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Remediating rigid rule-following in subclinical obsessive-compulsive disorder using a brief mindfulness task: A case-control pilot study

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ABSTRACT

A pioneering experiment by Hayes et al. (1986a, b) demonstrated the influence of instructional control and rule-governed behaviour on sensitivity to alternating reinforcement schedules. Hassoulas et al. (2017) replicated the same experimental design in a sample of participants exhibiting obsessive-compulsive behavioural (OCB) traits, supporting the results reported by the original study but also providing further insights into the maintenance of rigid rule following in OCB. The current pilot study replicated the same experimental design and procedure once again, however in considering whether a brief mindfulness-based intervention would facilitate contact with schedule contingencies in a group of participants exhibiting OCB traits. A total of 78 participants were recruited, 38 of whom exhibited OCB traits as measured using the Maudsley Obsessive-Compulsive Inventory (MOCI). The results revealed a significant difference in sensitivity to changing schedules between the group of participants exhibiting OCB traits and those with few such traits (n = 40), dependent on the degree of instructional accuracy they were provided with. The findings of the current study provide insights into the proposed concomitant administration of mindfulness-based interventions, alongside traditional first-line therapeutic modalities currently administered in the management of obsessive-compulsive disorder.

1. Introduction

1.1. Background

Sensitivity to schedule contingencies in humans has shown to be influenced by the presence of verbal instructions, provided either externally or generated internally (e.g., Baumann et al., 2009; Hayes, Brownstein, Haas, & Greenway, 1986; Hayes, Brownstein, Zettle, et al., 1986). Furthermore, the self-verbalising, or self-generating, of rules that exert control over schedule contingencies (and, by extension, behaviour) is a uniquely human trait that offers insight into how the acquisition of language shapes human behaviour. As such, insensitivity to schedule contingencies exhibited by humans (in comparison to other species) has historically been attributed to instructional-controlled behaviour (e.g., Catania & Shimoff, 1998; Monestes et al., 2017).

Exposure to verbal rules, whether self-generated or generated by others, has also shown to produce responding that is resistant to change when schedule contingencies are altered (LeFrancois et al., 1988; Rosenfarb et al., 1992). Baumann et al. (2009) revealed that exposure to one specific verbal rule produced resistance in adapting to changes in schedule contingencies, with schedule sensitivity only taking place when participants were provided with varied rules, thereby encouraging response variability.

1.2. Rule-governed behaviour and schedule sensitivity

Hayes, Brownstein, Zettle, et al. (1986) conducted a pioneering study that investigated schedule sensitivity by manipulating instructional accuracy in relation to the properties of two separate schedules. Specifically, participants were randomly assigned to one of four instructional groups and were presented with a multiple differential-reinforcement-of-low-rate (DRL) 6-s schedule as well as a fixed ratio (FR) 18 schedule. One instructional group received accurate information in relation to the properties of both schedules, whilst two of the groups received information pertaining to only one of the two schedules. The fourth instructional group received no information regarding either of the two schedules.

Participants who received accurate information about both schedules demonstrated schedule-sensitive responding during the task a whole, whilst those who received partial instructions demonstrated schedule sensitivity only when exposed to the specific schedule that made contact with the instructions they had received. These findings highlighted the role of verbal instructional control in facilitating contact with schedule contingencies in human participants.

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1.3. Obsessive-compulsive traits and schedule sensitivity

Hassoulas et al. (2017) replicated the experimental design by Hayes, Brownstein, Zettle, et al. (1986), however by investigating instructional control and schedule sensitivity between a group of participants with subclinical obsessive-compulsive behavioural (OCB) traits and a group of healthy controls. Whilst schedule sensitivity was found to be associated once again with the degree of instructional disclosure as in the original study by Hayes et al. the subclinical OCB trait group demonstrated rigid adherence to the instructions provided. The instructional control over responses to schedule contingencies exhibited by this group, and the subsequent rigid maintenance of this behaviour, was not matched by the control group. Whilst the control group produced contingency-shaped behaviour in the absence of the externally provided instructions, the subclinical OCB trait group only produced schedule-sensitive responses in the presence of explicit instructions.

It is therefore not surprising that behavioural flexibility has been a key area of interest in improving our understanding of the acquisition and maintenance of avoidant behaviour in obsessive-compulsive disorder (OCD) (e.g., Hassoulas et al., 2014, Schubert et al., 2022). The emergence of a third wave of cognitive and behavioural treatment modalities has emphasised the importance of facilitating psychological and cognitive flexibility through the application of practices such as acceptance and mindfulness (Hayes & Hofmann, 2017; Grant & Cassidy, 2022). This is of particular interest in the management of OCD, where the primary diagnostic criteria of the condition include the presence of unwanted and distressing thoughts or urges that are appraised as being of importance by the patient, along with the presence of rigid and repetitive ritualistic acts acquired in response to these internal events (American Psychiatric Association, 2013).

It has further been established that the acquisition and rigid maintenance of the avoidant compulsive behaviours incorporates an element of self-generated rule following (Hassoulas et al., 2017). Incorporating concepts of psychological and cognitive flexibility into existing evidence-based treatment modalities may therefore enhance the therapeutic efficacy of these first-line psychological treatments for OCD.

1.4. Remediating compulsive behaviour as part of managing OCD

Exposure and Response Prevention (ERP) is an established first-line psychological treatment modality for OCD, founded upon core behaviourist principles that has proven efficacious in challenging avoidant and ritualistic compulsive behaviours (e.g., Barlow, 2002; Hezel & Simpson, 2019; Rachman, 2004). ERP has, however, been criticised for not placing sufficient emphasis on the cognitive component of OCD (e.g., Salkovskis, 1985), and for the perceived aversiveness of the exposure technique by patients (e.g., Abramowitz et al., 2009; Twohig et al., 2010).

In addressing certain of these limitations, ERP with concomitant administration of additional evidence-based therapeutic modalities has been reported to produce a degree of success. For instance, Twohig et al. (2018) demonstrated that adding Acceptance and Commitment Therapy (ACT), a third-wave cognitive and behavioural therapeutic modality, to ERP in the treatment of OCD proved as efficacious as ERP alone, however by also focusing on psychological flexibility and treatment acceptance. Such findings hold promise, as these less aversive yet efficacious holistic treatment modalities for conditions such as OCD place equal emphasis on key cognitivist principles (e.g., Twohig et al., 2010).

Similarly, brief mindfulness-based interventions have been found to improve psychological and cognitive flexibility by encouraging clients to observe their thoughts non-judgementally, and to not react to their thoughts (Miller et al., 1995). For instance, Arch and Craske (2006) introduced a short mindfulness-based focused breathing task in assessing affective responses to the presentation of aversive visual stimuli. Their results revealed that even without prior training, the focused breathing group reported less affective disturbance by the negative stimuli and a greater willingness to engage with the material than participants who did not receive this intervention. This finding was supported by McHugh et al. (2010), who revealed a significant reduction in over-selectivity (i.e., where a limited number of stimuli in the environment control behaviour) in an older patient population who received a focused breathing induction. These results demonstrate that the use of a short and focused mindful breathing induction can facilitate greater behavioural flexibility even without prior mindfulness-based training.

Hanstede et al. (2008) applied a mindfulness-based intervention in attempting to reduce distress due to intrusive thoughts/urges and ritualistic compulsions in sub-clinical OCD. They found that participants with obsessive-compulsive traits reported a marked reduction in severity of distress. In addition, participants reported an improved ability in 'letting go' of thoughts, suggesting that mindfulness-based interventions can reduce anxiety associated with distressing obsessional thoughts and, by extension, possibly reduce the aversive experience of exposure and response prevention. This was further supported by Fairfax (2008), who suggested that the addition of a brief mindfulness-based intervention to first-line cognitive behavioural treatments could improve the attrition rate of ERP alone and produce longer-lasting reductions in symptom severity.

1.5. Rationale for the current study

The current study aimed to investigate the remediation of rule-governed behaviour in subclinical OCD through the use of a brief mindfulness-based intervention, as compared to an unfocused attention (basic relaxation) intervention. Mindful practice has also been found to facilitate sensitivity to changing contingencies (O'Connor et al., 2019). Whilst existing first line therapeutic modalities for OCD, such as ERP, have been found to be efficacious, high dropout rates have been reported given the aversive nature of the exposure intervention. It has therefore been suggested that a mindfulness-based ERP/CBT intervention might reduce the degree of adversity of the intervention whilst also facilitating schedule-sensitive responding to changing consequences. (Law & Boisseau, 2019).

A subclinical sample was recruited as it has been demonstrated that an improved understanding of obsessive-compulsive (OC) traits enhances our understanding of clinical OCD, as individuals with OC traits provide invaluable insights into how possible neurocognitive and behavioural characteristics may manifest in OCD (Gibbs, 1996; Johansen & Dittrich, 2013). Furthermore, piloting such an intervention on a sample of participants exhibiting sub-clinical traits initially is considered a useful exercise in identifying areas that could be improved when administering the study and intervention in a clinical sample of patients with an established diagnosis of OCD. It was predicted that participants with OC traits assigned to the brief mindfulness intervention would demonstrate sensitivity to changing contingencies, whilst those with OC traits assigned to the unfocused attention intervention group would not.

2. Method

2.1. Participants

Eighty-four participants were recruited to take part in this study. Data from six participants was excluded due to incomplete response sets, specifically due to the participants providing insufficient baseline data. This was due to participants omitting a number of responses to items from the measures administered, thereby resulting in inaccurate baseline scores. As such, responses from seventy-eight participants (53 females and 25 males) were included in the analysis. The mean age of the sample was 22.69 years (SD $\pm$ 6.99). Sixty-eight of the participants were Psychology undergraduate students who received subject credit for their participation. The remaining ten participants were volunteers who were recruited through advertisements for the study placed in the Psychology Department at Swansea University.

2.2. Measures

The Maudsley Obsessive-Compulsive Inventory (MOCI; Hodgson & Rachman, 1977) was administered as a measure of obsessive-compulsive behavioural traits. The questionnaire consists of 30 dichotomous items that measure the presence of obsessive-compulsive symptoms across four subscales: checking, washing/cleaning, doubting, and obsessional slowness. The measure has an internal reliability of 0.75 and a test–retest reliability of 0.80, and correlates moderately well with other OCD-related measures such as the Obsessive-Compulsive Inventory – Revised version (OCI-R), with a convergent validity score of $r = 0.65$ (Hajcak et al., 2004). A similar MOCI internal reliability of 0.72 was revealed for the current sample, with a convergent validity of $r = 0.61$ ($p < 0.01$) with the OCI-R.

A Contingency Awareness Questionnaire was designed by the authors specifically for the purposes of this study. The questionnaire consisted of 7 items, 5 of which were presented in a multiple-choice format, with four options for each item, and 2 open-ended items. The items measured how participants interpreted the most effective way of responding during the task, in terms of accumulating points, and whether their responses were consistent with the schedule contingencies presented throughout the task. As such, the measure assessed participants' recognition of the colour square that corresponded to the schedule in effect, serving as a discriminative stimulus assessing awareness of the schedule that was active during a specific trial.

2.3. Design

A case control study design was utilised by assigning participants to a subclinical OCD group and a group of healthy controls. This was done on the basis of participants' scores on an obsessive-compulsive symptoms and trait measures. Specifically, a median split was used to divide participants into a 'high scoring' OCB group (i.e., those who scored above the median split and exhibited elevated OCB traits) and a 'low scoring' OCB group (i.e., those who scored below the median split).

The experimental design applied by Hassoulas et al. (2017), which was based on the original design by Hayes, Brownstein, Zettle, et al. (1986), was replicated in this study. Specifically, multiple differential-reinforcement-of-low-rate (DRL) 6-s and fixed ratio (FR) 18 schedules of reinforcement were administered as part of a computerised behavioural task that participants were presented with. Responses were recorded in the form of computer mouse clicks in the presence of the alternating DRL 6s and FR18 schedules. As per the experimental design by Hayes, Brownstein, Zettle, et al. (1986) and Hassoulas et al. (2017), participants responded during the task to one of two on-screen buttons for a period of at least 6s when the DRL 6s was live or after 18 consecutive mouse clicks when the FR18 schedule was active.

Additionally, induction scripts for the focused breathing (brief mindfulness) and the unfocused attention (basic relaxation) interventions were retrieved from Arch and Craske (2006). The focused breathing script aimed to induce mindful awareness and bring participants' attention to the present moment during a 15-min induction, whilst the unfocused attention script acted as a 15-min unfocused attention intervention. Both scripts were pre-recorded by the experimenter, presenting participants with identical focused or unfocused intervention recordings during the experimental task.

Ethics approval was sought and provided by the Swansea School of Psychology Research Ethics Committee.

2.4. Apparatus

The computerised task was administered in a controlled environment, with all participants required to complete the task in a quiet laboratory room, measuring 2 m × 1.5 m. The computer-based task designed by Hassoulas et al. (2017) was utilised in this study. Specifically, the task was programmed using Visual Basic, version 6, and was administered using an HP Pavilion dv9000 laptop with 17-inch WXGS wide screen. Data was automatically captured as saved in a protected Excel file. Guided instructions pertaining to the focused breathing (brief mindfulness) intervention and the unfocused attention (basic relaxation) intervention were administered using an Olympus portable VN-3200PC digital audio recorder dictaphone, with a USB hub.

The computer-based task was identical to the experimental task used by Hassoulas et al. (2017), which was a modification of the original task designed by Hayes, Brownstein, Zettle, et al. (1986). Participants were presented with a 5 × 5 grid in the centre of the monitor, as demonstrated in Fig. 1 below.

The computerised task was comprised of 3 pre-intervention sessions and 3 identical post-intervention sessions. Each session consisted of 8 trials each. During each of these trials, participants were presented with the DRL-6s schedule for 2 min and the FR18 schedule for another 2 min. Each trial therefore lasted 4 min, with the order of the schedules not being counterbalanced (in keeping with the original experimental procedure being replicated). Upon completion of the 8th trial and therefore at the end of each session, participants were notified that they could take a break if they so preferred. The task was paused until they were reading to continue, with the next session being initiated when they were ready to resume the task.

During each trial, participants were instructed to accumulate as

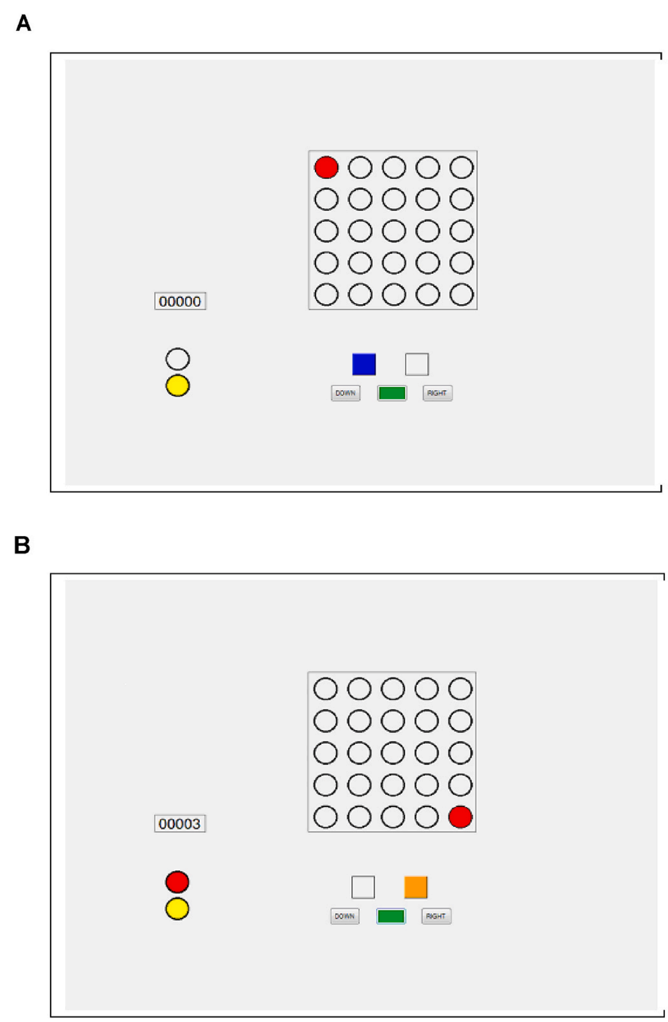

Fig. 1. Pre- and Post-intervention (brief mindfulness and basic relaxation) responses for MOCI high and low scoring groups, per schedule of reinforcement (DRL-6s and FR-18) during the A. minimal instruction condition, B 'Go Slow' partial instruction condition, C 'Go Fast' partial instruction condition, and D. accurate instruction condition.

many points as they could by moving a red marker through the 5 × 5 grid (see Fig. 2). Below the grid, two squares appeared representing each of the two schedules. When the square to the left turned blue, this indicated that the DRL-6s schedule was active. When the square to the right turned yellow (and the other square was deactivated), the FR 18 schedule was active. This same process was repeated across all trials.

The manner in which participants could move the marker within the grid depended upon which of the two squares was lit. Directly below the two squares were three buttons that controlled the movement of the marker within the grid. Participants could either select the "DOWN" button to move the marker one place down, the "RIGHT" button to move the marker one place to the right, or the green-coloured button (situated between the "DOWN" and "RIGHT" keys) to begin accumulating points.

When the DRL-6s schedule was active, participants could move the marker "RIGHT" or "DOWN" only after 6-s of responding to one button without switching between the two buttons. When the FR 18 schedule was active, they could move the marker by performing 18 consecutive presses to one of the two buttons. Responses performed on the green button, however, were only recorded once participants moved the red marker to the bottom right corner of the grid, in order to commence point accumulation. When the red marker was successfully manoeuvred into the designated location, a red light beneath the points counter was activated. The manner in which they accumulated points was once again contingent upon the schedule that was active at the time (illustrated by either the blue or yellow square being active).

2.5. Procedure

Participants were initially administered the participation information and consent form, along with the MOCI questionnaire. Upon completion of the MOCI, participants were introduced to the computerised task with a two-trial practice session. The first of the official three pre-intervention sessions then commenced, with each session lasting 15 min. At the 45-min mark, and therefore after the three pre-intervention sessions, a message appeared on screen requesting that participants inform the experimenter that the initial part of the computerised task had been completed.

During this interval, participants were randomly assigned to either the focused (mindfulness-based) breathing or the unfocused (basic relaxation) attention intervention condition. Participants were asked to take a seat in the laboratory, where the task was being completed, and to make themselves comfortable. The experimenter then played either the focused breathing or unfocused attention induction recording, depending on the intervention condition the participant was allocated to. Both recordings lasted 15 min.

The focused breathing intervention was adapted by Arch and Craske (2006), based on the focussed breathing brief mindfulness sitting meditation introduced by Kabat-Zinn (1990). As participants declared to have had no prior mindfulness training, the focused breathing intervention was restricted to bringing the participants' attention to the sensations of breathing, and therefore making contact with the present. For instance, participants were instructed to:

Notice the sensation of breathing air in. Notice the sensation of breathing air out. As you breath air into your body, fill your mind with the thought "just this one breath". As you breathe air out of your body, fill your mind with the thought "just this one exhale".

The participants receiving the unfocused attention intervention were presented with an unfocused attention/basic relaxation audio script, whereby they were encouraged to allow their thoughts to flow freely, without offering any resistance to them. Specifically, the instructions they received were as follows:

Don't try to focus on your thoughts, just let them drift without hesitation. There is no need to focus on anything in particular. Allow yourself to think freely. Try not to focus on any one thing.

As such, participants receiving the unfocused attention intervention were encouraged to observe their thoughts without focusing on anything in particular, such as their physiological responses or bringing awareness to the present moment. The unfocused nature of the intervention therefore did not facilitate a mindful, or acceptance-based, approach during the task.

Once the induction recording ended, participants were instructed to initiate the second half (i.e., the three post-intervention sessions) of the computer-based task by pressing the space bar on the keyboard when they were ready to resume. The post-intervention sessions were identical to the sessions presented during the first half of the computerised task. Upon completion of the second half of the task, participants were administered the Contingency Awareness Questionnaire before being debriefed.

3. Results

As per the initial experimental design by Hayes, Brownstein, Zettle, et al. (1986) and the subsequent study by Hassoulas et al. (2017), participants were randomly allocated to one of the four instructional conditions in this pilot. These included: a minimal instructions condition, where participants received no explicit instructions about how to respond to either schedule they were presented with; a partial instructions condition instructing participants to 'go fast' in an effort to make contact with the FR18 schedule; a partial instructions conditions instructing participants to 'go slow' in an effort to make contact with the DRL-6s schedule; and an accurate instructions condition that instructed participants to respond either 'fast' or 'slow' when deemed appropriate, in an attempt to facilitate contact with both schedules of reinforcement that were administered during the task.

In considering our sample size, an a priori power analysis was formed using G*Power version 3.1 (Faul et al., 2007). This indicated a required sample size of 80 to achieve 95% power in detecting a medium effect at a significance criterion of $\alpha = 0.05$. As such, whilst a total of 84 participants were recruited, the sample size of 78 was deemed to be sufficient following the exclusion of 6 participants due to incomplete data collated.

A total of 18 participants were randomly allocated to the minimal instructions condition, with a further 18 participants allocated to the accurate instructions condition. A total of 21 participants were allocated to each of the partial instruction conditions. Upon completion of the first half of the computerised task, participants were subsequently randomly allocated to either the focused breathing (brief mindfulness) or unfocused attention (basic relaxation) intervention. The number of participants within each condition allocated to the brief mindfulness intervention and the unfocused attention invention are illustrated in Table 1.

3.1. Descriptive data analysis

Scores on the MOCI range from 0 to 30. A median split was applied to divide the sample into a group of participants with higher scores on the MOCI and a group with scores that fell below the median. The group with the higher MOCI scores were considered to possess OCB traits, given that they scored above the median on the overall scale of the measure. This approach is in keeping with the application of a median split using the overall MOCI scale, a measure of obsessive-compulsive behaviour, in previous studies (e.g., Hassoulas et al., 2014; Hassoulas et al., 2017).

The mean sample score of 6.65 (SD 3.9) and median of 7 were found to be in keeping with MOCI sample means and median cut-off scores reported in sub/nonclinical samples by Hodgson and Rachman (1977), Sternberger and Burns (1990), Thomas et al. (2000), and Sanchez-Meca et al. (2011). Further analysis was performed to measure whether the median split applied did indeed sufficiently differentiate between high and low scoring groups on the basis of the MOCI and OCI-R scores. This revealed a significant difference between high and low scorers on the MOCI, $t(76) = 10.76$; $p < 0.001$, as well as on the OCI-R, $t(76) = 12.7$; p

Table 1
Number of participants allocated at random to each instructional condition and each intervention.

	Minimal instructions	Partial instructions ('Go Slow')	Partial instructions ('Go Fast)	Accurate instructions
Brief mindfulness	8	10	11	9
Basic relaxation	10	11	10	9

< 0.001.

Participants scoring 6 or more out of a possible 7 on the Contingency Awareness measure were assigned to the 'contingency aware' group (n = 39), whilst those scoring 5 or below were assigned to the 'contingency unaware' group (n = 39). A significant difference was revealed between the two groups when contingency awareness was assessed, $t(76) = 15.21$; $p < 0.001$. Mean MOCI scores for participants assigned to high and low scoring MOCI group within each of the four instructional conditions are represented in Table 2.

3.2. Quantitative analysis

A six-factor mixed-model analysis of variance (ANOVA) was performed. Instructional condition (minimal, 'go slow', 'go fast' and accurate), intervention (focused breathing versus unfocused attention), MOCI scoring group (high versus low), and schedule contingency awareness scorer group (awareness of schedules versus unawareness) were analysed as between-subject variables, with schedule (DRL 6-s versus FR 18) and session (pre versus post intervention) as within-subject variables. A Bonferroni correction procedure was also performed. A significant main effect of trial at both pre, $F(1,48) = 35.24$, $p = 0.001$, and post intervention, $F(1,48) = 122.92$, $p = 0.000$ were revealed.

A significant three-way interaction was found for schedule, intervention and contingency awareness group at post intervention using the Bonferroni correction procedure, $F(1,48) = 15.32$, $p = 0.001$. A further significant interaction was found for schedule, condition and MOCI group for the post intervention session only, $F(3,48) = 2.95$, $p = 0.042$. A significant between-subjects interaction was produced for intervention, condition and MOCI group at post intervention, $F(3,48) = 2.80$, $p = 0.045$.

Simple effects analyses were performed to further analyse the significant interactions. The effect of session (pre- and post-intervention) on MOCI scoring group was analysed, for both the DRL-6s and FR 18 schedules during each of the four instructional conditions. This did not reveal a significant effect of session during the minimal instruction condition for either MOCI scoring group on either schedule, $ps > 0.09$.

Significant effects of session were revealed for the FR-18 schedule in the 'go slow' partial instructions condition for the high scoring MOCI group, $F(1,70) = 25.9$, $p = 0.002$, and for the low scoring MOCI group, $F(1,70) = 4.78$, $p = 0.03$. Significant effects were also produced for the FR-18 schedule in the 'go fast' partial instructions condition for both the high scoring MOCI group, $F(1,70) = 3.87$, $p = 0.039$ and the low scoring group, $F(1,70) = 6.58$, $p = 0.026$. Significant effects were produced for the high scoring MOCI group only in the accurate instructions condition for both the DRL-6s schedule, $F(1,70) = 3.02$, $p = 0.041$, and the FR-18 schedule, $F(1,70) = 8.95$, $p = 0.02$ (Fig. 2).

Table 2
Mean MOCI scores (μ) and standard deviations (σ) for participants allocated to each instructional condition who scored above the MOCI median (MOCI High Group) and those who scored below the median (MOCI Low Group).

	Minimal instructions	Partial instructions ('Go Slow')	Partial instructions ('Go Fast)	Accurate instructions
MOCI High Group	$\bar{x} = 9.36$ ($\sigma = 2.58$)	$\bar{x} = 10.00$ ($\sigma = 3.51$)	$\bar{x} = 9.67$ ($\sigma = 3.35$)	$\bar{x} = 10.46$ ($\sigma = 1.51$)
MOCI Low Group	$\bar{x} = 3.57$ ($\sigma = 1.62$)	$\bar{x} = 3.54$ ($\sigma = 2.07$)	$\bar{x} = 2.75$ ($\sigma = 2.01$)	$\bar{x} = 4.29$ ($\sigma = 1.11$)

These findings are consistent with the results reported by Hassoulas et al. (2017) and replicate the outcomes for both MOCI scoring groups in that study. Further simple effects analyses were performed on MOCI scoring group in relation to schedule of reinforcement for instructional condition and type of intervention. Table 3 highlights the results of the simple effects analyses.

4. Discussion

4.1. Overview of results

The results revealed a significant interaction of MOCI scoring group, intervention type, and instructional condition. Further analyses revealed that provided with minimal instructions, the low scoring group receiving the unfocused attention intervention performed with greater schedule sensitivity to both schedules. Significant differences in schedule sensitivity post intervention were found for the 'go slow' and 'go fast' partial instruction conditions for the high scoring MOCI groups, irrespective of intervention type. Specifically, significant differences in responding were revealed for the high scoring groups in the 'Go Slow' partial instruction condition, with both intervention types facilitating schedule sensitive responding.

The high scoring MOCI group presented with the brief mindfulness intervention, however, responded with greater sensitivity to both schedules when accurate instructions were provided. These results support the findings by Hassoulas et al. (2017), who demonstrated that the high scoring OCB trait group performed with greater sensitivity when accurate and partial instructions were provided. Importantly however, the current study's findings illustrate that a brief mindfulness intervention in particular produced a superior effect on post-intervention schedule sensitivity for the high scoring group. Specifically, this finding demonstrates that the introduction of a mindfulness task, albeit brief in nature, facilitated greater schedule-sensitive responding in those participants assigned to the high scoring MOCI groups. This supports the authors' prediction that a brief mindfulness task would produce sensitivity to changing schedule contingencies post intervention.

This also lends support to the suggestion proposed by Hanstede et al. (2008) that a mindfulness-based intervention could contribute to remediating compulsive behaviour without the added anxiety experienced during an ERP intervention. Whilst only a brief focused breathing induction was administered in this study, the results nevertheless indicate that individuals with subclinical OCD traits may benefit from a brief mindfulness-based exercise in responding to changing schedule contingencies. The combination therefore of accurate instructions and a mindfulness-based task can extinguish previously acquired ritualistic compulsive responding by enabling the individual to make contact with changing environmental contingencies.

Twohig et al. (2010) investigated whether Acceptance and Commitment Therapy (ACT), a third-wave cognitive-behavioural treatment modality that applies exposure to aversive stimuli through the non-judgemental experience of anxiety, was more effective at reducing OCD symptom severity when compared with progressive relaxation training (PRT). In a subsequent randomised-control trial, Twohig et al. (2018) also revealed that adding ACT to ERP produced equally efficacious outcomes as traditional ERP-administration alone. Twohig et al. (2018) did also report, however, that no significant difference in

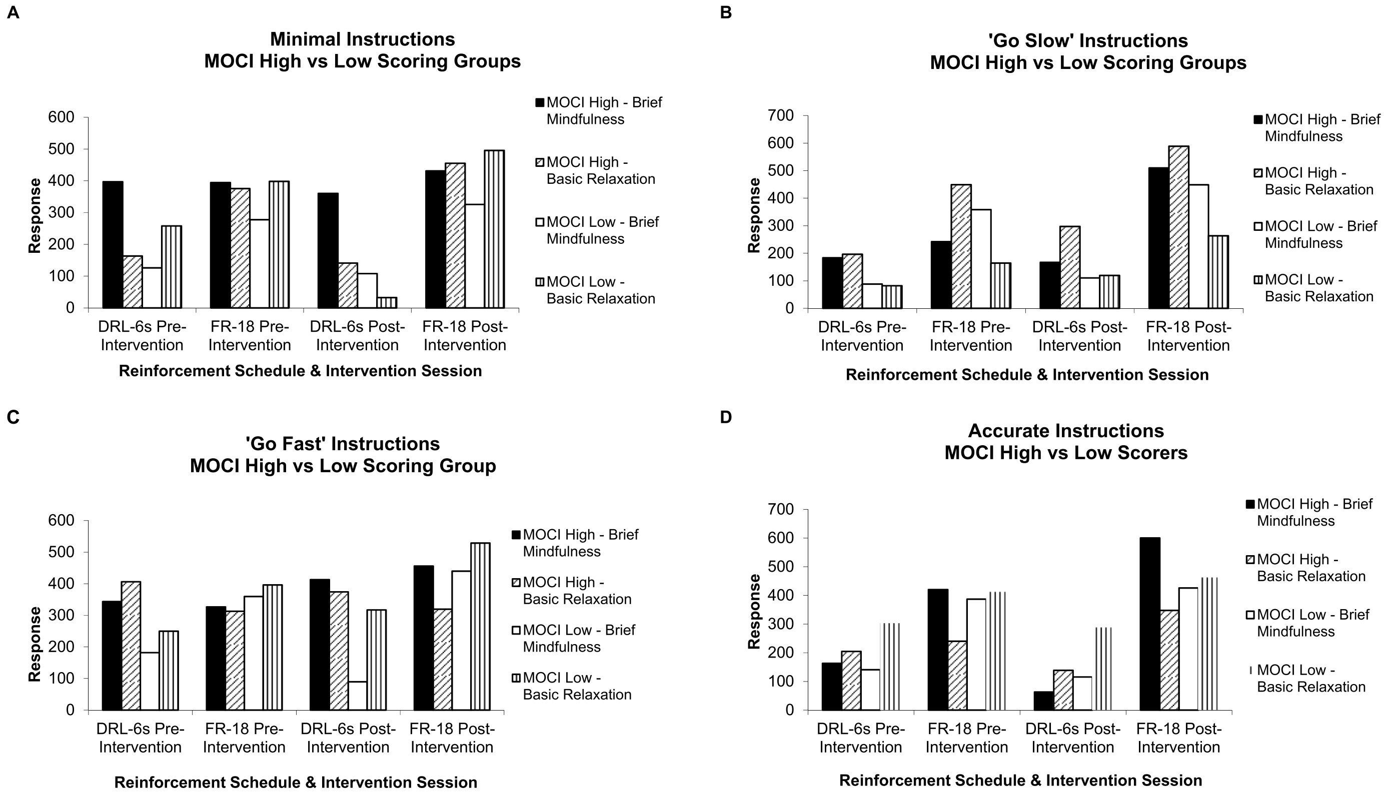

Fig. 2. A. The beginning of a DRL-6s trial (blue square lit), with the red marker in the top left corner. B. The position of the marker in the bottom right corner, during an FR trial (yellow square lit), where the red circle is lit to indicate a period of point acquisition.

Table 3
Further analyses of the significant interactions between MOCI scoring group performance (as measured by responses to each schedule of reinforcement) with instructional condition and intervention type.

	Minimal instructions	Partial instructions ('Go Slow')	Partial instructions ('Go Fast')	Accurate instructions
MOCI High – Brief mindfulness	$p > 0.05$	$F(1,58) = 20.71, p < 0.001$ **(FR-18)**	$F(1,58) = 5.52, p = 0.02$ **(FR-18)**	$F(1,58) = 2.49, p = 0.05$ **(DRL-6s)** $F(1,58) = 8.02, p = 0.01$ **(FR-18)**
MOCI High – Basic Relaxation	$p > 0.05$	$F(1,58) = 2.95, p = 0.03$ **(DRL-6s)** $F(1,58) = 5.63, p = 0.02$ **(FR-18)**	$p > 0.05$	$p > 0.05$
MOCI Low – Brief mindfulness	$p > 0.05$	$p > 0.05$	$F(1,58) = 2.82, p = 0.04$ **(DRL-6s)**	$p > 0.05$
MOCI Low – Basic relaxation	$F(1,58) = 14.7, p = 0.002$ **(DRL-6s)** $F(1,58) = 2.74$ $p = 0.04$ **(FR-18)**	$p > 0.05$	$F(1,58) = 5.81, p = 0.02$ **(FR-18)**	$p > 0.05$

drop-out rates were observed between participants receiving ERP only and those receiving ERP + ACT. Whilst they did not observe a superior effect of dropout rate for the combination of therapeutic modalities, prior research has highlighted that patients do find third-wave modalities such as ACT to be highly acceptable (Twohig et al., 2010). The results of the current study therefore tentatively support those by Twohig et al. in that third-wave cognitive-behavioural therapies could contribute cumulatively to the outcomes of traditional therapeutic modalities, which are also perceived as more acceptable by patients.

In relation to clinical OCD, Singh et al. (2004) found that a mindfulness-based treatment successfully reduced symptoms severity and anxiety, even at three-year follow up. This has been attributed to the cumulative effect of behaviour modification through the frequency of practicing mindfulness-based exercises (e.g., Kingston et al., 2007). Whilst state anxiety was not measured as part of the current study, it can be suggested that mindfulness-based tasks administered alongside traditional ERP treatment may prove efficacious whilst alleviating the distress of the conventional therapeutic process by bringing awareness, in a non-judgemental way, to thought processes and emotional responses to treatment. It is important to note, however, that the findings of the current pilot study pertain specifically to a subclinical sample when considering the responses performed by the high scoring MOCI group during the rule-governed behaviour task. Both OC measures administered during the current study are not routinely used as diagnostic tools but rather as screening tools for traits and symptoms of OCD. The presence of such traits have been suggested to provide insight into how symptoms of OCD may manifest (Johansen & Dittrich, 2013).

Moore and Malinowski (2009) reported that mindful awareness facilitates psychological flexibility and attention focus. This has implications for obsessive-compulsive behaviour, as perseverance in responding and the reported insensitivity to changes in schedules of reinforcement could be addressed by supporting the maintenance of mindful practices. Furthermore, including mindfulness-based exercises to the management of OCD could prove effective not only in the non-judgement experiencing of anxiety induced by aversive events, but also in bringing awareness to the urge to perform the behaviour compulsion, by noticing the urge without judging or responding to it.

Further investigation into a proposed combined mindfulness-based

ERP intervention would be required to evaluate the efficacy of a such an approach, and whether this improves current attrition rates. Third-wave therapeutic modalities have been found to be perceived as more acceptable by patients, thereby warranting further exploration into how combination treatment might alleviate certain patient perceptions in relation to exposure-based treatments. Key limitations of the current pilot study include power and sample size, as such any future research aiming to replicate the current experimental design would need to carefully consider sample size estimations. A randomised-control-trial, recruiting patients with an established OCD diagnosis, would also be advantageous in exploring whether the findings of the current study are replicated with a clinical sample.

CRediT authorship contribution statement

Athanasios Hassoulas: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Phil Reed:** Methodology, Conceptualization. **Louise McHugh:** Methodology, Investigation, Conceptualization.

Declaration of competing interest

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