Abstract

Background and objectives: Safety behaviors, defined as engagement in avoidance within safe environments, are a key symptom of obsessive-compulsive and related disorders. They may interfere with daily functioning and as such their emission should be reduced. The purpose of the current study is to investigate the effects of the non-contingent presentation of safety signals (cues produced by safety behaviors) on reducing safety behaviors in participants self-reporting low and high OCD profiles. **Methods**: In total, 32 participants were asked to play a game to gain points and avoid their loss. After having developed avoidance behavior, evidenced by maintaining all of their earned points, they were exposed to safe environments where no point loss was programmed. In Test 1, safety cues (blue bar) were produced contingent on performing safety behaviors. In Test 2, safety cues were presented continuously without any response requirement. **Results**: Findings demonstrated that high OCD group displayed higher rates of safety behaviors than low OCD group. However, exposure to the non-contingent presentation of safety signals eliminated their emission in both groups. **Limitations**: Future studies need to evaluate the effects of different non-contingent schedules on the suppression of safety behaviors. **Conclusions**: These findings contribute to the literature by demonstrating that non-contingent introduction of safety signals eliminated safety behaviors completely, even in high OCD participants, who performed safety behavior at higher rates. Such a treatment protocol may ameliorate exposure therapy in which response prevention constitutes a key element and is generally associated with increased drop-out rates.

Keywords: non-contingent presentation; safety signals; safety behaviors; exposure therapy; obsessive-compulsive disorders

The effects of the non-contingent presentation of safety signals on the elimination of safety behaviors: An experimental comparison between individuals with low and high obsessive-compulsive profiles

Avoidance is defined as behavior that prevents the onset of an aversive or unfavorable outcome, whereas escape removes the presence of a threatening stimulus or event (Dinsmoor, 1954, 1977). Avoidance and escape can be either overt (e.g., running away or removing a painful stimulus) or covert (e.g., creating pleasant mental pictures). By default, engagement in these behaviors reduces or eliminates the fear or distress that a person feels, thus strengthening response emission. When avoidance or escape occurs frequently in environments that are free from sources of aversive stimulation (i.e., "safe" environments), these responses are referred to as safety behaviors (e.g., Salkovskis, 1991, 1996). Safety behaviors initially elicit pleasant emotions, such as a sense of security; however, in the long-term, they may serve to prevent the individual from engaging in other productive activities. For example, the time expended repeatedly cleaning a surface or checking to ensure a door has been locked may prevent the person from engaging in social or recreational activities. Safety behaviors constitute a key element of a number of psychological conditions, including obsessive-compulsive disorder (OCD; American Psychiatric Association [APA], 2013).

OCD is a serious mental health condition that is characterized by repetitive overt and covert behaviors that cause distress, apprehension, or interfere with a person's everyday functioning (APA, 2013; Veale & Roberts, 2014). These overt or covert acts can be obsessions (e.g., intrusive recurrent thoughts), compulsions (e.g., uncontrollable urge to behave in a certain way), or both. Obsessions usually serve to provide a source of aversive stimulation, especially in situations where danger does not explicitly exist. For example, obsessions might include excessive focus on moral or religious ideas or cleanliness. Compulsions, on the other hand, are behaviors that reduce the anxiety produced by

obsessions, and might include ordering, counting, checking and cleaning (APA, 2013; Stasik, Naragon-Gainey, Chmielewski, & Watson, 2012). Compulsions may function as avoidance behaviors that reduce threat or safety behaviors that elicit a sense of security (Rachman, Radomsky, & Shafran, 2008). However, the motivation for performing these behaviors may differ across situations and/or individuals. This differentiation is important, as performing compulsions to avoid a perceived unwanted outcome may render their emission more resilient than performing them to achieve a goal (e.g., Meudlers, van Daele, Volders, & Vlaeyen, 2016).

OCD affects a substantial proportion of the population and epidemiological studies suggest its lifetime prevalence to vary between 1.5% and 3.5% (Angst et al., 2004; Crino, Slade, & Andrews, 2005; Subramaniam Soh, Vaingankar, Picco, & Chong, 2012). Further, as many as 28.2% of the general population have reported OCD symptoms at least once in their lifetimes (Ruscio, Stein, Chiu, & Kessler, 2010). One of the most well-researched treatments for OCD is exposure and response prevention (ERP), which has produced durable effects across a wide range of OCD symptoms (Olatunji, Davis, Powers, & Smits, 2013; Öst, Havnen, Hansen, & Kvale, 2015; Rosa-Alcázar, Sánchez-Meca, Gómez-Conesa, & Marín-Martínez, 2008). In ERP, the sufferer is exposed to situations that elicit anxiety and evoke obsessive thoughts, but is prevented from engaging in compulsions (e.g., Rachman et al., 1979). Repeated exposure to these situations reduces anxiety because the aversive event does not occur (i.e., extinction learning) or because new associations are developed by pairing the feared stimulus with a harmless one (Bouton, 1993; Craske, Treanor, Conway, Zbozinek, & Vervliet, 2014).

Although exposure treatments have been proven successful in treating anxiety and obsessive-compulsive disorders (e.g., Deacon & Abramowitz, 2004), these treatments are not without their limitations. For example, response prevention, which has been proposed as the

key element in treating OCD-related conditions (Abramowitz, 1996), is generally associated with greater refusal (Kozak, 1999) and drop-out rates (Foa et al., 2005). A recent meta-analysis found that the dropout rate for ERP in OCD patients is lower (14.7%) than has been reported in previous studies (25%; Abramowitz, Taylor, & McKay, 2009). This rate is comparable to attrition estimates for other conditions, such as depression, and for other treatments, including cognitive therapy (Ong, Clyde, Bluett, Levin, & Twohig, 2016). Although these rates are lower than previously estimated, they still indicate that as many as one sixth of those who suffer from OCD and seek treatment will remain untreated.

To improve treatment acceptability and reduce drop-out rates, a growing body of research has examined the judicious use of safety behaviors, defined as their prudent use at early treatment stages (see Rachman et al., 2008). For example, Rachman, Shafran, Radomsky, & Zysk (2011) found that the combination of exposure to contaminants (rubbing the bottom of one's shoe) and the use of safety behaviors (the use of a wipe) significantly reduced fear of contamination in a student population reporting contamination fears. These results were slightly superior to the ones produced by those who were exposed to contaminants, but did not engaged in safety behaviors. However, those who engaged in safety behavior were more likely to report transient return of mild fear, suggesting that treatments that employ safety behaviors may need further refinement.

Milosevic & Radomsky (2013a) examined the efficacy of a cognitive rationale with the use of safety behaviors on reductions of fear of spiders. Participants were instructed to approach spiders with the primary aim of disconfirming their negative beliefs about them. Results showed that those who were offered safety items (e.g., gloves and jackets) approached the spider more closely than those who did not. However, participants from both groups demonstrated comparable declines in their negative beliefs regarding spiders. These results are consistent with findings suggesting that engagement in safety behaviors does not

necessarily preclude extinction of the feared stimulus, evidenced by initial greater reductions in fear and greater proximity of the feared stimulus (Hood, Antony, Koerner, & Monson, 2010; Milosevic & Radomsky, 2008; Sy, Dixon, Lickel, Nelson, & Deacon, 2011; van de Hout, Engelhard, Toffolo, & Uijen, 2011). Thus, their use has been associated with enhanced treatment acceptability (Levy & Radomsky, 2014). However, the extensive use of safety behaviors may not be beneficial and fears may eventually return when the person stops performing them (Lovibond, 2000; Powers, Smits, & Telch, 2004; Volders, Meulders, de Peuter, Vervliet, Vlaeyen, 2012). Therefore, more research is needed to further understand the nature of safety behaviors and refine their use in exposure treatment protocols (e.g., Thwaites & Freeston, 2005).

It is well established that safety behaviors are maintained not only via the elimination of perceived threats, but also through the production of either external or internal cues which have been correlated with the absence of feared stimuli (Lohr, Olatunji, & Sawchuk, 2007). These cues are commonly referred to as safety signals (Angelakis & Austin, 2015a, 2015b; Engelhard et al., 2015; for a review on animal literature see Dinsmoor, 2001). It has been proposed that safety signals function as inhibitory conditioned cues that prevent extinction of the feared stimulus, because they predict the absence of the primary aversive events and thus retain the emission of the behaviors that produce them (e.g., Soltysik, Wolfe, Nicholas, Wilson, & Garcia-Sanchez, 1983). The reinforcing effects of safety signals may explain why OCD patients have an elevated fear of contamination in the absence of physical contact with pollutants, or that they may not feel clean even after repeatedly washing (Rachman, 2004). In everyday life, a range of external stimuli may come to function as safety signals, including sounds, odors, material items (e.g., a cross or a “lucky” shirt), or even human figures (e.g., a trusted companion). Internal stimuli, such autonomic responses, also may acquire capacity to function as safety signals. It is possible that the introduction of these signals independent of

the emission of safety behavior (i.e., non-contingent presentation) may serve as a method of judicious use of safety behavior in exposure therapy.

Non-contingent or response independent presentation of events (Rescorla & Skucy, 1969) is a widely used method for treating aberrant behavior in individuals with (Hanley, Piazza, & Fisher, 1997) and without (e.g., Austin & Soeda, 2008) developmental disorders. In non-contingent preparations, highly preferred stimuli (e.g., attention) are delivered on fixed (Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993), variable (Sprague, Holland, & Thomas, 1997), or continuous (Hanley et al., 1997) time schedules independent of the organism's behavior. Continuous or frequent presentations of these events serve to abolish the deprivation associated with them, such that the behaviors typically used to produce those events become less frequent or cease completely (Lalli, Casey, & Kates, 1997; Vollmer et al., 1993). Similar preparations and outcomes have been observed in psychopharmacology. For example, Markou, Arroyo, & Everitt (1999) demonstrated that the non-contingent cocaine administrations of a dose equal to or higher to the one administered in baseline sessions produced satiation effects in a rat-analogue example, evidenced by lack of engagement in cocaine-seeking behavior. Those animals who received cocaine contingent on emission of required responses, including those who received non-contingent doses lower to those administered in baseline, showed an increased cocaine-seeking behavior. These findings demonstrate the potential effects of the non-contingent presentations of reinforcing events on reducing the emissions of behaviors that produce them.

A similar treatment protocol designed to reduce or eliminate the engagement in safety behaviors in those with compulsive or related behaviors has yet to be examined. It is possible that a treatment based on the non-contingent presentation of stimuli associated with safety may facilitate the abandonment of safety behaviors, and further improve the acceptability of exposure treatments. The present study examined (1) the extent to which the production of

external safety signals maintained engagement in safety behaviors in danger-free environments, and (2) whether non-contingent presentation of safety signals suppressed safety behavior in participants self-reporting low and high OCD profiles. In view of the results of similar studies, we hypothesized that participants with high OCD profiles would engage in safety behavior at higher rates than low OCD participants, but the non-contingent presentation of safety signals would effectively eliminate or reduce safety-seeking behaviors in both groups.

Method

Participants

Participants were recruited using an opportunity and volunteer sample. Participants were recruited via an advert in a university-based psychology student magazine, adverts posted around the university, and online through the use of social media (e.g., Facebook). Those interested in participating were asked to complete an online version of the Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002), which served as the initial screening survey. Potential participants had to meet four inclusion criteria: (1) Score half a standard deviation or more above the mean (for the high OCD group) or below (for the low OCD group) of the study's measures (described below) (2) Be over 18 years old, (3) Have no self-reported color blindness or physical impairments and (4) Be fluent in English. Those who did not fulfil the first criterion (n = 6) were offered the choice to participate in similar projects, but excluded for participation from this study. These participants did not differ from the main pool of participants in terms of demographics. In total, 17 individuals took part in the study (M_{age} = 26.19, *S.D.* = 4.95; 53.1% Females). The vast majority of those resided within the United Kingdom (78.13%) and were British citizens (68.75%). The participant sample included 14 students and 18 non-students (see Table 1).

Measures

Obsessive-Compulsive Inventory-Revised (OCI-R). It is an 18-item self-report scale that assesses distress related to six OCD categories, including checking, washing, obsessing, hoarding, ordering and neutralizing (Foa et al., 2002). It instructs individuals to rate the amount of distress a particular symptom has caused in the past month using a 5-point Likert scale, ranging from *0* = Not at all to *4* = Extremely. Its psychometric properties are established as very good or excellent (e.g., Angelakis, Panagioti, & Austin, 2017). The mean for the non-clinical population was reported as 18.82 (*S.D.* = 11.10) by the original study. In the current study, the Cronbach's alpha was $\alpha = 0.92$

Dimensional Obsessive-Compulsive Scale (DOCS). It is a 20 item self-report scale that measures the severity of four OCD symptom dimensions, including unacceptable thoughts, contamination, symmetry/ordering, responsibility for harm and mistakes (Abramowitz et al., 2010). Several studies have established the DOCS as a reliable measure of OCD symptoms (Viar, Bilsky, Armstrong, & Olatunji, 2011; Wheaton, Abramowitz, Berman, Riemann, & Hale, 2010). The mean for non-clinical samples was reported as 10.57 (*S.D.* = 9.83) by the original study. In the current study, the Cronbach's alpha was $\alpha = 0.80$.

Becks Depression Inventory-II (BDI-II). It consists of 21 items designed to measure the existence and the severity of depressive symptoms (Beck, Steer, & Brown, 1996). Each item has a 4-point scale. A score over 18 suggests moderate to severe symptoms of depression. Its psychometric properties have been reported as very good or excellent (Cook, Orvaschel, Simco, Hersen, & Joiner, 2004; Sacco et al., 2016). The mean for non-clinical samples has been reported to be 11.03 (*S.D.* = 8.17; Storch, Roberti, & Roth, 2004). In the current sample, the Cronbach's alpha was $\alpha = 0.84$.

Setting and Apparatus

Sessions were conducted in 230cm by 185cm rooms featuring a desk measuring 60cm by 60cm, a chair, and a laptop. An HP laptop with an external mouse was placed on a desk with an external Infinity® USB foot pedal placed under the desk. The positioning of the mouse and foot pedal was adjusted by the participant in accordance with individual preference (e.g., left-handed vs right-handed participants). White noise was played through the laptops' speakers to mask external noises that might distract participants. Experimental protocols and data collection were implemented using the Microsoft Visual Basic® 2008 Express Edition software. The computer game used in this study was adapted by Angelakis and Austin (2015a, 2015b).

Procedure

Pre-experimental assessment. Before the experiment, potential participants completed the OCI-R, DOCS and BDI-II scales. They were then classified as low or high OCD participants based on their scores (see above for cut-off scores). Descriptive information on either group is presented in Table 1.

Baseline. Participants were invited to play a computer game in which they could search for hidden treasures by clicking on a map of Europe (adapted from Angelakis & Austin, 2015a). Instructions on the screen indicated that the game's main objective was to earn points by uncovering as many treasures as possible and to avoid bombs (which resulted in loss of treasures). Participants were instructed that clicking on the map would uncover both treasures and bombs. Uncovering a treasure added one point to the counter and uncovering bombs resulted in a loss of one point. The number of points earned and lost was displayed on a counter at the top of the screen. Participants were further instructed that pressing the foot pedal would allow them to avoid bombs. Depressing the foot pedal changed a red bar on the right side of the computer screen to blue for 9 s, which resulted in a safe

period, wherein no bombs would be delivered for 20 s. Participants were not instructed about the meanings of the colored bars or the length of the safety period, only that depressing the foot pedal would allow them to avoid bombs. They were free to press the pedal as frequently and as quickly they liked. Following the first click in the session, treasures were delivered on a variable schedule (VR)-60 (range: 10 to 110 clicks), while bombs were delivered on a variable interval (VI)-20 s schedule (range: 1 to 40 sec). These schedules were reset after a treasure or bomb was delivered. The purpose of the baseline condition was to establish avoidance of bombs, as well as establishing the red bar as a warning signal for potential bombs and the blue bar as a safety signal. Each participant completed three 30-min baseline sessions before proceeding to test conditions. Prior to the first baseline session, each participant completed an up to 10-min training session to ensure they knew how to play the game.

Contingent safety signals (Test 1). During Test 1, the delivery of treasures was activated using identical schedules as in baseline. The red bar (threat of point loss) as well as the bombs were removed. The removal of the red bar was an advantage as it accentuated the absence of point loss. At the start of the condition, the blue bar appeared on the screen for 9 s before disappearing. This was designed to inform participants that the blue bar was still accessible. This condition lasted 20 min.

Non-contingent safety signals (Test 2). During Test 2, point delivery was activated using identical schedules as in baseline. As in Test 1, both the red bar and the bombs were removed. However, the blue bar remained on screen throughout the entire session (e.g., non-contingent presentation). This condition lasted 20 min.

Experimental design. A withdrawal design with two test conditions was utilized. Test condition order was counterbalanced across participants to control for potential sequence effects. Half of the participants were exposed randomly to Test 1-Test 2 and then to Test 2-

Test 1, while the other half was exposed randomly to Test 2-Test 1 followed by Test 1-Test 2. Prior to entering the first test condition of a session, participants completed a 10-min warm up, which was identical to baseline. In total, participants completed three 30-min baseline sessions and two 40-min exposures to Tests 1 and 2.

Response measure. The primary dependent variable was the frequency of pedal presses. Participants also were asked to report (1) whether they noticed the differences between the baseline and test conditions (e.g., the absence of the red bar in Test 1, or the continuous presentation of the blue bar in Test 2), and (2) whether they felt *anxious* or *safe* in the presence or absence of the blue bar (i.e., safety signal).

Statistical Analyses. Analyses were conducted using IBM SPSS® (version 23.0) statistical package. Data were analyzed based on the mean frequency of pedal presses across each experimental condition (i.e., three baseline sessions, two Test 1 sessions, and two Test 2 sessions). The distribution of pedal presses was found to be normal in baseline and both in Test 1 and Test 2 conditions. Tests of normality also revealed no deviation from normal distribution for the study's main measures, but for the BDI-II. Independent *t*-tests or Mann-Whitney tests were performed to examine differences between the low and high OCD groups on the study's main measures (Table 1) and to further detect differences of pedal presses across baseline and test conditions. The effects of the contingent and non-contingent presentation of the safety signals (i.e., blue bar) on pedal pressing between low and high OCD participants were examined by conducting a 2 (group) x 2 (condition) mixed ANOVA. All tests were two-tailed and the significance level was set at $p < 0.05$.

Results

Descriptive Statistics

Clinical and demographic characteristics for the low and high OCD groups are summarized in Table 1. These participants differed significantly on the measures of OCD

and depression. Overall, the aggregated mean scores for the OCI-R at Time 1 (M = 24.16, SD = 16.10) and Time 2 (M = 24.00, SD = 15.66), as well as for DOCS (M = 12.19, SD = 6.07) and BDI-II (M = 12.53, SD = 4.26) closely resembled those produced by similar studies utilizing non-clinical participants (e.g., Tolin, Woods, & Abramowitz, 2006). With regards to the demographic information, no significant differences were observed between the two groups except occupation. In particular, the unemployment rate was much higher for the high OCD (53%) than the low OCD group (5.9%), $x^2(2) = 11.10$, $p = 0.01$.

Main Analyses

The results from the mixed ANOVA revealed a main effect of the contingent and non-contingent safety signal exposure on pedal pressing, F (1, 30) = 5565.66, $p < 0.001$, η^2 = 0.98. This means that participants engaged in pedal pressing more reliably in conditions where it produced safety signals (i.e., blue bars) than in those where safety signals were offered non-contingently. We also found a main group effect between low and high OCD participants on pedal pressing, F (1, 30) = 173.32, $p < 0.001$, $\eta^2 = 0.88$. This means that low OCD participants engaged in less pedal presses across conditions compared to high OCD participants. Last, we detected an interaction effect between low and high OCD groups on pedal pressing across contingent (Test 1) and non-contingent (Test 2) presentations of safety signals, F (1, 30) = 172.15, $p < 0.001$ $\eta^2 = 0.90$, as shown in Figure 1. This indicates that pedal presses across the different phases were dependent on OCD scores.

Table 2 presents the means and standard deviations of pedal pressing between the low and high OCD participants across baseline and test conditions. Independent t-tests revealed significant differences at baseline in pedal pressing (i.e., avoidance) between low (M = 196.43, SE = 2.83) and high OCD participants (M = 213.33, SE = 4.34), $t(30) = -3.34$, $p<0.01$, d= 1.17. On average, high OCD participants in Test 1 engaged in pedal pressing (i.e., safety behavior) more reliably (M = 139.03, SE = 2.70) than those with low OCD levels

(M = 98.06, SE = 1.70), $t(30) = -13.18$, $p<0.001$, $d = 4.61$. However, pedal pressing did not differ between high and low OCD participants in Test 2, $t(30) = -1.09$, $p = 0.29$, $d = 0.38$.

Qualitative responses to the manipulations of the test conditions

All of the participants reported that they noticed the changes between the baseline and test conditions. The vast majority of the participants (68.75%) stated that the presence of the blue bar made them happy, whereas only 31.25% declared that they remained neutral. With regards to their exposure to Test 1, they declared that, even if the red bar was absent, the appearance of the blue bar made them feel *safe* or *secure*. During their exposure to Test 2, they all declared that there was no need to press the pedal, since the bar provided them with a sense of security that no bombs would appear. The majority of the participants (65.63%) also reported that they had even forgotten about the presence of the bar and were more focused on gaining treasures.

Discussion

Consistent with our initial hypotheses, results confirmed that the non-contingent presentation of safety signals suppressed the emission of safety behavior in participants with both high and low OCD profiles. Further, in conditions where safety signals were produced contingent on engaging in safety behaviors, those with high OCD profiles performed those behaviors at higher rates than those with lower OCD profiles. These findings are important for three main reasons. First, they confirmed that access to safety maintains safety behaviors (e.g., Rachman, 1984; Woody & Rachman, 1994); second, they detected differences pertaining to the rates of safety behaviors between high and low OCD groups; and third, they verified the suppressive effects of non-contingent presentation of safety signals on safety behavior.

The maintenance of safety behaviors by the production of safety cues had been reliably demonstrated in animal studies (Dinsmoor & Sears, 1973; Fernando, Urcelay, Mar,

Dickinson, & Robbins, 2014; Rescorla, 1969). However, only recently have studies expanded this line of research to human participants (Angelakis & Austin, 2015a, 2015b; Engelhard et al., 2015). These studies supported the notion that safety behaviors produce stimuli that strengthen their emission due to their negative correlation with danger (Dismoor & Sears, 1973). Given that safety implies the absence of danger (Blakey & Deacon, 2015; Olatunji, Etzel, Tomarken, Ciesielski, & Deacon 2011), the production of safety cues preserves threat expectations. In other words, for a person who is already sensitive to the production of safety cues, the ability to perform safety behaviors maintains an erroneous belief about potential - but likely non-existent - threats (Gangemi, Mancini, & van de Hout, 2012; Lovibond, Mitchell, Minard, Brady, & Menzies, 2009; Olatunji, Etzel, Tomarken, Ciesielski, & Deacon, 2011; van den Hout & Kindt, 2004), most likely through inhibition of the extinction of the target stimulus (Lovibond, Davis, O'Flaherty, 2000).

Consistent with the results of similar studies investigating the effects of the non-contingent presentation of stimuli on behavior reduction, the current findings demonstrated an elimination of safety behaviors in participants with low and high OCD profiles (Markou et al., 1999; Vollmer et al., 1993). This suggests that similar mechanisms may underlie the effectiveness of such strategies in eliminating safety behavior. Specifically, the continuous presentation of safety signals seems to attenuate motivation to engage in safety behaviors (Hanley et al., 1997; Vollmer et al., 1993), which may increase the reinforcing potency of alternative stimuli or conditions. Therefore, the person may eventually become more motivated to engage in alternative behaviors, such as leaving his house, or engaging in social activities. However, this important possibility remains to be tested by future studies.

Unsurprisingly, our results demonstrated that the high OCD group engaged in higher rates of safety behaviors. This finding is consistent with the existing literature, which suggests that OCD patients have an elevated sense of threat compared to normal controls and,

as such, tend to search for reassurance more frequently (e.g., Gillan et al., 2014; Morillo, Belloch, & García- Soriano, 2007). This finding is important for two main reasons. First, it yielded information regarding the conditions under which low OCD participants developed safety behaviors. Second, it provided evidence that engagement in problem behavior at higher rates can be reduced or eliminated as effectively as any other problem behavior that exists at lower rates. However, future research should investigate potential differences with regard to the maintenance of the suppression of behavior operating at higher and lower rates.

Although the outcomes of this research are promising in terms of implications for therapeutic approaches, continuous access to safety signals might be difficult to replicate in real world settings for an extended period of time. Therefore, it would be interesting to further investigate methods of programming schedule thinning (i.e., downward titration of safety signals). In other applied preparations, the schedule of access to pleasant events/reinforcers was gradually decreased as reductions in target behaviors occurred (e.g., Goh, Iwata, & DeLeon, 2000; Lali et al., 1997). However, an interesting question is whether reductions of safety behaviors can be maintained on a thinner schedule and whether the schedule can be eliminated completely.

Recently, Levy & Radomsky (2016) addressed a similar question regarding fading the use of safety behavior during exposures to feared stimuli by employing three different conditions, namely participant-initiated (PI) fading, experimenter-initiated time (ET; where fading was yoked to time observed in PI), and experimenter-initiated distress (ED; where fading was based on subjective fear ratings). PI was superior to ET, as evidenced by considerably fewer reports of obsessive beliefs and subjective fear, as well as higher self-efficacy ratings. ED approximated results yielded by PI, although the latter condition produced higher self-efficacy ratings. These finding highlight the importance of participants' input in the therapeutic process. It would be interesting to replicate these findings through a

process of thinning the schedule of access to safety signals.

Clinically, non-contingent safety signal presentation could improve exposure treatments by offering the sufferer a variety of non-contingent cues that maintain his engagement in safety behaviors. For example, for those patients who worry excessively about whether they have locked their doors, specific stimuli (such as a light that stays on when a door is locked) could be associated with checking behavior and offered non-contingently. Similarly, for patients who repeatedly wash their hands, a noticeable mark on their hands after they have washed them could signal that they are clean until it fades. The non-contingent use of safety cues may provide a sense of security that may help the sufferer resist urges to engage in safety behaviors and potentially lead to more adaptive behavior. It is possible that by performing such behaviors, the feared stimulus will be eventually associated with other neutral or positive events. It subsequently may acquire a more positive meaning for the person (Bouton, 1993), rendering exposure therapy as a more acceptable treatment option (e.g., Milosevic & Radomsky, 2013b). However, this possibility needs to be explored by future studies.

This study has some limitations that warrant discussion. First, although we tested participants' self-reported OCD symptoms, we did not include participants who were formally diagnosed with OCD. Therefore, the effectiveness of the non-contingent presentation of safety signals on suppressing safety behaviors in OCD sufferers remains to be tested. Second, despite promising outcomes, the sample size was modest. Future research with larger sample sizes is needed to bolster the findings. Third, adventitious reinforcement remains an issue when applying non-contingent procedures (e.g., Morse & Skinner, 1957; Skinner, 1948). In particular, if the behavior to be reduced is emitted at high rates, the chances that the non-contingent presentation of the reinforcing agent will follow and strengthen it are increased. Future studies should address this limitation by adding a time-

delay procedure that ensures that the non-contingent presentation of the safety signals does not coincide with the emission of the safety behavior.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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Table 1
Descriptive and clinical characteristics of the study's sample

	Low OCD		High OCD			
	N	%	*N*	%	$x^2(df)$	*P*
Gender						
Male	7	41.2	8	53.3		
Female	10	58.8	7	46.7	0.47 (1)	0.49
Place of Birth						
United Kingdom	11	64.7	11	73.3		
European Union	6	35.3	4	26.7	0.28 (1)	0.60
Place of Residence						
United Kingdom	13	76.5	12	80		
European Union	4	23.5	3	20	0.06 (1)	0.81
Occupation						
Student	8	47.1	6	40.0		
Employed	8	47.1	1	6.7		
Unemployed	1	5.9	8	53.3	11.10 (2)	0.01
Education level						
Secondary school	7	41.2	7	46.7		
College/University	6	35.3	6	40.0		
Masters	4	23.5	2	13.3	0.54 (2)	0.76
	M	SD	M	SD	*t* or *U*	*P*
Age	25.88	4.95	26.53	5.10	-0.37	0.72
OCI_T1	10.41	4.18	39.73	8.04	-13.17	0.001
OCI_T2	11.24	3.11	38.47	10.49	-10.70	0.001
DOCS	7.76	4.09	17.20	3.45	-7.80	0.001
BDI-II	9.24	1.99	16.27	2.74	6.00 (z = -4.64)	0.001

Note. OCI_T1 = Obsessive-Compulsive Inventory-Revised at Time 1, OCI_T2 = Obsessive-Compulsive Inventory-Revised at Time 2, DOCS = Dimensional Obsessive-Compulsive Scale, BDI-II = Beck Depression Inventory II, *M* = Mean, *SD* = Standard deviation, *N* = Number of participants.

Table 2
Means and standard deviations of pedal presses between groups

	Baseline				*Contingent SS*				*Non-Contingent SS*			
	M	SD	*t*†	*P*	M	SD	*t*†	*P*	M	SD	*t*†	*P*
Low OCD*	196.43	11.65			98.06	6.96			2.65	0.61		
High OCD**	213.33	16.79	-3.34	0.01	139.03	10.47	-13.18	0.001	2.90	0.71	-1.09	0.29

Note. *M* = Mean, *SD* = Standard deviation, † = Independent *t*-tests conducted between low and high OCD participants across baseline and test conditions.

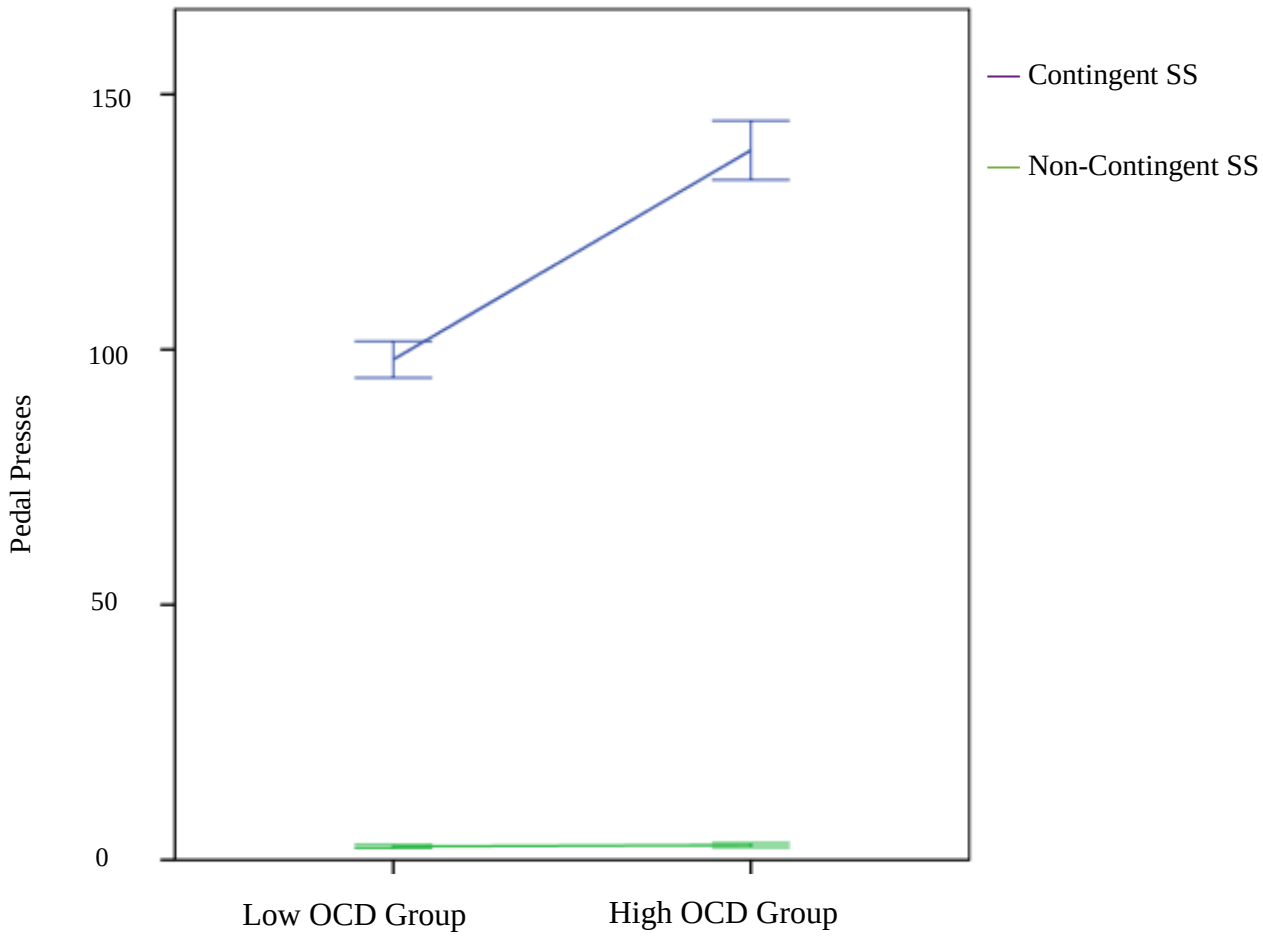

Figure 1. Interactions between high and low levels of OCD on pedal pressing across the contingent and non-contingent presentations of safety signals, with 95% IC errors bars.