**Title**:

Assisting relapse prevention in OCD using a novel mobile app-based intervention: A case report.

**Running Title:**

Relapse prevention in OCD using a novel mobile app.

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**Abstract**

Mobile health-apps increase the accessibility of Cognitive Behavioral-based interventions before, during, or following treatment. GGOC is a mobile app to challenge maladaptive beliefs in Obsessive-Compulsive Disorder (OCD). This single-case study assesses the usefulness of GGOC as a relapse prevention tool for individuals with OCD. **Method**: The patient was a 26-years-old female, with severe contamination and washing/cleaning OCD symptoms (Y-BOCS=33) and co-morbid Major Depression. GGOC was used for relapse prevention (daily/2weeks) following 32 weekly/sessions of individual CBT. Patient completed 47 levels dedicated to OCD-relevant maladaptive beliefs. Before and after GGOC, the Obsessive-Compulsive Inventory (OCI-R), Obsessive Beliefs Questionnaire (OBQ-20) and DASS-20 Depression were completed. **Results:** The OBQ-20 and OCI-R scores decreased from pre- to post-GGOC. The Y-BOCS score decreased from 7 to 2 before and after GGOC, respectively. **Conclusions:** Findings support the efficacy of GGOC as a relapse prevention tool for individuals with OCD and contributes to maintain the gains after CBT.

**Keywords:** obsessive-compulsive disorder; cognitive behavioral therapy; maladaptive beliefs; mobile health apps.

1. **Background**

 Obsessive-Compulsive Disorder (OCD) is an incapacitating disorder that causes impairment in multiple areas of patients’ lives (Bobes, González, Bascarán, Arango, Sáiz, & Bousoño, 2001; Doron, Derby, Szepsenwol, Nahaloni, & Moulding, 2016; Huppert, Simpson, Nissenson, Liebowitz, & Foa, 2009; Schwartzman, Boisseau, Sibrava, Mancebo, Eisen, & Rasmussen, 2017). Cognitive Behavioral Therapy (CBT), including exposure with response prevention, is the first-choice treatment for OCD (NICE, 2005), with comparable or even greater efficacy than selective serotonin reuptake inhibitors (SSRIs) (i.e., Romanelli, Wu, Gamba, Motjabai, & Segal, 2014).

According to current CBT models of OCD, individuals’ maladaptive interpretations of their unwanted and disturbing intrusive thoughts, images or impulses, can lead to clinical obsessions and then to counterproductive strategies to keep them under control. Thus, those interpretations, which have been operationalized as beliefs about the importance of thoughts and their control, perfectionism, intolerance to uncertainty, overestimation of threat, and inflated personal responsibility (OCCWG, 1997, 2005; Rachman, 1997; Salkovskis, 1985), play a key role in the escalation from normal but unwanted intrusive cognitions to obsessions and compulsions.

CBT interventions try to challenge OCD-related beliefs and associated misappraisals using psychoeducation, cognitive restructuring, exposure and response Prevention (ERP), behavioral experiments, cognitive bias modification (CBM; Abramowitz, 2006; Teachman, Beadel, & Steinman, 2014), and metacognitive training (MCT; Hauschildt, Schröder, & Moritz, 2016; Moritz, Stepulovs, Schröder, Hottenrott, Meyer, & Hauschildt, 2016). Through these interventions, the therapist tries to increase patients’ access to alternative explanations for their intrusive disturbing cognitions, thus helping them to re-evaluate their maladaptive interpretations and beliefs and reduce compulsive behaviors. Therefore, the shift from behavioral explanations to a more cognitive-based theory of OCD has changed the emphasis “from behavioral maintaining factors to a focus on the person’s beliefs and the associated appraisals of perceived threat” (Rachman, 2002, p. 626).

However, CBT has some limitations. For instance, the maintenance of gains achieved during CBT is limited (Cabedo, Carrió, & Belloch, 2018; Foa, 2010). Relapse rates of up to 50% have been reported, especially when recovery is unclear (Eisen et al., 2013). Hence, it is especially important to devote specific sessions to relapse prevention and, if possible, planned follow-up sessions that help patients to maintain and increase the gains obtained during the treatment. Nonetheless, many patients have difficulties accessing CBT treatments and/or follow-ups, due to lack of trained professionals, difficulties in accessing adequate mental health resources, economic problems, or even fear to the stigma (Belloch et al., 2009; Del Valle, Belloch, & Carrió, 2017; Shafran et al., 2009).

Mobile health (mHealth) platforms have unique advantages that may assist in overcoming some of these limitations (Price et al., 2014). For instance, the low cost, ease of use via personal devices, constant availability, and wide reach of these platforms may reduce stigma and increase the accessibility of CBT-based interventions before, during, or following treatment (Mahoney, Mackenzie, Williams, Smith, & Andrews, 2014; Price et al., 2014; Roncero, Belloch, & Doron, 2018; Wootton, Dear, Johnston, Terides, & Titov, 2013). Moreover, these alternative CBT delivery platforms are consistent with the stepped-care approach for OCD (NICE, 2005). Patients may begin with low intensity interventions and, if needed, gradually receive more intensive interventions (Tolin, Diefenbach, & Gilliam, 2011).

Nevertheless, most mHealth applications translate existing desktop treatments into mobile apps without exploiting the special capabilities of this platform. These formats often involve tasks requiring high internal motivation, a long attention span, and high persistence from users (e.g., free text inputs and reading long text). Easy to use applications requiring a relatively short attention span may help overcome the barriers to accessing effective treatments (Roncero et al., 2018).

Consistent with this proposal, a recent open trial found that a mobile application using short, daily training exercises was effective in reducing OCD-related beliefs and OCD symptoms (Roncero et al., 2018). In a further study, these authors designed a cross-over randomized control trial with university students. They found that using the GGOC app for 3 minutes a day on 15 consecutive days was associated with medium-large effect size reductions in OCD-related beliefs and symptoms. Moreover, these effects remained significant at the 15 days follow-up (Roncero, Belloch, & Doron, *submited)*.

 GGApp is a digital platform that provides a variety of applications designed to reduce maladaptive beliefs underlying several psychological symptoms and disorders, such as OCD, Body Dysmorphic Disorder, and Mood Disorders. Each app in this platform consists of around 45 levels targeting maladaptive beliefs associated with a specific set of symptoms. For instance, the app GGRO targets maladaptive beliefs associated with OCD symptoms (e.g., overestimation of threat, importance of thoughts, perfectionism) as well as relationship OCD (ROCD) symptoms (e.g., catastrophic beliefs about relationships; Doron, Derby & Szepsenwol, 2014). Users of these apps learn to respond to statements that challenge maladaptive beliefs by embracing them (i.e., pulling them down towards themselves) and discard statements consistent with their maladaptive beliefs by throwing them away from themselves (upwards).

 In this case study, we assessed the usefulness of GGOC as a relapse prevention tool for individuals presenting OCD symptoms. As mentioned above, GGOC is a GGApps mobile app specifically designed for people with OCD symptoms. GGOC addresses the aforementioned maladaptive beliefs common to most OCD symptom presentations, as well as memory distrust and fear of self (Radomsky, Gilchrist, & Dussault, 2006; Nedeljkovic, Moulding, Kyrios, & Doron, 2009). GGOC also includes levels of specific OCD symptom dimensions, such as fear of harm, contamination fears, ‘not just right’ feelings, and scrupulosity.

**II. Case conceptualization**

 Joan (a pseudo-name) is a 26-year-old Caucasian female who was admitted to a specialized OCD and related disorders outpatient psychology clinic of the University. She was referred by the psychiatric unit of the Hospital where she had been receiving pharmacotherapy for the past five years for treatment resistant OCD with contamination obsessions and washing/cleaning compulsions. Joan has higher university studies, but she had never worked in any job related to her studies. Occasionally, she worked in childcare, but at intake she was unemployed and not receiving a salary. She was living at her parents’ home and was an only child. For the past year, she had a boyfriend with whom she shared some weekends. Her mother had a Major Depressive Disorder that had partially remitted with pharmacotherapy. No other family mental health problems were found.

At intake, Joan showed a highly interfering level of washing and cleaning compulsions and avoidance behaviors that occupied between 3 and 5 hours each day. The compulsions were instigated by obsessions in the form of doubts *(“Am I clean enough?, Am I dirty? Is the towel clean? Is the shower contaminated? Is this -knife, dish, chair, glass, shirt, underwear…- dirty or contaminated?”*) and physical sensations of dirtiness *(“I feel like I’m dirty”*). These thoughts and sensations led her to look for "safe clean places” (e.g., specific sites at her home or at her boyfriend’s home) and avoid leaving home (due to contamination fears in using public transport, entering a shop, or at a restaurant, etc.). She also avoided any form of physical contact with her parents and boyfriend when she thought she was clean (*“If I feel clean, I avoid hugging and kissing my parents and my boyfriend”*). In order “*to feel safe and clean*”, she spent between 1 and 2 hours a day showering, and she used more than 1 liter of liquid soap. She also cleaned all her personal objects (mobile phone, credit cards, bag, clothes) every day. Although the patient recognized that her behaviors were excessive, her insight level was low. A high level of family (and boyfriend) accommodations for the patient’s OCD symptoms was also observed. The patient attributed the onset of her symptoms to the break-up with her former boyfriend, who psychologically abused her, after a four-year relationship.

In addition to the obsessive-compulsive symptoms, the patient presented comorbid Major Depression secondary to her OCD. She presented anhedonia and insomnia, she felt sad, empty, hopeless, and worthless, and she found it difficult to think or concentrate on anything. She had gained weight (more than 15 kg in the past year), which she attributed to bad eating habits. These “bad habits” were related to her avoidance behaviors because she refused to eat homemade meals due to her contamination fears, and only ate pre-cooked food. No suicidal ideation was observed. These symptoms had worsened in the preceding month because of the appearance of two panics attacks following an unsuccessful job interview.

 The patient had previously received psychological treatment for one year, but no symptom remission was observed. In spite of this, she was motivated to be engaged in a new psychological treatment, even though she would have to travel 400 kilometers every week to come to the assessment and treatment sessions at our outpatient service.

**III. Treatment**

1. Assessment at intake

 The patient was individually screened with a full history and examination by one of the authors (A.B). The assessment consisted of two individual sessions lasting 120–150 min each. Intake assessment consisted of a diagnostic interview using the Anxiety Disorders Interview Schedule for the DSM-IV: Lifetime version (ADIS-IV-L; Di Nardo, Brown, & Barlow, 1994). Information about basic demographic data (age, gender, occupation, educational level, socio-economic status), medical conditions, and current/past psychological or pharmacological treatment was also recorded. The therapist also completed the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS; Goodman et al., 1989a, 1989b) to assess OCD severity and response to treatment. At intake, the scores on the Y-BOCS were 16 and 17 for obsessions and compulsions, respectively (total score: 33), indicating severe OCD symptoms. The patient was informed about the purpose of the study and the assessment procedure and gave her explicit written consent to participate. In the second assessment session, the patient filled out a questionnaire packet containing OCD-specific self-reports and OCD symptom dimensions.

 b. Intervention

The treatment consisted of CBT for OCD, combined with the pharmacotherapy prescribed by the psychiatrist who referred the patient to our clinic. This treatment consisted of an SSRI (Escitalopram, 30 mg/day) and a non-SSRI antidepressant (Clomipramine, 25 mg/day). The CBT format was individual and lasted 8 months (32 sessions, one/week session). Combined with ERP, cognitive techniques were applied to challenge the patient’s misinterpretations about her obsessions. The maladaptive beliefs most endorsed by Joan about her obsessions were importance of thoughts and their control, overestimation of threat, intolerance to uncertainty, and perfectionism.

 Behavioral experiments were planned as at-home tasks between treatment sessions. The comorbid Major Depressive Disorder was also treated using behavioral activation. The treatment protocol for OCD was fully manualized following the guidelines by Belloch, Cabedo, and Carrió (2010). Regarding pharmacotherapy, the psychiatrist reduced the doses according to the patient’s improvement. At the end of CBT, only a low dose of Escitalopram was maintained (10 mg every 2 days).

 At the end of the cognitive and ERP sessions, the Y-BOCS score was 7 (3 and 4 for obsessions and compulsions, respectively), which indicates that Joan was recovered according to the Jacobson and Truax (1991) criteria (YBOCS ≤ 7 plus YBOCS pre- *versus* post-treatment decrease of at least 6 points). In light of this, the therapist recommended the use of GGOC for two consecutive weeks as a substitute for the usual two face-to-face sessions devoted to relapse prevention. The GGOC content and procedure are explained below. During this time, no interaction with the patient took place. Once the procedure had been explained, Joan agreed to participate and signed a specific informed consent.

 i. Relapse prevention with GGOC

For the relapse prevention component, Joan was asked to use GGOC for two weeks. GGOC was developed by one of the authors (GD), an expert in OCD and related disorders, in collaboration with GI, a mobile platform developer. This application consists of game-like interactions that are intended to help users increase their accessibility to self-statements that facilitate more adaptive appraisals of thoughts, emotions, and events associated with OCD. Users of GGOC are presented with ‘blocks’ featuring statements such as “I take things as they come” or “Everything can end in a catastrophe”. Users then have to respond to these statements by either embracing them (i.e., pulling the ‘blocks’ downwards towards themselves) or rejecting them (i.e., throwing the 'blocks' upwards away from themselves).

Joan progressively completed 47 levels dedicated to OCD-relevant maladaptive beliefs (3 levels per belief), such as dealing with threat, importance of thoughts, overcoming perfectionism, etc. In this way, she was exposed to alternative interpretations of the relevant maladaptive belief in each stage. For instance, statements challenging perfectionism included “Mistakes teach me to overcome my fears” and “Imperfect is human”. Joan was also encouraged to adopt approach behavioral strategies (rather than avoidance), including tolerance of negative emotions, by responding to statements such as “I can tolerate doubts”.

In GGOC, three levels address each specific maladaptive belief. Before dealing with a new belief, a screen is presented with the rationale for challenging the specific maladaptive belief. For example, before learning to challenge over-estimation of threat, Joan was presented with the following statement: “The world can be dangerous, but the tendency to look for danger all the time increases fears and anxieties. Let's learn to reduce this tendency!” Following the completion of six levels pertaining to two beliefs (e.g., importance of thoughts and overestimation of threat), users may see an encouraging statement such as: “Excellent! Now you’ve learned how to better deal with your thoughts and better recognize the way you overestimate threat”. Each level completed is also followed by a short memory quiz where the user has to identify one OCD-challenging statement that appeared in the last completed level. Push notifications remind users to use the app every day. Following the completion of three levels on a given day, a screen appears, prompting users to stop using the app for that day. Users are also advised to train once a day at a preset time rather than in response to distressing thoughts or events. Figure 1 shows a diagram of the complete treatment and assessment points.

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 c. Assessment pre- and post-relapse prevention sessions

 The patient completed the following self-report measures before and after using GGOC. These measures were completed online.

*-Obsessive-Compulsive Inventory* (OCI-R; Foa et al., 2002). Is a self-report questionnaire assessing distress produced by OCD symptoms. The OCI-R includes 18 items rated on a 5-point Likert scale from 0 (*not at all*) to 4 (*extremely*).

*-Short form of the Obsessive Beliefs Questionnaire* (OBQ-20; Moulding et al., 2011). This is an abbreviated version of the 44-item Obsessive Beliefs Questionnaire-Revised (OCCWG, 2005). The OBQ-20 is composed of 20 items rated on a 7-point scale ranging from 1 (*strongly* *disagree*) to 7 (*strongly* *agree*).

*-Short version of the Depression, Anxiety, Stress Scale* (DASS; Lovibond & Lovibond, 1995). This is a self-report questionnaire listing negative emotional symptoms (depression, anxiety, and stress). The short version consists of 21 items rated on a 4-point scale ranging from 0 (*did not apply to me at all*) to 3 (*applied to me very much, or most of the time*). In the present study, only the depression scale (7 items) was used.

 The therapist completed the Y-BOCS before and after the use of GGOC, and before the CBT in the initial assessment session.

 d. Outcomes following GGOC use.

 Figure 2 shows patient change in the scores on the OBQ-20 from pre- to post-relapse prevention using GGOC. As the figure reveals, OBQ total scores and all the specific subscales (responsibility/ threat estimation; perfectionism/certainty; importance/control of thoughts) showed a reduction. The OBQ subscale that showed the largest pre-post reduction was importance/control of thoughts, which was one of the belief domains most endorsed by the patient. The score on this subscale dropped 3.2 points. Moreover, after the two weeks using the GGOC, the Y-BOCS score decreased from 7 to 2 points (1 for obsessions and 1 for compulsions).

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 Figure 3 summarizes changes in symptoms (OCI-R) from baseline (pre-treatment), to pre-relapse prevention and post-relapse prevention using GGOC. As the figure shows, there was a reduction in both the cleaning/washing and neutralizing subscales, as well as the OCI-R total score, from pre- to post-relapse prevention. Finally, the score on the DASS depression subscale was similar at two time points (pre-relapse prevention: Raw Score: 8/21; post-relapse prevention: Raw Score: 8/21).

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 e. Qualitative report about GGOC by patient

 After using GGOC, the patient was asked for her opinion about the application. She said the app felt accessible, was easy to use, and required only short daily interactions. She found the App especially useful as a reminder of what she had learned in the therapy sessions: to not pay attention to her doubts about the cleanliness or dirtiness of the objects she sees and touches, to not try to suppress these doubts, and to challenge her beliefs about her thoughts/doubts. For example, she said: “*I remembered things we learned, such as that the world is not dangerous, or that uncertainty is part of life, or that I am not more vulnerable than others, or that having doubts is normal and even good”.* Furthermore, she joked by saying that the app was more pleasant than the usual daily records of obsessions and associated beliefs that her therapist asked about during CBT.

1. Conclusions

 Although Joan reached our center after unsuccessful treatments, she had an excellent response to CBT treatment. Her score on the Y-BOCS dropped from 33 (severe OCD) before treatment to 2 (non-OCD) after the relapse prevention intervention using the GGOC-app. Moreover, she maintained a low dose of pharmacotherapy, and so she can be considered recovered. The patient showed great treatment adherence, and this undoubtedly influenced the treatment result because she was also recovered after CBT and before using the GGOC-app. Nonetheless, as mentioned earlier, the patient had to travel more than 800 km. round-trip every week to receive treatment, which was highly time consuming and expensive because she did not receive any payment. Along with her recovered status, this was one of the reasons we proposed the use of the GGRO, instead of the two relapse prevention sessions included in our CBT protocol, as the last two active treatment sessions. Preventing relapse is one of the most important ingredients of any treatment, even when the patient has acquired an acceptable or good level of symptom remission, as in Joan’s case. As mentioned in the introduction section, the relapse of patients with OCD is high, even after successful CBT.

 Our data show that the use of GGOC for relapse prevention for two weeks decreased OCD symptoms related to the patient’s core fears, which were cleaning/washing and neutralizing (i.e., OCI-R symptoms), and was also helpful in maintaining and increasing the therapeutic gains after CBT. Moreover, the app was useful for changing specific-OCD dysfunctional beliefs the patient endorsed in relation to her obsessions, mainly importance of thoughts and their control. Depressive symptoms did not decrease after the GGOC. This was probably due to the low score after finishing CBT and prior to GGOC use because the patient had fully recovered from the major depressive symptoms she presented at intake. Currently, the patient is on a two-year follow-up and remains free of OCD and depressive symptoms.

 The data presented here are based on a single case study. Nonetheless, the results are consistent with previous findings using the same platform with University students (Roncero, et al., 2018; Roncero, et al., *submitted*). Increasing awareness of negative self-talk and accessibility to alternative interpretations by actively pulling or pushing statements that are in/consistent with maladaptive beliefs may help to reduce these beliefs. Using this mechanism, the app seems to have further solidified Joan’s benefits from CBT therapy. This may be particularly relevant to individuals with OCD who do not have financial resources or live in remote areas where access to a CBT therapist for the relapse prevention session is limited. Moreover, using GGOC to reduce levels of maladaptive beliefs in at-risk populations may increase resiliency to OCD and related disorders.

This application is a tool that is easy-to-use, pleasant for patients, and available any time without interfering with their daily lives. The data suggest that it is useful for empowering patients as active agents in managing their own mental health. The difficulty in accessing specialized and cost-effective treatments is one of the main barriers for mental-health sufferers. Improving and facilitating this access is one of the most important endeavors for professionals, and a tool such as the GGOC app presented here could help to this. GGOC could also be useful as a reminder tool between CBT sessions. In any case, further studies should confirm the results found here in larger patient samples and in other symptom dimensions or OCD subtypes.

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**Conflict of interest**

The third author (GD) is a co-developer of GGOC. GD is also a co-founder of GGapps.net. GGOC is the subject of this evaluation and therefore has financial interest to GGapps.net.

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**Figure 1.** *Diagram of the complete treatment and assessment points.*

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*Note:* The first measurement point (T0: pre-treatment/baseline) refers to pre-CBT. The two next points are pre-relapse prevention (T1. Pre-GGOC) and post-relapse prevention using GGOC (T2. Post-GGOC).

**Figure 2**. *Changes in obsessive beliefs (OBQ-20) between pre-relapse prevention, and post-relapse prevention using GGOC.*

OBQ-20 = Short form of the Obsessive Beliefs Questionnaire-20*.*

**Figure 3.** *Changes in OCD symptoms (OCI-R) from baseline (pre-treatment) to pre-relapse prevention and post-relapse prevention using GGOC.*

OCI-R = Obsessive Compulsive Inventory-Revised.