which increased with hand-dirting behaviour. Participants scored points when they got the figure’s hands dirty without washing them afterwards. As participants continued vicarious exposure to dirt, the figure’s anxiety level declined, simulating habituation. Results showed that more hand dirtying enactments in the first session were related to better treatment effect, and it was concluded that repeated vicarious exposure was a therapeutic factor.

Kozak et al. (1988) studied processes related to outcome in an exposure treatment in 14 OCD patients based on the emotional processing theory (Foa & Kozak, 1986). According to this theory it was hypothesized that fear activation should
occurred during exposure and that habituation of fear would take place within and across sessions. Processes were measured during sessions 6 and 14 with electrodermal activity, subjective units of discomfort (SUDS) rated on a 0-100 scale, and heart rate. Results of both physiological and self-report measures showed that anxiety increased during exposure and that habituation took place during the sessions. Habituation over sessions was established with self-report only. In relation to treatment outcome, results showed that activation of fear and habituation over sessions predicted better treatment results.

Moergen et al. (1987) studied generalization of fear habituation in a multiple baseline across fear stimuli design (i.e., visual, auditory, behavioural and cognitive), in an OCD patient with fear of the number 13. Following a baseline phase, visual stimulus exposure was provided. Subsequently, exposures to auditory, behavioural and cognitive stimuli were added on the 6th, 9th, and 12th day of treatment. Results showed decreases in anxiety levels in response to all four stimulus forms before prolonged exposure to a new type of stimulus was introduced during treatment. These results suggest that exposure to a single stimulus form may result in sufficient generalization of treatment effect. However, the single case design precludes firm conclusions, for instance it is unclear whether a different order of stimulus types during the exposure would have lead to the same results. Overall, these three studies provided specific information on processes of change related to treatment success of exposure based treatments.

The studies of Anholt, Kempe, De Haan, Van Oppen, Cath, Smit and Van Balkom (2008) and Wilson (2002) investigated the order of changes in obsessions and compulsions during respectively ERP versus CT, and CT by measuring obsessions and compulsions on a weekly basis. Anholt et al. (2008) hypothesized that ERP would primarily affect behaviour, thus reducing compulsions first, and that CT would primarily affect thought and therefore obsessions were expected to reduce first. However, changes in compulsions preceded changes in obsessions in both treatments, which lead to the conclusion that reduction of compulsions is the process through which both ERP and CT give rise to change. However, Wilson’s (2002) results were not in line with these findings; sometimes changes in obsessions, compulsions and anxiety co-occurred, however sometimes they also changed in opposite directions. Results gave no indication for decreases in compulsions to precede decreases in obsessions. It should be noted that Wilson’s (2002) study concerned individual trajectories of change of six subjects, whereas Anholt et al. (2008) studied groups of 30-31 subjects thereby averaging out individual differences, which could explain the differences in findings. A limitation of these studies is that the only cognitive aspect that was measured were obsessions. Cognitive treatment explicitly challenges negative appraisals and dysfunctional beliefs. Also, ERP is considered to –indirectly- affect appraisals and beliefs by disconfirming and thereby weakening the strength of catastrophic thoughts (e.g., Rachman, 1996). Furthermore, the experience of mastering an OCD relevant situation might induce more positive associations with respect to the OCD stimuli and self efficacy, which
further affects the strength and impact of dysfunctional cognitive associations (cf. Bandura, 1977). So, both ERP and CT are expected to affect beliefs and appraisals, and therefore, the investigation of these cognitive aspects (besides changes in obsessions) would shed more light on the processes of change of these two treatments.

The studies of Rhéaume and Ladouceur (2000), Storchheim and O’Mahony (2006), and Williams, Salkovskis, Forrester and Allsopp (2002) explicitly investigated changes in beliefs both during C(B)T and ERP, based on the cognitive-behavioural model of OCD. All three studies reported decreases in dysfunctional beliefs during successful treatment, irrespective of type of treatment, which is in line with the conclusions based on treatment outcome studies that successful treatment of OCD is related to significant changes in obsessional beliefs (Emmelkamp et al., 2002; Bouvard, 2002). As for the process of change of these dysfunctional beliefs, different aspects were studied: Rhéaume and Ladouceur (2000) investigated whether changes in beliefs were a precursor of changes in compulsive behaviour and vice versa, and found this relationship to be bi-directional. Williams et al. (2002), and Storchheim and O’Mahony (2006) assumed that changes in beliefs and compulsive behaviour would occur in tandem, and results were in line with this hypothesis. Rhéaume and Ladouceur (2000) also investigated possible differences between ERP and CT in processes of change, and found that in both treatments cognitive changes sometimes preceded behavioural change, and in some instances followed behavioural change within the same subject. Furthermore, patients in the ERP condition showed a larger number of beliefs involved in the process of symptom changes than patients in the CT condition.

In spite of methodological differences and limitations, the above mentioned process studies provided specific information on processes of change in relation to treatment outcome, e.g., hand-dirtying behaviour in session one predicted better treatments results in a computer aided treatment (Kirkby et al., 2000), and activation of fear and habituation over sessions predicted better results for ERP (Kozak et al., 1988). When considering the theoretical background (see Table 1), it is interesting to see that mechanisms of change in ERP were studied based on the habituation/emotional processing theory (Foa & Kozak, 1986), as well as based on the cognitive-behavioural model. Kozak et al. (1988) also proposed that besides activation of fear and habituation over sessions, cognitive variables would probably be involved in an exposure treatment as well. With respect to the cognitive-behavioural model of OCD, it can be concluded that cognitive change seems to be related to treatment effect. Furthermore, the relationship between behavioural- and cognitive change seems to be closely linked, and might be bi-directional.
Methodological issues in process studies

Sample size & composition
Concerning methodological characteristics of the studies in Table 1, first of all, the rather small sample sizes of the studies may catch the eye, ranging from 1 participant to 14 participants. The benefit of closely studying a small number of cases however, is that it facilitates more in-depth analysis of individual patterns of change (Wilson & Chambless, 2005), and therefore can shed light on possible qualitative characteristics of change processes. For instance, Rhéaume and Ladouceur (2000) reported that distinct patterns were observable in all patients in terms of number of beliefs involved as well as the various links between them and the symptoms. This indicates that the process might be highly idiosyncratic, something which would not easily be found in a large patient sample which involves averaging data. However, sample size is also one of the major limitations of most studies presented in Table 1. For example, Wilson (2002) reported that two of the six included patients had co-morbid post traumatic stress disorder (PTSD), another

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Theoretical background</th>
<th>Treatment</th>
<th>Assessment points</th>
</tr>
</thead>
</table>
| Anholt et al. (2008)   | n = 61; 54.8% F  
Mean age: 33.8 (18-65)  
Diverse symptom themes | Habituation theory & Cognitive-behavioural model | CT n = 31  
ERP n = 30  
16 sessions | Weekly |
| Kirkby et al. (2000)   | n = 13; 9 F  
Mean age: 41 (28-54)  
13 'washers' | Computer aided ERP training  
3 sessions | During the sessions |
| Kozak et al. (1988)    | n = 14; 8 F  
Mean age: 34.4 (19-50)  
10 'washers', 4 'checkers' | Emotional processing theory | ERP  
15 sessions | During sessions 6 and 14 |
| Moergen et al. (1987)  | n=1, M  
Mean age: 20  
‘fear of number 13’ | Habitation theory | ERP  
23 days (inpatient) | Daily, after each presentation of number 13 |
| Rhéaume & Ladouceur (2000) | n = 6; 3F  
Mean age: 35.3 (21-43)  
6 ‘checkers’ | Cognitive behavioural  
model | ERP (n=3)  
CT (n=3)  
24 sessions | Daily |
| Storchheim & O’Mahony (2006) | n = 6; 6F  
Mean age: 30.2 (18-43)  
Diverse symptom themes | Cognitive behavioural  
model | 5 sessions ERP + 7 sessions ERP & CT | Daily |
| Williams et al. (2002) | n = 6; 3 girls  
Mean age: 14.3 (12-17)  
Diverse symptom themes | Cognitive behavioural  
model | CBT  
7-10 sessions | Once per session |
| Wilson (2002)          | n = 6; 3 F  
Mean age: 33.2 (20-50)  
Diverse symptom themes | Cognitive behavioural  
model | CT  
10-18 sessions | Daily |
patient had a co-morbid depression, and another one might have had some slight
cognitive deficits. In a large sample the effects of comorbidity may be averaged
out across patients. With only six patients however, two out of six with co-morbid
PTSD means a third of the sample, which obviously complicates straightforward
conclusions. Furthermore, comparing the process of change in ERP and CT is an
interesting research question, but cannot be answered by studying three patients
per treatment condition (see Rhéaume & Ladouceur, 2000). So, initially process
research might benefit from small scale studies to explore processes of change
and individual differences closely, but when general tendencies become clear, these
should be studied in large samples as well, in order to facilitate generalization of
results.

Secondly, the composition of the samples deserves attention. Some samples
concern a specific subtype of OCD (e.g., ‘checkers’ in Rhéaume & Ladouceur, 2000),
whereas other studies investigated OCD in general. The importance of study-
ing OCD subtypes is currently supported by various researchers (e.g., McKay,
Abramowitz, Calamari, Kyrios, Radomsky, Sookman, Taylor & Wilhelm, 2004), and

<table>
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<tr>
<th>Process measure</th>
<th>Data-analysis of process</th>
<th>Results</th>
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<tr>
<td>Structured Clinical Interview</td>
<td>Generalized estimating equations</td>
<td>Reductions in compulsions preceded reductions in obsessions in both ERP and CT</td>
</tr>
<tr>
<td>Human Computer Interactions (HCl)</td>
<td>Specifically written computer programs automatically analysed HCl</td>
<td>More hand dirtying enactments in the first session were related to better treatment effect → repeated vicarious exposure is therapeutic factor</td>
</tr>
<tr>
<td>Physiological measures (electrodermal activity, heart rate) and self-report</td>
<td>Univariate repeated measures ANOVA + correlation</td>
<td>Activation of fear and habituation over sessions predicted better treatment results</td>
</tr>
<tr>
<td>Self-report</td>
<td>Visual inspection</td>
<td>Generalization over stimuli took place before a new type of stimulus was introduced during treatment</td>
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<tr>
<td>Self-monitoring forms</td>
<td>Multivariate Time Series Analysis (V-ARMA)</td>
<td>Bidirectional relations between changes in beliefs and behaviour in both ERP &amp; CT</td>
</tr>
<tr>
<td>Self-report</td>
<td>Visual inspection + calculation of critical difference</td>
<td>Changes in beliefs and behaviour occurred in tandem during both treatment phases</td>
</tr>
<tr>
<td>Self-report</td>
<td>Visual inspection + correlation</td>
<td>Changes in responsibility kept pace with changes in symptom level</td>
</tr>
<tr>
<td>Self-report</td>
<td>Visual inspection + piecewise linear growth modelling</td>
<td>In some time segments obsessions and compulsions changed together, but sometimes also in opposite directions</td>
</tr>
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</table>
could have important implications for understanding variability in treatment response (Calamari, Wiegartz & Janeck, 1999). Considering that OCD is a very heterogeneous disorder, and because of the small sample designs, inclusion of patients who are similar on clinically relevant aspects (splitting) might facilitate the interpretation of results. For instance, patients with washing compulsions might not go through the same process of change as compulsive hoarders. Studying a specific OCD subtype decreases the subtype related variability which enhances the comparability of the within subject variability between patients.

**Selection & operationalization of process variables**

The operationalization of process variables is a key factor in studying processes. Since process variables need to be assessed frequently, administration should be easy and should take only little time. Furthermore, since patterns of change are under study, it is important that the process measure is sensitive enough to detect relatively small changes. Most studies in Table 1 used self-report measures and assessment mostly took place daily or during the session. In general, nine levels of analysis can be distinguished, ranging from ‘Liminal’ (split seconds) to ‘Biographic (life course) (Orlinsky et al., 2004). The lab-sessions of Kozak et al. (1988) enabled on-line investigation of processes of change during exposure with response prevention. Also, the Human Computer Interactions in the Kirkby et al. (2000) study provided an on-line impression of change processes (Kirkby et al., 2000). Daily or weekly measures, on the other hand, provide a more overall impression over time, irrespective of what happens during a treatment session, as applied in the other studies. This is important since not all therapeutic change happens during treatment sessions. For instance, doing homework assignments and encountering new situations with the knowledge acquired during a treatment session can lead to changes as well.

With self-report measures, reactivity is an important concern. Patients’ attention is purposefully directed towards specific aspects of their thoughts and behaviours which might affect the outcome. Storchheim and O’Mahony (2006) mentioned the possibility of a treatment effect of self-monitoring in their study. Moreover, patients’ responses might be biased, for example to please the therapist. Finally, some processes might not be easily accessible by introspection, for instance the ability of patients to reflect on their thoughts is restricted (e.g., Nisbett & Wilson, 1977).

When investigating the cognitive-behavioural model of OCD, the primary variable of interest would be some type of belief or appraisal. Besides the question of how to assess beliefs and appraisals, the question arises of what exactly to assess. The studies in Table 1 mostly assessed beliefs and used different measures to do so. Storchheim and O’Mahony (2006) investigated general beliefs representing the six belief domains as distinguished by the OCCWG (1997). Rhéaume and Ladouceur (2000) reformulated questionnaire items on which participants scored relatively high at pre-test in a personalized way. Items concerned responsibility, perfection-
ism and danger occurring if compulsions would not be performed. Williams et al. (2002) used the Responsibility Interpretations Questionnaire on a weekly basis (Salkovskis, Wroe, Gledhill, Morrison, Forrester, Richards, Reynolds & Thorpe, 2000). With respect to what exactly to assess (e.g., negative automatic thoughts, beliefs, core beliefs), dysfunctional beliefs were used most often, and also seem most suitable in this type of research since they involve themes that are relevant to a number of situations and are subject to change during the entire treatment period. Assessing, for instance, the credibility of automatic thoughts might be relatively easy for patients, but they are restricted to certain situations and patients may have many of them, which complicates selection of the most important ones for the researcher. Core beliefs, on the other hand, are likely to be more rigid than beliefs, and changes may be restricted to the final stage of treatment, and hence may provide less detailed information about the process of change over the course of treatment.

As mentioned before, explicit measures (self-report) provide insight into individuals’ subjective experiences and appraisals, and are limited by what a participant is willing and able to report. Therefore, there is increasing interest in implicit measures, such as the Implicit Association Test (IAT, Greenwald, 1998), which have the promise to circumvent the problem of reactivity and may tap into relevant associations that are not readily accessible for introspection (De Houwer, 2002; Huijding, 2006). By relying on reaction time tasks, it is assumed that participants will perform better (i.e., faster and/or more accurate) when the attribute properties of the required response are somehow associated with the target stimulus. A first application of the IAT in the context of OCD, showed an IAT effect on importance of thoughts. However, the implicit associations showed no direct relationship with other measures of OC beliefs (Teachman, Woody & Magee, 2006). These preliminary findings underline the idea that implicit measures may provide important complementary information regarding dysfunctional beliefs in OCD.

**Treatment**

Following current cognitive-behavioural views of OCD, modifying dysfunctional beliefs is a necessary prerequisite for successful interventions. Current effective treatments for OCD are exposure with response prevention (ERP), cognitive therapy (CT), and SSRI’s, or a combination of these. The major question is whether treatment success is mediated by cognitive change or whether different, treatment specific, mechanisms can be distinguished. To answer this question it is important to implement one type of treatment at the time, i.e., to be able to attribute the effects to a single dependent variable. For instance, suppose three different generally effective treatments for OCD (ERP, CT, and SSRI’s) are provided to different patients, and some patients do not show cognitive changes during treatment. Does that mean that dysfunctional beliefs are not a key factor in the process of change for OCD, or is it possible that differences in processes of change are related to type of
treatment? Results of an experiment in which brief exposures with a habituation rationale were compared to brief exposures with a cognitive rationale illustrated this: The cognitive rationale resulted in decreases in the level of self-reported anxiety, meta-cognitive belief and the urge to neutralize, whereas the habituation rationale lead to increased anxiety (Fisher & Wells, 2005). The latter is in accordance with the results of Kozak et al. (1988) who found that activation of fear predicted better treatment results. The results of these two studies suggest that maybe both type of treatments address beliefs, but that the processes of change differ. It seems that an increase in anxiety is not necessary for CT to be effective, whereas it seems to be an important process characteristic, and maybe even a crucial condition, for an efficacious ERP treatment. It should be noted however that preliminary findings in subjects with spider phobia indicated that high levels of anxiety might also be hindering successful exposure (Johnstone & Page, 2004). Either way, we can conclude that if different treatments would be combined and the process shows no cognitive change, it is possible that beliefs do not play a role, or that other relevant factors in the process of change were not properly addressed. Furthermore, when different treatments are provided subsequently, it is not clear whether changes in the present phase are due to the current treatment or due to the treatment provided previously (Storchheim & O’Mahony, 2006). Finally, two treatments might be effective due to the same mechanism, for instance cognitive change, but can be characterized by different processes of change. In ERP new behaviour is practised which can disconfirm beliefs, therefore behaviour change might precede cognitive change. In CT on the other hand, dysfunctional beliefs are explicitly targeted and modified and can subsequently lead to new behaviour. In these cases, the process of change is different, but the mechanism could be the same.

Therefore, to obtain more insight in processes of change it seems important to implement one type of (protocolized) treatment at the time. Furthermore, it is important to keep treatment characteristics in mind, and maybe add variables that are not related to type of treatment, like self-efficacy beliefs and the occurrence of spontaneous new behaviour (instead of practised new behaviour).

Data analysis
The data-analysis column shows that one study solely relied on visual inspection to interpret process data, and three studies used this as a main strategy. Although visual inspection might be helpful to detect trends and/or (un)expected (ir)regularities, it is questionable whether it allows a proper interpretation of the data pattern, for example, because of high variability or systematic improvement of performance during baseline (Kazdin, 2003). Therefore, it seems important to use formal tests of clinical and statistical significance. Additional statistical techniques differed between studies (see Table 1), indicating that there is no wide spread consensus on how to analyse process data as of yet, which might hamper comparison and interpretation of results from different studies. In this section
we will consider two statistical methods as potential steps after visual inspection; Hierarchical linear modelling and Dynamic systems modelling (cf. Laurenceau, Hayes & Feldman, 2007).

In an ANOVA-based analysis, individual differences are attributed to sampling or measurement error, with as a result a fixed-effects model that assumes that everyone in that group had the same treatment effect, whereas process research aims to provide meaning to these individual differences. The hierarchical linear model (HLM), also referred to as multilevel analysis (Bryk & Raudenbush, 1992; Gibbons, Hedeker, Elkin, Waternaux, Kraemer, Greenhouse et al., 1993; Snijders & Bosker, 1999), is a very flexible method for analysing repeated measurements within a subject. It can accommodate fixed effects (i.e., group effects) and random effects such as session-specific or subject-specific effects. This way, treatment efficacy can be established on group level and individual differences can be studied as well. Furthermore, HLM can handle missing data quite well (which is often highly problematic for more conventional statistical methods) and it takes into account independence between measurements (within the subject). The linear piecewise growth model (see Wilson, 2002) is a subtype of the hierarchical linear model (Bryk & Raudenbush, 1992). First, a regression model is fitted to each participant’s repeated measures data (capturing intra-individual change). Subsequently, average parameters of change and the amount of individual variability around these average parameters is estimated (capturing inter-individual variability in intra-individual change) (Laurenceau et al., 2007). This technique is a more sophisticated way to answer process oriented research questions regarding shape of change and mediators of change than statistical mediation analysis, since it considers multiple levels of analysis and enables to establish a temporal relation which requires simultaneous and repeated assessment (see Nock (2007) for a review of strategies to evaluate mechanisms of change). An important limitation of HLM and growth curve modelling is the assumption of unbounded increases or decreases in an outcome over long periods of time (increases or decreases to infinity), since symptom patterns might be more dynamic, e.g., oscillations around an equilibrium, or sudden shifts.

Dynamic systems modelling represents an alternative approach to modelling these types of non-linear and discontinuous trajectories. Dynamic systems theory (e.g., Thelen & Smith, 1994) stresses the relevance of variability which is considered to bear important information about the nature of developmental processes. During a transition, variability is large and the system (i.e., the individual) is free to explore new and more adaptive behaviour (Thelen & Smith, 1994). Van Geert and Van Dijk (2002) presented several new methods to visualize and describe intra-individual variability in individual time-serial data of repeated observations, among which the moving min-max graph. This graph enables the investigation of both the developmental trend and variability around a general trend and consists of three lines; the moving average, the moving minimum and the moving maximum (for instance, it picks the maximum value of observations 1 to 5, then of observa-
Conclusions and future directions

In this paper we focused on the merits of process research in bridging the gap between treatment practice and theoretical models. It has been argued that in order to understand treatment efficacy, it is crucial to understand how individuals change over time. Based on a theory which characterizes these changes, processes of change can be studied. In the case of OCD, cognitive-behavioural models postulate that, when a patient is improving, beliefs should be held with decreasing conviction, implying the loss of their influence during treatment. Important first steps regarding the study of processes of change in the treatment of OCD have been made. Decreases in dysfunctional beliefs were found to be related to successful treatment outcome in three studies which involved OCD and cognitive change (i.e., Rheame & Ladouceur, 2000; Williams et al., 2002; Storchheim & O’Mahony, 2006). These results are in line with the conclusions of Emmelkamp et al.’s (2000) and Bouvard’s (2000) reviews on cognitive change in treatment outcome studies. Changes in beliefs were found to occur mostly in tandem with behaviour changes. However, since relationships also seemed to be bi-directional, the actual evidence of the role of cognitive change as a necessary and/or sufficient factor in successful treatment has yet to be provided. Storchheim and O’Mahony (2006) suggested that the degree to which cognitive and behavioural changes occur concurrently may co-vary with the overall strength of response of a given patient. However, since distinct patterns were observable for all patients in Rhéaume and Ladouceur’s (2000) study, in terms of number of beliefs involved as well as the various links be-
tween these beliefs and symptom changes, the process of change may also be highly idiosyncratic. In order to investigate processes of change that are not directly related to type of treatment, it seems important to make a distinction between practised new behaviour (conducted in homework assignments) and ‘spontaneous’ new behaviour.

Cognitive changes characterized both the process of change of ERP as well as CT. However, research showed that a CT and an ERP rationale elicit differential anxiety responses during an experimental exposure session (Fisher & Wells, 2005) indicating that the process of change of ERP and CT might not be the same. Possibly, ERP first requires an increase in anxiety before cognitive change can take place. Exposure to OCD stimuli activates fear networks, which, according to Foa and Kozak (1986) is necessary to modify the fear network. If cognitive change is a mediator in treatment outcome for OCD, the question remains what would be the most efficacious way to modify dysfunctional beliefs. Moreover, it is important to study moderator variables which specify when certain effects will hold. One moderator variable could be OC-symptom subtype. It is possible that certain OC-subtypes would benefit more from one type of treatment than the other (e.g., Wilson, 2002). For instance, pure obsessionals have found to be difficult to treat with ERP. For these patients cognitive treatment may be more efficacious to activate the mechanism of change. Considering the more phobic like qualities of patients with mainly washing rituals, this group might benefit more from exposure treatments than from pure cognitive methods. Moderator variables can be tested using multi-level analysis as well, and can also be tested with a repeated measures analysis in the interaction effect.

For any of these questions to be answered properly more process research is warranted. Small scale studies, preferably within a certain OCD subtype, can provide further insight into the idiosyncratic processes of change. Moreover, processes should also be studied within larger samples, since comorbidity and other between-patient variation would be of less influence on the results on group level, and generalizability of the findings would increase. Larger samples are also needed to enable comparison of processes of change across different treatments.

A crucial factor in future process studies investigating the cognitive-behavioural model of OCD is the operationalization of beliefs. Operationalization concerns both content (e.g., inflated responsibility, perfectionism, overestimation of threat, intolerance of uncertainty) and form (different ‘layers’ of beliefs). Dysfunctional beliefs seem to be the best option since they are subject to change over the entire treatment period. Given the rapidly accumulating evidence supporting the importance to differentiate between implicit and explicit beliefs (e.g., De Houwer, 2002; Huijding, 2006, Teachman et al., 2006) it seems worthwhile to complement traditional self-report measures with implicit measures such as the IAT (Greenwald et al., 1998).

Since OCD is a very heterogeneous disorder, we would recommend studying a specific subtype, especially in small scale studies. Different criteria for subtyp-
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...have been suggested such as age of onset, comorbidity and symptom contents (McKay, Abramowitz, Calamari, Kyrios, Radomsky, Sookman et al., 2004). Another criterion for subtyping could be the importance of dysfunctional beliefs. Recently, two studies in large OCD patient samples showed that approximately half of the samples scored comparable to normal controls on OC-beliefs (Calamari, Cohen, Rector, Szacun-Shimizu, Riemann & Norberg, 2006; Taylor, Abramowitz, McKay, Calamari, Sookman, Kyrios et al., 2006). Studying processes of change in different subtypes might provide answers to the question to which extent and on what features these subtypes differ. Furthermore, it might be helpful to investigate one type of treatment at the time, since the specific process of change might not be the same for every treatment (cf. Fisher & Wells, 2005). Finally, the importance of the application of formal tests (besides visual inspection) in data-analysis should be emphasized, to provide a more solid basis for evaluating the role of dysfunctional beliefs in OCD. HLM and more specifically growth curve modelling enables researchers to study change both on group and individual level, and might be considered the current statistical state of the art in assessing change and mediators of change. Applying dynamic systems modelling is relatively new in clinical research, but seems a promising technique to provide meaning to individual trajectories of change and inter-personal differences (cf. Laurenceau et al., 2007).

To conclude, knowledge of factors contributing to an effective treatment and of the actual change processes is important for the scientific underpinning of treatment. In addition, more insight into how and why treatment works can provide clinicians with more useful information regarding how and when to conduct certain interventions than traditional outcome research. Even though process research is still in its infancy and methodological differences hamper comparison, the available studies do show their additional value in answering the questions of why and how treatment works. The increased attention for process studies besides the common treatment outcome studies, combined with the availability of promising modern techniques for data-analyses hopefully stimulates further process research in order to contribute to bridging the gap between clinical practice (i.e., the treatment procedures) and theories of symptomatology (e.g., the cognitive-behavioural model).