School of Psychology
Ysgol Seicoleg

Mental imagery interventions in eating disorders and imagery processing in obsessive-compulsive disorders: A systematic review and quantitative study exploring the role of mental imagery

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Thesis preface

The aim of this research was to explore how mental imagery can impact on eating disorders and obsessive-compulsive disorder (OCD), and to explore whether mental imagery-based interventions can be appropriate and effective for these populations. Mental imagery can be defined as cognitive experiences that have sensory properties, and therefore will closely resemble actual perceptual experiences. These sensory properties can be visual, olfactory, tactile, acoustic, or gustatory.

The systematic review aimed to understand the evidence base for mental-imagery interventions in eating disorders. These interventions can include imagery rescripting, positive imagery, and guided imagery, among others. A previous review had been conducted in 2011, which focussed on the effect of imagery interventions in cognitive behavioural therapy. The scope was widened for this review, looking at imagery interventions in any context. Three databases were searched including Psycinfo, EMcare, and Medline, with search terms relating to mental imagery interventions and eating disorders being developed in collaboration with a librarian. Three hundred and forty-two papers were screened, and thirteen papers met the inclusion criteria, and therefore were included in the review.

The review found that imagery interventions are comparable to other interventions, such as enhanced cognitive behavioural therapy (CBT-E). However, caution is needed in interpretation as imagery interventions can be included in courses of CBT-E, which may mean that there is some overlap in the delivery of treatments. This review found that imagery interventions were shorter in duration than established interventions and showed a lower attrition rate during therapy than other interventions. Suggestions have been made that imagery interventions may be more meaningful to service users, and therefore may be better at retaining people through therapy. This review

acknowledges the need for more high-quality research papers investigating mental imagery interventions in eating disorders, although initial research appears promising in this area when considering effectiveness, retention, and efficiency in delivery.

The empirical paper describes a quantitative study that explored the effects of mental imagery processing on a population that display obsessive compulsive behaviours. Current interventions for OCD focus on people's reactions to verbal cognitions, but mental imagery has been shown to have an important role in people's processing, especially when considering emotional links. Previous research has found that heightened or distorted mental imagery is present in disorders such as post-traumatic stress disorder (PTSD), generalised anxiety disorder (GAD), and clinical depression. However, there appears to be no research that investigates the difference in impact between verbal and imagery cognitions within the context of OCD.

Eighty-five participants were initially recruited through two systems: one university based and the other an online resource bank for those interested in participating in research. Thirteen participants were excluded, leaving seventy-two full sets of results. Participants were required to complete the Obsessive-Compulsive Inventory (OCI), the Spontaneous Use of Imagery Scale (SUIS), and the State-Trait Anxiety Inventory (STAI) before commencing the study. Participants were then asked to look at word-image pairings and instructed to process them either verbally or through imagery. This was manipulated by asking participants to complete a sentence using the word-image pairing in the verbal condition, and the imagery condition asked participants to mentally visualise the word-image pairing. The STAI was used as a measure of anxiety after each processing block.

Findings from the empirical study showed that there was no significant difference between anxiety ratings and different types of processing in the full sample. When participants were split based on high and low OCI scores (creating two groups of high and low OCD tendencies), there was no significant difference in the impact of imagery processing on anxiety ratings. Therefore, this study concluded that imagery processing may not significantly affect a population with OCD tendencies more than healthy controls. Other interesting results were apparent from the data, such as the large number of people scoring over the clinical cut-off for the OCI measure, suggesting that OCD rates are higher in the general population that the current estimates, or that the covid-19 pandemic has significantly affected the population and more people are likely to develop OCD as a result. Recommendations for future research are suggested, and limitations with regards to completing this study within a covid-19 context are discussed to inform further research.

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Mental imagery-based interventions for people with disordered eating behaviour: A systematic review

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Abstract

Background

Eating disorders can be incredibly debilitating and often present with an array of comorbid mental health difficulties. Certain eating disorders, such as anorexia nervosa, have high mortality rates and poor prognoses. The time from recognition of eating disorder to assessment and treatment can often be lengthy, and the duration of illness can, in extreme cases, be lifelong.

Methods

Three databases (Medline, Psycinfo, and Emcare) were searched. Articles were included if they were based on mental imagery, described an intervention, and were applicable to those either with or at risk of developing an eating disorder.

Results

Thirteen studies met the inclusion criteria. Of the thirteen, eight focussed on imagery rescripting as an intervention, two used guided imagery, one study used positive imagery, one used imagery modification, and the remaining study used compassionate imagery exercises as part of a larger intervention. All papers showed positive effects of imagery interventions. However, imagery interventions were also shown to have poorer outcomes than other interventions in some studies.

Conclusions

Mental imagery-based interventions may be useful for those who do not respond to traditional interventions such as cognitive behavioural therapy or cognitive restructuring. Imagery based interventions in this review were found to have lower dropout rates in therapy than other interventions and are also deliverable in a shorter timeframe. Effectiveness rates of imagery interventions were comparable to existing recommended interventions. More high-quality research is needed in this area.

Keywords: Mental imagery, eating disorders, intervention

Introduction

Eating disorders

Eating disorders are behavioural conditions that centre around a disturbance in eating patterns or behaviours, often intended to control weight and significantly impacting physical health or psychosocial functioning (Fairburn & Brownell, 2005). The diagnostic and statistical manual of mental disorders (DSM-5) separates eating disorders into distinct categories, these being anorexia nervosa (AN), bulimia nervosa (BN), binge eating disorder (BED), and other specified feeding or eating disorder (OSFED; American Psychiatric Association, 2013). Avoidant and restrictive food intake disorder (ARFID) has also been added to the DSM-5 and was previously referred to as 'selective eating disorder'. Each of these diagnoses has a specific relationship with food, with anorexia being the intense restriction of food intake due to body dissatisfaction or fear of fatness, bulimia often being characterised by a binge / purge cycle, binge eating disorder being the intense consumption of a high number of calories in a short period of time, and ARFID being a condition characterised by avoiding certain types of food or restricting their calorific intake. OSFED serves as a 'catch-all' for other cases that do not fit into the specific criteria. Eating disorders can be severe and chronic mental health disorders and are often associated with negative outcomes and high mortality rates, particularly anorexia nervosa (Arcelus et al., 2011). Estimates vary on the prevalence of eating disorders in the UK, with some sources estimating that approximately 700,000 people have an eating disorder (BEAT, 2015), whilst others claim this is much higher, around 1.6 million (Sweeting et al., 2015).

Eating disorders typically begin during adolescence and early adulthood (Rohde et al., 2015), with young females more likely to be affected (Hoek & Van Hoeken, 2003; Striegel-Moore et al., 2018). However, this may be due to underdiagnosis of eating disorders in males, and a misunderstanding of

how males may present (Strother et al., 2012). Societal narratives that eating disorders only affect young women may also inhibit young men from recognising their eating disorder before it becomes entrenched (Maclean et al., 2015). Eating disorders appear to have a higher prevalence in certain diverse groups, such as those within sexual and gender minority populations (Nagata et al., 2020), or those diagnosed with autism spectrum disorder (Huke et al., 2013). This may be due to enhanced body dissatisfaction or increased rates of gender / body dysphoria (Nagata et al., 2020), although currently this area appears poorly understood. Eating disorders often present as comorbid with other difficulties. For those diagnosed with anorexia nervosa, 15% – 60% are also likely to experience depression, 20% – 60% an anxiety disorder, 12% - 21% substance abuse, and 20% - 80% will also be diagnosed with a personality disorder (Miller & Golden, 2010). High mortality rates are also apparent in AN, with estimates ranging from 5 to 15% mortality rate over a 20-year follow-up period (Ratnasuriya et al., 1991; Lowe et al., 2001). People diagnosed with bulimia nervosa tend to have a more positive prognosis that those with AN (Miller & Golden, 2010).

Treatments vary based on the type of eating disorder a person is diagnosed with, and NICE guidelines outline the interventions people with eating disorders should be offered (National Institute for Care and Excellence, 2017). Adults with AN should be offered enhanced cognitive behavioural therapy (CBT-E), Maudsley anorexia nervosa treatment for adults (MANTRA), or specialist supportive clinical management (SSCM). For adolescents with AN, family therapy is often recommended as a first-choice treatment. Those with BED should also be offered CBT-E, either in group or individual format, alongside self-help and guidance materials. Bulimia nervosa treatments also focus on CBT-E, with bulimia nervosa family therapy (FT-BN) for children and young people. Matrics Cymru evidence tables also outline interventions for anorexia, bulimia, and binge eating disorder (National Psychological Therapies Committee, 2017). As well as aligning with the NICE guidelines, these tables propose alternative therapies, such as interpersonal therapy (IPT; Klerman &

Weissman, 1994), cognitive analytic therapy (CAT; Ryle & Kerr, 2020), and motivational enhancement therapy (MET; Miller, 1992).

There has been a recent acceleration in the study and treatment of eating disorders, with understanding of family-based approaches becoming more nuanced, and more treatments being available for adults (National Collaborating Centre for Mental Health, 2004). Enhanced cognitive behavioural therapy CBT-E) is one of the more prominent treatment methods available, and significant advances have been made in this area over the past five years (Mulkens & Waller, 2021). CBT-E is delivered in four stages, these being focus on gaining a mutual understanding of difficulties with food and eating; reviewing progress and developing a therapy plan; focussing on the processes that might maintain difficulties with food and eating; and relapse planning (Murphy et al., 2010). CBT-E is recommended as a longer treatment, with Fairburn (2008) proposing that up to 40 planned sessions of therapy can be necessary.

Treatments such as CBT-E have been shown to have good effectiveness for people with eating disorders (Jenkins et al., 2019; Knott et al., 2015), however, completion rates of therapy remain a barrier to effective intervention, with Jenkins et al. (2019) finding an attrition rate of 46% throughout the course of therapy. As CBT-E is a large commitment for patients and services, shorter forms of intervention have been trialled, such as Waller et al. (2018) proposing a 10-session intervention of CBT-E for people who are not underweight (CBT-T). CBT-T demonstrated similar results to a full course of CBT-E and had a smaller dropout rate of 31% at post-treatment, but 62% of people did not attend a three-month follow-up. Motivation and readiness to change may impact on a person's ability to engage with therapy, and motivational interventions for those with eating disorders have been shown to be as helpful as low-intensity treatments (Denison-Day et al., 2018).

Although current treatments such as CBT-E show good effectiveness, attrition rates are high, which may mean that a certain population are not receiving an intervention due to treatment being a 'poor fit'. Therefore, it may be worth looking at alternative treatments. Imagery-based techniques may offer a shorter, and potentially more personally meaningful alternative to existing established therapies.

Mental imagery

Mental imagery can be defined as cognitive experiences that have sensory properties, and therefore will closely resemble actual perceptual experiences (Klein & Moritz, 2014). For example, a person may recall an episodic memory of their first day of school and be able to picture this vividly in their mind, and they may also be able to recall experiences in other sensory modalities, such as sounds and smells, that accompany this memory. The result is a sensory experience that almost recreates the initial perceptual experience. This can also be true for imagined experiences, such as a person catastrophising a future experience.

Mental imagery has been shown to be important in a range of different disorders. Mental imagery is naturally a primary focus in post-traumatic stress disorder due to the presence of flashbacks and re-experiencing (Holmes, 2003; Hirsch & Holmes, 2007). These flashbacks can be so powerful and overwhelming that people often describe their bodily sensations as feeling as though they were reliving the traumatic experience (Brewin, 2015). PTSD symptoms can sometimes be so severe that that a person will also experience high levels of paranoia, and auditory, visual, tactile, and olfactory hallucinations (OConghaile & DeLisi, 2015), akin to the experience of hallucinations in schizophrenia or psychosis. Hallucinations can be defined as being a strong experience of mental imagery (Nanay, 2016), as a person is perceiving without any external stimulus (Kosslyn et al., 1995). Those with

psychosis have traditionally been thought of as having mental imagery that is 'too vivid' and uncontrollable (Aynsworth, 2017; Morrison, 2001), however, recent evidence has cast doubt on this hypothesis, with Auvinen-Lintunen et al. (2022) instead finding that mood was the best predictor of imagery vividness, and that individuals with early-onset psychosis did not differ from a control group on measures of vividness and controllability.

Mental imagery in depression has also been explored, with Holmes et al. (2016) finding an excess of intrusive negative images, impoverished positive imagery, and lack of specificity in memories. Furthermore, if those with depression can be guided with positive prospective mental imagery, this can increase reward anticipation and reward motivation, and consequently reduce depressive symptoms (Pile et al., 2021). Given that mental imagery appears to play a part in many mental disorders, imagery interventions may provide a transdiagnostic intervention that may need to be personally tailored dependent on a person's difficulties.

People with eating disorders have been shown to have differing experiences of mental imagery than healthy controls. Hijne et al. (2020) found that spontaneous mental images in women with eating disorders were more vivid, more likely to be negative, more anxiety-provoking, experienced with a lower sense of control, and involve more sensory modalities when compared to controls. Furthermore, women with BN have reported more spontaneous images that are recurrent and significantly more negative and anxiety provoking than healthy controls (Somerville et al., 2007). The content of the images experienced is individualised, but links have been made to experiences of trauma and sexual abuse (Costin, 2018; Vanderlinden & Vandereycken, 2018; Vidaña et al., 2020) consistent with people with eating disorders having significantly higher adverse childhood experiences (ACEs) than healthy controls (Rienecke et al., 2022). Links have also been found between imagery in eating disorders and high exposure to body image material through media

(Munsch et al., 2021; Roberts & Good, 2010; Levine & Harrison, 2004), with increased exposure having a causal impact on the probability of a person developing an eating disorder.

Given that mental imagery has been shown to be important in a range of different disorders (Holmes, 2003; Holmes et al., 2016; Brewin, 2015), and that people with eating disorders also report differences in mental imagery compared to healthy controls (Hijne et al., 2020; Somerville et al., 2007), imagery-based interventions may provide an alternative route to intervention compared to the already established interventions, such as CBT-E.

Previous reviews

Tatham (2011) reviewed the role of imagery-based techniques in cognitive behavioural therapy for adults with eating disorders. They further specified their review to explore whether imagery techniques are effective in targeting the core beliefs, as Leung et al. (2000) found that pre-treatment core beliefs were associated with the degree of change in disorders such as bulimia nervosa. This review found that imagery rescripting may be effective in addressing three areas of eating disorders that have historically been difficult to treat, these being core beliefs, emotional dysfunction, and body image. They also highlighted that research investigating imagery-based techniques in eating disorders was scarce, with the review only using the empirical results from two papers (Ohanian, 2002; Cooper et al., 2007). Given the link between mental imagery and emotion, they concluded that imagery-based techniques can enhance CBT techniques in therapy. Participants also anecdotally reported that imagery-based techniques personally meaningful, and Tatham (2011) notes that this may address the problem of dropout and attrition rates often seen in eating disorder research (such as Jenkins et al., 2019).

Aims

This review will aim to synthesise the current research literature around mental imagery-based interventions for eating disorders. This review will focus on:

- The imagery-based strategies that have been offered to people with eating disorders
- The quality of the research studies that have been undertaken to evaluate their effectiveness
- The effectiveness of the interventions in reducing eating disordered behaviour and underlying emotional functioning

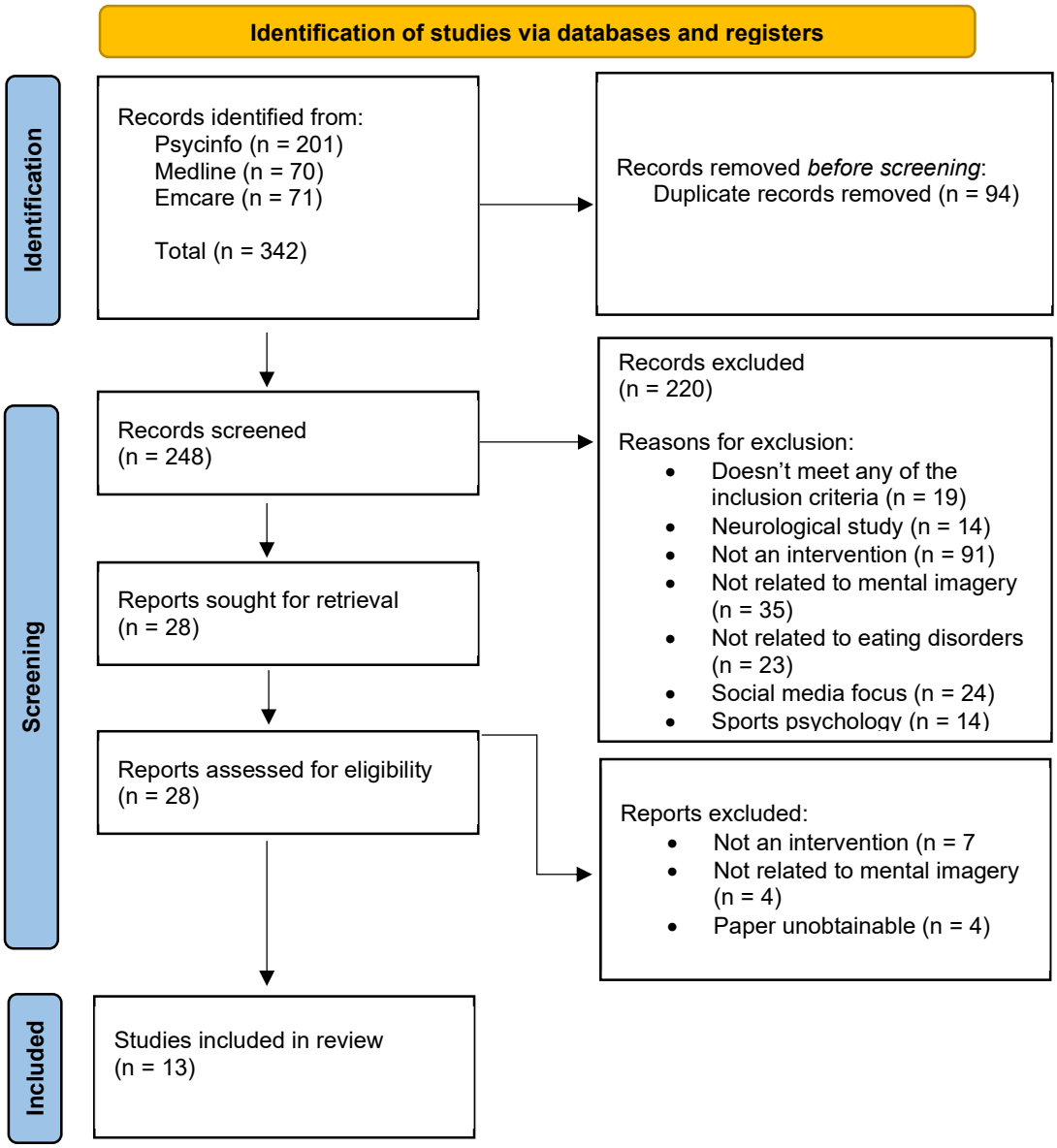
Methods

Protocol and registration

The systematic review followed the Preferred Reporting Items for Systematic review and Meta-Analysis Protocols (PRISMA-P) guidelines. The protocol for this review was registered in the international prospective register of systematic reviews (PROSPERO; registration number: CRD42022297897). The review set out to report the efficacy of mental imagery-based interventions for eating disorders including the study characteristics, design, methodology, quality, and challenges of implementation

Search strategy

This systematic review was conducted in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) Statement guidelines. A systematic search of research literature was conducted to identify studies with quantitative outcomes studying the effects of mental imagery on eating disordered behaviour. A meeting was held between the researcher and a specialist university librarian to ensure the literature search was as detailed as possible. The librarian contributed by recommending search terms and databases that would be appropriate to gain the most accurate set of results. The librarian also advised on a reliable process of removing duplicate search results, and how to export these results to a separate programme (Microsoft EndNote).Three electronic databases were used for the current review: PsycINFO, Ovid Emcare, and Ovid Medline. Search terms used for each database were “imagery” OR “mental imagery” AND “eating disorder*” OR “disordered eating”. Although this systematic review was focussed on mental imagery interventions specifically, it was decided that the term ‘intervention’ would not be added to the search terms in case it excluded relevant results (as terms such as ‘course’, ‘treatment’, ‘plan’ etc. could have been used instead). As there were only 342 results without the addition of the term ‘intervention’ or any of its variations, it was decided that these would be manually screened.



Inclusion and exclusion criteria

There were no exclusions based on the age of the participants. The inclusion criteria for the systematic review were as follows:

1. Must be relevant to mental imagery

As the area of investigation is mental imagery, the most basic assumption is that the studies must be relevant to mental imagery in some way. All papers specifically referred to the term as mental imagery, and no alternative terms were identified.

2. Must be an intervention targeting mental imagery

The intervention itself must be targeting mental imagery, however, outcome measurements may vary. For example, a mental imagery intervention may have its outcomes measured by a reduction in eating disordered behaviour, as opposed to purely measuring whether the content of the mental imagery has changed. There was a wealth of papers examining the content of mental imagery and what a person may experience, but this review will solely focus on interventions and their effectiveness in treating those with eating disorders or those at risk of developing eating disorders.

3. Must be related to eating disorders / those as risk of developing an eating disorder

Some studies with larger samples used measures of eating disorder tendencies, rather than focussing on participants who had been formally diagnosed with an eating disorder. This meant that the papers were assessing those with traits or those 'at risk' of developing an eating disorder. These studies were included in this review.

The exclusion criteria were:

1. Papers not in English as a first language

Data extraction

The Cochrane Developmental, Psychosocial, and Learning Problems (CDPLP) form was used as a guide to develop a bespoke data extraction form. This form was adapted to extract information relevant to this review. The form extracted the following data:

- The aims of the study
- The design of the study

- Duration of intervention
- Inclusion and exclusion criteria
- Method of recruitment
- Number of participants
- Demographic information about participants
- Intervention groups
- Outcomes of intervention

Quality checks

A sample of 13 included papers and 13 excluded papers were checked by a second rater. An initial concordance rate of 85% was found. Two were deemed as being excluded by the second rater when first rater included, and two were deemed as being included by second rater when first rater excluded. This was resolved by discussing the four papers in a meeting. After discussion, no papers were changed from the initial results.

Evaluation of study quality

The quality of included studies was assessed by the Quality Assessment Tool for Quantitative Studies (Thomas et al., 2004). This tool rates the strength of the studies based on several factors, these being: (a) selection bias, (b) study design, (c) confounders, (d) blinding, (e) data collection methods, (f) withdrawals and dropouts, (g) intervention integrity, and (h) analyses. The items 'intervention integrity' and 'analyses' do not contribute to the overall score of a studies' strength. This tool will assign a rating of study strength by using three categories: strong, moderate, or weak. Criteria for 'strong' papers is that there are no areas assigned a score of three, 'moderate' allows for one score of three, and 'weak' will have two or more ratings of three. Thirteen eligible studies were screened using this tool by two independent raters. There were two discrepancies between raters when

deciding the study strength. These were discussed and the primary rater's categorisations was changed as a result.

Results

Descriptive characteristics of included studies

Thirteen studies were included in this review, with participants across all studies totaling 531. Three hundred and one received a target intervention related to imagery, eighty-seven were allocated to studies that were interventions but not related to mental imagery, and the remaining 143 were in control conditions. Three of the included studies were case studies, involving only one participant (Ohanian, 2002; Cooper, 2011; Esplen & Garfinkel, 1998). All three of these were rated as weak evidence using the quality assessment tool. Four were randomized controlled trials (Esplen & Garfinkel, 1998; Zhou & Wade, 2020; Zhou et al. 2020; and Pennesi & Wade, 2018), with ratings ranging from 'weak' to 'strong' for these.

Calculation of effect sizes for included studies

Some studies included effect sizes as a complement to the significance testing (ten Napel-Schutz et al., 2022; Duarte et al., 2017; Kadriu et al., 2021; Pennesi & Wade, 2017; Dugue et al., 2018; Zhou et al., 2020). Therefore, an effect size calculator was used for the remaining studies to gain a comparator to other interventions (Lenhard & Lenhard, 2016), if information for calculating effect sizes was available in the research paper. These effect sizes were calculated and interpreted with guidance and reference to Cohen (1988). Additional guidance for calculation of repeated measures design was provided by Morris & DeShon (2002). Cohen (1988) benchmarks were used to interpret effect sizes as small (0.20), medium (0.50), or large (0.80).

Table 1 – Outcome table for the thirteen included studies

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2022	ten Napel-Schutz et al.	Moderate	Cohort based study	10	PTSD in underweight eating disorder patients	Anorexia Nervosa or Other Specified Feeding and Eating Disorder (OFSED)	Imagery rescripting	15 – 21 weeks	3 months	PTSD Scale-Self Report for DSM-5 (PSS-SR) Visual Analogue Scales (VAS) Post-Traumatic Cognitions Inventory (PTCI) Body Mass Index (BMI) Eating Disorder Evaluation-Questionnaire (EDE-Q) Difficulties in Emotion Regulation Scale (DERS)	Significant decrease on PSS-SR scores at 3 month follow up (p = 0.003, effect size 1.53) Significant decrease on posttraumatic cognitions inventory (PTCI; p = 0.043, effect size 4.00) Significant decrease on visual analogue scales (VAS) in domains of negative emotions (p = 0.039, effect size 1.39), self-belief (p = 0.005, effect size 2.35), and body-belief (p = 0.004, effect size 3.79) Significant decrease on eating disorder evaluation questionnaire (EDE-Q; p = 0.050, effect size 1.45) Significant decrease on difficulties in emotion regulation scale (DERS; p = 0.010, effect size = 2.41) Significant increase in Body Mass Index (BMI, p < 0.001, effect size = 3.80)

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
1998	Esplen et al.	Strong	Randomised controlled trial (RCT)	58	Guided imagery group, control	Bulimia nervosa	Guided imagery designed to enhance self-comforting in bulimia nervosa	6 weeks	0	Diagnostic Survey for Eating Disorders (DSED) Eating Disorder Inventory (EDI) Eating Attitudes Test (EAT-26) Binge and Purge self-reports Basic Personality Inventory (BPI) – Impulse Expression subscale Modified version of UCLA Loneliness Scale Modified version of Aloneness / Evocative Memory scale Soothing Receptivity Scale	Significant decrease in bingeing and purging frequencies in guided imagery condition (bingeing $p < 0.001$, purging $p < 0.001$, effect size = 2.187) Significant decreases in Drive for Thinness ($p < 0.001$, effect size = 0.7), Bulimia ($p < 0.001$, effect size = 0.879), and Ineffectiveness subscales ($p = 0.004$, effect size = 0.693) Significant decrease on Eating Attitudes Test (EAT-26; $p < 0.001$), including Bulimia ($p < 0.001$) and Dieting ($p = 0.009$) subscales

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2018	Harlowe et al.	Moderate	Cohort analytic study	66	One positive imagery condition, one negative imagery condition	No formal diagnosis, high levels of eating disorder cognitions as defined by scores on EDE-Q	Positive imagery	Single session	0	Eating Disorder Examination Questionnaire 6.0 (EDE-Q) Rosenberg Self-Esteem Scale (RSE) State self-esteem scale (SSES) Self-Esteem Implicit Association Test (SE-IAT) State Self-Concept Clarity Scale (SSCCS) Self-discrepancy index (SDI) Positive and negative affect scales (PANAS)	Explicit positive self-esteem significantly increased after positive imagery retrieval ($p < 0.001$, effect size = 0.7), and significantly decreased after negative imagery retrieval ($p < 0.001$, effect size = 1.053) No significant difference between groups on implicit self-esteem

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
1998	Esplen & Garfinkel	Weak	Case study	1	Guided imagery	Bulimia nervosa	Guided imagery	Single session	0	Bingeing and purging frequency	Reduction in binge and purge frequency (once or twice every few weeks, reduced from 3 to 6 episodes weekly) Greater sense of control Increase in mood and renewed life interest

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2020	Zhou	Moderate	Randomised control trial (RCT)	11	Treatment as usual + imagery rescripting, treatment as usual	Anorexia Nervosa and Otherwise Specified Feeding and Eating Disorders (OSFED)	Imagery rescripting	4 weeks	0	Depression Anxiety Stress Scale (DASS) Clinical Impairment Assessment Questionnaire (CIA) Eating Disorder Examination-Questionnaire (EDE-Q) Body Image Acceptance & Action Questionnaire (BI-AAQ) Self-Compassion Scale-Short Form (SCS-SF) Dysfunctional Attitude Scales Short Form 1 (DAS-SF1) Clinical Perfectionism Questionnaire (CPQ)	TAU significantly better at reducing symptoms of depression than TAU + IR TAU significantly better at reducing symptoms of stress than TAU + IR TAU significantly better at reducing global eating psychopathology than TAU + IR IR improved negative core beliefs about self, others, and the world within one session IR reduced dysfunctional attitudes within a month

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2017	Duarte	Moderate	Controlled clinical trial	20	Intervention or waiting list control	Binge Eating Disorder (BED)	Intervention (mindfulness, soothing rhythm breathing, compassionate imagery practices)	4 weeks	4 weeks	Body Mass Index (BMI) Eating Disorder Examination 17.0D (EDE) Binge Eating Scale (BES) Body Image Shame Scale (BISS) Depression, Anxiety, and Stress Scale (DASS) Cognitive Fusion Questionnaire – food craving Body Image Acceptance and Action Questionnaire Five-Facet Mindfulness Questionnaire Compassionate Engagement and Action Scales Self-Compassion Scale Forms of Self-Criticism and Self-Reassurance Scale	<u>Decrease</u> Binge eating symptoms (p = 0.003, effect size 0.89) Eating psychopathology indicators (p = 0.003, effect size = 0.89) Overvaluation of weight and shape (p = 0.003, effect size 0.89) Cognitive fusion with food craving (p = 0.003, effect size = 0.89) Inadequate self subscale for self-criticism (p = 0.007, effect size = 0.69) Depressive symptoms (p = 0.007, effect size = 0.81) Stress symptoms (p = 0.006, effect size = 0.82) <u>Increase</u> Psychological flexibility regarding body image (p = 0.016, effect size = 0.72) Nonjudging facet of mindfulness (p = 0.007, effect size = 0.60)

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2011	Cooper	Weak	Case study	1	None	Bulimia nervosa	Imagery rescripting	Single Session	0	Rational and emotional belief ratings for 4 separate statements – pre and post	Reduction in rational and emotional belief rating for 'I'm all alone' (R20 to R10, E90 to E60) Reduction in emotional belief rating for 'I'm unloved' (E80 to E60) Reduction in rational and emotional belief rating for 'I'm uncared for' (R20 to R10, E90 to E50) Reduction in rational and emotional belief rating for 'I'm not wanted' (R20 to R10, E100 to E60)

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2007	Cooper	Moderate	Controlled clinical trial	24	Experimental group (imagery modification), control	Bulimia nervosa	Imagery modification	Not stated (single session assumed)	0	Eating Attitudes Test (EAT) Eating Disorder Belief Questionnaire (EDBQ) Beck Depression Inventory (BDI) Rosenberg Self Esteem Scale (RSE) Body Mass Index (BMI)	Significant reduction in negative rational self-beliefs ($F = 4.6$, $df = 1,22$, $p < .05$) Significant reduction in negative emotional self-beliefs ($F = 15.1$, $df = 1,22$, $p < .001$) Significant reduction in emotional self-blame beliefs ($F = 37.8$, $df = 1,22$, $p < 0.001$) Significantly reduced restraint on behaviour measure ($F = 8.2$, $df = 1,22$, $p < 0.01$)

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2021	Kadriu	Strong	Controlled clinical trial	66	Imagery rescripting of autobiographical memories, imagery rescripting of intrusive memories, no task control	People at risk of developing an eating disorder (no formal diagnosis)	Imagery rescripting	1 week	0	Eating Disorder Examination-Questionnaire (EDE-Q) Eating Disorders Inventory (EDI-3) ED-related sentence completion task (ED-SCT) Eating Disorders Beliefs Questionnaire (EDBQ) Spontaneous Images Questionnaire (SIQ) Early Memory Questionnaire (EMQ) Centrality of Event Questionnaire (CES) Depression Anxiety Stress Scale (DASS-21) PTSD Symptoms Self-Report Scale (PSS-SR)	Significant reduction on EDE-Q scores of imagery rescripting for memories ($p = 0.001$, effect size = 0.82) and imagery rescripting for intrusive images ($p = 0.003$, effect size = 0.73) compared to control Significant decrease in ED-SCT scores for imagery rescripting of autobiographical memories ($p = 0.004$, effect size = 0.66), and rescripting of intrusive images ($p = 0.01$, effect size = 0.58) No significant effect of time or group on EDBQ scores Overall reduction in ED symptoms across all groups, including control

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2020	Zhou	Moderate	Randomised control trial (RCT)	130	Body imagery rescripting, general imagery rescripting, psychoeducation, control	Participants at risk of developing an eating disorder (no formal diagnosis)	Imagery rescripting	1 week	1 week	Weight Concerns Scale (WCS) Eating Disorder Examination-Questionnaire (EDE-Q) Body Image Acceptance & Action (BI-AAQ) Self-Compassion Scale-Short Form (SCS-SF) Fear of Self-Compassion (FSC) Dysfunctional Attitudes Scales Short Form 1 (DAS-SF1) Positive and Negative Affect Schedule (PANAS) Body Image States Scale (BISS)	Both imagery and psychoeducation had significant impact on global eating psychopathology and body acceptance (effect size range 0.60 – 0.78) Psychoeducation did not impact secondary variables, whereas imagery rescripting improved self-compassion and fear of self-compassion (effect size range 0.61 – 0.80) Imagery rescripting improved dysfunctional attitudes (effect size = 0.82)

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2018	Dugue	Strong	Controlled clinical trial	36	Cognitive restructuring or imagery rescripting	Binge Eating Disorder (BED) or Bulimia Nervosa	Imagery rescripting	2 sessions (average 4 days apart)	1 week	Eating Disorder Examination Questionnaire (EDE-Q) Spontaneous Use of Imagery Scale (SUIS) Beck Depression Inventory (BDI-V) State Trait Anxiety Inventory (STAI-T) Visual Analogue Scales (VAS)	No differences between cognitive restructuring and imagery rescripting on any of the outcome measures, although both showed a positive effect Imagery rescripting effective at increasing positive emotions (effect size = 2.06) Imagery rescripting effective at reducing negative emotions (effect size = 0.77) No effect on rational core beliefs (effect size = 0.01) Imagery rescripting effective at reducing emotional core beliefs (effect size = 0.68) Effect sizes of reduction of emotional core beliefs were larger within imagery rescripting than cognitive restructuring

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2018	Pennesi	Strong	Randomised control trial (RCT)	107	Imagery rescripting, cognitive dissonance, control	At risk of developing an eating disorder (no formal diagnosis)	Imagery rescripting	1 week	0	Weight Concern Scale (WCS) Body Image-Acceptance and Action Questionnaire (BIAAQ) Depression Anxiety and Stress Scale-Short form (DASS-21) Self-Compassion Scale Short-form (SCS) Clinical Impairment Assessment-Questionnaire (CIA) Eating Disorder Examination Questionnaire (EDE-Q)	Participants in IR condition reported significantly higher body image acceptance than those in cognitive dissonance condition (p = 0.014, effect size = 0.49) Participants in IR condition reported significantly higher levels of self-compassion than those in control condition (p = 0.009, effect size = 0.59) Participants in IR condition reported significantly lower levels of disordered eating than those in control condition (p = 0.016, effect size = 0.59)

Year of publication	Lead author	Quality rating	Study design	Participants (n)	Participant groups	Eating disorder diagnosis	Interventions	Intervention length	Follow-up period	Measures	Outcomes
2002	Ohanian	Weak	Case study	1	Imagery rescripting	Bulimia Nervosa	Imagery rescripting	Single session	3 months	Bingeing and vomiting frequency	Eight sessions of CBT reduced symptom behaviours by 50% Reduction in bingeing vomiting behaviour of almost 75% one month after single session of imagery rescripting No quantitative data for follow-up points of a further month later and a further 6 weeks later

Results of the quality assessment tool

The Quality Assessment Tool for Quantitative Studies assigned strong ratings to four papers, moderate to six papers, and weak to the remaining three papers. The area most consistently assigned a 'weak' rating on the overall form was the blinding of the studies, as the interventions were commonly being administered by the researchers themselves. This may also introduce a level of bias into the results.

Table 2.

Results of Quality Assessment Tool (QATQ)

	ten Napel-Schutz et al. (2022)	Esplen et al. (1998)	Harlowe et al. (2018)	Esplen & Garfinkel (1998)	Zhou & Wade (2020)	Duarte et al. (2017)	Cooper (2011)	Cooper et al. (2007)	Kadriu et al. (2021)	Zhou, Pennesi & Wade (2020)	Dugue et al. (2018)	Pennesi & Wade (2018)	Ohanian (2002)
Selection bias	1	1	2	3	3	1	3	1	1	2	1	1	3
Study design	2	1	2	3	1	1	3	1	1	1	1	1	3
Confounders	1	1	3	1	1	1	1	1	1	3	1	1	1
Blinding	3	1	2	2	2	2	3	2	2	2	2	2	3
Data collection method	1	1	1	3	1	1	3	3	1	1	1	1	3
Withdrawals and dropouts	1	1	1	1	1	3	3	1	2	3	1	1	1
Rating	**Moderate**	**Strong**	**Moderate**	**Weak**	**Moderate**	**Moderate**	**Weak**	**Moderate**	**Strong**	**Weak**	**Strong**	**Strong**	**Weak**

Study design

Of the thirteen studies, four were randomised control trials (Esplen et al., 1998; Zhou & Wade, 2020; Zhou et al., 2020; and Pennesi & Wade, 2018), four were controlled clinical trials (Duarte et al., 2017; Cooper et al., 2007; Kadriu et al., 2021; Dugue et al., 2018), three were case studies (Esplen & Garfinkel, 1998; Cooper 2011; Ohanian; 2002), one was a cohort based study (ten Napel-Schutz et al., 2022), and one was a cohort analytic study (Harlowe et al., 2018).

Of the thirteen studies, none included a power calculation to calculate the number of participants required. This is an unfortunate weakness of the included papers. Three papers were case studies of single participants, and others had relatively small sample sizes (Duarte et al., 2017; Zhou & Wade, 2020; ten Napel-Schutz et al., 2022). Sample sizes were not discussed in any papers as being limitations, however, the low sample sizes may be explained by the rigid inclusion criteria (ten Napel-Schutz et al., 2022), limited access to people with eating disorders (Duarte et al., 2017; Cooper et al., 2007), or the environment that the study was being conducted in (such as hospital rehabilitation units; ten Napel-Schutz et al., 2022) having low participation rates.

Seven studies were rated by the quality tool as having participants that are representative of the target population. Three studies were marked down for being single participant case studies (Esplen & Garfinkel, 1998; Ohanian, 2002; Cooper 2011). Zhou & Wade (2020) extended an offer to take part to thirty-three people, and fifteen gave their consent to take part. Therefore, this study was determined to have a low rate of agreement from participants to take part (less than 60% agreement), and therefore had some selection bias evident. Harlowe et al. (2018) was rated as being 'somewhat likely' to be representative, as this study used an analogue population of students that scored highly on a measure

of eating disorder tendencies. Zhou et al. (2020) also used an analogue population of university students. Other studies in this review used participants that had been diagnosed with eating disorders and are therefore more likely to be representative of the target population.

Risk of bias

As previously stated, the area most likely to obtain a 'weak' rating on the quality assessment tool was the blinding condition. Only one study attracted a 'strong' rating for blinding (Esplen et al., 1998), whereas the other studies were not able to fully blind their intervention. This was a result of the researchers delivering the interventions, such as imagery rescripting, themselves. This may introduce a level of bias into the results, as researchers are aware of which group receives which intervention.

Outcome measures

Forty-three different outcome measures were used in the thirteen studies, with a total of seventy-five separate outcome measures being administered overall. The three papers rated as weak by the quality assessment tool did not use validated outcome measures, and instead relied upon information such as self-reported bingeing and vomiting frequency (Ohanian, 2002; Esplen & Garfinkel, 1998) or rational and emotional belief ratings (Cooper, 2011). Although these are highly meaningful outcomes, these were single case studies, and therefore may not be the most reliable result. This behaviour was also not measured using validated outcome measures and relied upon participant's self-report of their behaviour. Excluding the three papers that did not use validated outcome measures, the remaining ten papers averaged seven outcome measures per study (range 5 – 11). The most frequent measure administered was the Eating Disorder Examination-Questionnaire (EDE-Q), appearing in seven of the thirteen studies. Body mass index (BMI), one of the main markers of progress for a person with an

eating disorder, was used as a measure in three studies (Cooper, 2007; Duarte et al., 2017; ten Napel-Schutz et al., 2022).

Effectiveness of interventions

Eight of the thirteen studies used imagery rescripting as their intervention. One paper used 'imagery modification' (Cooper, 2007), although the protocol for this appears to be similar to imagery rescripting. Two studies used guided imagery as their intervention of choice (Esplen & Garfinkel, 1998; Esplen et al., 1998). One study used positive imagery (Harlowe et al., 2018). The remaining study used compassionate imagery exercises as part of a larger intervention, including mindfulness and soothing rhythm exercises (Duarte et al., 2011).

All thirteen studies showed a positive effect of imagery interventions for reducing eating disorder behaviour. Eight of these studies had a control or comparison group, either being waiting list or no task controls (Duarte et al., 2017; Kadriu et al., 2021), or alternative interventions (Esplen et al., 1998; Zhou & Wade, 2020; Cooper et al., 2007; Zhou et al., 2020; Dugue et al., 2018; Pennesi & Wade, 2020). Pennesi & Wade (2020) compared imagery rescripting and cognitive dissonance as interventions, and found that imagery rescripting was more effective, leading to higher body image acceptance, higher self-compassion, and lower levels of disordered eating. Imagery rescripting was also shown to have similar effectiveness to other established interventions, such as cognitive restructuring. Dugue et al. (2018) found that although both interventions reduced eating disordered behaviour, there was no significant difference between the effectiveness of imagery rescripting and cognitive restructuring. They did however note that the effect sizes of the reduction of emotional core beliefs was larger within the imagery rescripting intervention.

One study found that imagery rescripting was less effective than treatment as usual, at least in the short term (Zhou & Wade, 2020). Treatment as usual was not defined by Zhou & Wade (2020), only stating that all participants were attending a state-wide eating disorder service in southern Australia. Of the eleven participants recruited all of them were female, with eight having a diagnosis of anorexia nervosa, and three with otherwise specified feeding and eating disorders. Imagery rescripting was used as an adjunct to treatment as usual in this case. Their results indicated that although imagery rescripting did not worsen any symptoms, it did appear to 'slow the change for disordered eating and erode participants' confidence'. Other explanations for this result were offered, such as inappropriate timing of the intervention, the effectiveness of imagery rescripting takes longer to appear, the mode of delivery (face-to-face) may not have been helpful, and that the content of the imagery was not tailored to the participant appropriately.

To summarise, it appears that imagery rescripting can be an effective intervention in reducing eating disorder symptomology, but some studies suggest that other forms of treatment are either equally as effective, or perhaps more effective, than imagery rescripting.

Mode of delivery

Eleven of the thirteen studies were delivered face-to-face in laboratory and community settings. Two studies looked at the effectiveness of online interventions for women at risk of developing an eating disorder (Pennesi & Wade, 2017; Zhou et al, 2020).

Duration of intervention

One study did not formally report the duration of the intervention (Cooper, 2007). Four studies reported on the effectiveness of a single session (Ohanian, 2002; Cooper, 2011; Esplen & Garfinkel, 1998; Harlowe et al., 2018). Only one of these single session interventions had a follow-up period, with the others taking pre and post measures before and after the single session. The longest study followed participants for approximately six months (ten Napel-Schutz et al., 2022), with three months of intervention and a three-month follow-up. The remaining studies varied from one to six weeks in intervention length. Seven studies required participants to complete homework tasks outside of the intervention, although no studies had a reliable way of confirming whether participants had completed this.

Attrition rates of intervention

It was possible to calculate dropout rates for seven of the thirteen studies. Three studies were based upon single session imagery interventions (Ohanian, 2002; Cooper, 2011; Esplen & Garfinkel, 1988), whilst three were based upon single participant case studies (Harlowe et al., 2018; Zhou & Wade, 2020; Cooper et al., 2007), and therefore had no dropout rate. For the remaining studies, dropout rates are summarised in Table 3.

Table 3.

Dropout rates of studies (where applicable)

Lead author(s)	Participants recruited	Participants dropped out	Dropout rate of imagery intervention (%)	Dropout rate of other intervention (%)	Dropout rate of control condition (%)
ten Napel-Schutz et al. (2022)	12	2	17%	N/A	N/A
Esplen et al. (1998)	58	8	14.3%	N/A	13.3%
Duarte et al. (2017)	33	13	35%	N/A	44%
Kadriu et al. (2021)	89	23	26%	N/A	N/A
Zhou et al. (2020)	130	11	8%	N/A	N/A
Dugue et al. (2018)	39	3	8%	N/A	N/A
Pennesi & Wade (2020)	115	8	3%	10%	8%

The above table shows that dropout rates for the available studies varied from 3% - 35%. Of the three studies included in Table 3 that had control conditions, the dropout rates were broadly similar to the intervention conditions. Only one study included a comparator intervention (Pennesi & Wade, 2020), and the dropout rate of the imagery intervention was 7% less than the comparator.

Replicability

The Template for Intervention Description and Replication (TiDieR) checklist (Hoffman et al., 2014) was used to assess whether each study provided sufficient information to enable replication. This template includes twelve items, and page numbers are recorded where the relevant information can be found in each research paper. Two areas that were notably weaker were the description of who facilitated the interventions, and the materials available to enable replication. The lack of materials can be explained by the fact that imagery interventions are often flexible and tailored to the session content. Only 42% of studies described fidelity checks for the interventions, an area which may need to be improved in future studies. Full results can be seen in Table 4.

Table 4.

Results of the TidDieR checklist for replicability of studies (data summarised across two separate tables)

TiDier item	ten Napel-Schutz et al. (2022)	Esplen et al. (1998)	Harlowe et al. (2018)	Esplen and Garfinkel (1998)	Zhou and Wade (2020)	Duarte et al. (2017)	Cooper (2011)
1. Name of intervention	6	1348	1	106	37	1438	454
2. Rationale	2	1348	3	106	38	1438	458
3. Materials	-	1350	-	-	-	-	462
4. Procedures	7	1350	5	113	39	1439	460
5. Facilitator	7	1350	-	-	-	-	-
6. Mode of delivery	-	1350	-	113	37	-	-
7. Setting	6	-	-	113	38	-	-
8. Dosage	6	1348	5	114	39	1439	463
9.Planned adaptations	-	-	-	-	-	-	-
10.Modifications	-	-	-	-	-	-	-
11. Planned fidelity checks	7	-	5	-	-	-	-
12. Actual fidelity checks	7	-	5	-	-	-	-
Total by paper	**67%**	**58%**	**50%**	**50%**	**50%**	**33%**	**42%**

TiDier item	Dugue et al. (2018)	Pennesi and Wade (2017)	Ohanian (2002)	Zhou et al. (2020)	Kadriu et al. (2021)	Cooper (2007)	Total by item
1. Name of intervention	183	440	353	1906	1	2	**100%**
2. Rationale	184	440	354	1906	2	3	**100%**
3. Materials	185	-	-	-	-	-	**25%**
4. Procedures	185	440	354	1909	5	6	**100%**
5. Facilitator	-	-	-	1909	5	-	**33%**
6. Mode of delivery	-	441	-	1909	5	-	**50%**
7. Setting	-	441	-	1909	-	-	**42%**
8. Dosage	184	441	355	1909	5	-	**92%**
9.Planned adaptations	-	-	-	-	5	-	**8%**
10.Modifications	-	-	-	-	5	-	**8%**
11. Planned fidelity checks	-	442	-	1910	5	-	**42%**
12. Actual fidelity checks	-	442	-	1910	5	-	**42%**
Total by paper	**42%**	**67%**	**33%**	**75%**	**83%**	**25%**	

Discussion

Overview

The aim of this review was to summarise evidence for mental imagery-based interventions for eating disorders. Specifically, we were assessing the types of interventions that have been used and their effectiveness. A previous review by Tatham (2011) reviewed the role of imagery-based techniques in cognitive behavioural therapy for adults with eating disorders, however, at the time, they highlighted that research into this area was scarce. Since 2011, more research has been conducted exploring this area, therefore, a systematic review appeared necessary.

Comparison to other interventions

Tatham (2011) suggested that imagery interventions may be more meaningful to people with eating disorders, and therefore these interventions are more likely to experience a lower dropout rate. The results of this review lend evidence to this suggestion, with dropout rates for seven of the thirteen studies being available for calculation. Dropout rates of imagery interventions ranged from 3% - 35%, with an average rate of 16% across all seven studies. These studies also appear to have healthy sample sizes, with a range of 12 – 130 participants, with the average being 68 participants. Current interventions such as CBT-E have been found to have higher dropout rates, with Jenkins et al. (2019) stating that 46% of CBT-E participants dropout over the course of therapy. This may be expected due to the large 40-session commitment that CBT-E requires of patients. Furthermore, CBT-T, the 10-session adaptation of CBT-E for people who are not underweight, has also been found to have an average dropout rate of 39% over the course of therapy (Keegan et al., 2022). However, it must also be noted that imagery-based interventions, such as imagery rescripting, can often form part of these CBT

interventions themselves, so it is unclear whether there is some overlap in intervention provided. Other interventions, such as motivational interviewing, have also been found to have similar dropout rates to CBT interventions (Katzman et al., 2010), suggesting that imagery-based interventions are better at retaining participants compared to various types of eating disorder interventions.

Imagery interventions can often be completed in a shorter timeframe than other interventions for eating disorders. Five studies reported on the effects of a single session of imagery-based interventions, three of these being case studies (Ohanian, 2002; Cooper, 2011; Esplen & Garfinkel, 1998), one being a controlled clinical trial (Cooper et al., 2007), and one being a cohort analytic study (Harlowe et al., 2018). Two of these studies used imagery rescripting (Cooper, 2011; Ohanian, 2002), one used imagery modification (Cooper, 2007), one used positive imagery (Harlowe et al., 2018), and one used guided imagery (Esplen et al., 1998). Each of these five studies reported positive effects of their respective imagery-based intervention. However, only one case study used a follow-up period of three months (Ohanian, 2002). Despite this limitation, single-session interventions still showed effectiveness with pre-post measures, and therefore this may be evidence for their usage in eating disorder interventions. The remaining eight studies had a range of intervention length of one to twenty-one weeks, with an approximate average intervention length of 4.5 weeks. Although sessions per week can vary, if we were to assume one session per week for a course of CBT-E and CBT-T, imagery-based interventions are significantly shorter in duration than both currently recommended interventions. Therefore, imagery-based interventions may provide a shorter and more efficient intervention for eating disorders.

Keegan et al. (2022) conducted a systematic review and meta-analysis exploring the effectiveness of 10-session CBT-T for non-underweight eating disorders. This allows us to compare the effect sizes of the

interventions included in this review against CBT-T. Keegan et al. (2022) provides a pooled effect size for reductions in eating disorder psychopathology, giving a value of 1.49, a large effect size for CBT-T. Atwood & Friedman (2019) also conducted a systematic review on CBT-E, finding typically medium to large effects for CBT-E interventions, although this data was not pooled. The effect sizes for imagery interventions relating to eating disorder psychopathology included in this review ranged from 0.59 to 2.187, with Pennesi & Wade (2020) finding imagery rescripting lowered disordered eating (effect size, 0.59), and Esplen et al. (1998) finding a significant reduction in binge and purge frequency after a guided imagery intervention (effect size, 2.187). Imagery interventions appear to be comparable to CBT-E and CBT-T, but a full meta-analysis would allow direct comparison of these effect sizes and allow us to interpret results with confidence, and this may be an area to focus on in further research.

These results also highlight a current difficulty with this area of research, that being the variation in which outcomes are measured for those with eating disorders. The current review found that across thirteen studies, forty-three separate outcome measures were used. Although some measures can be grouped into categories such as eating disorder psychopathology, others are not as amenable to grouping, such as fear of self-compassion or perfectionism. There is also the broadness of the area of eating disorders, as anorexia nervosa can present very differently to bulimia nervosa or binge eating disorder. Whilst weight gain may be an appropriate outcome measure for anorexia nervosa, it may not be as applicable for bulimia nervosa. Future reviews may benefit from narrowing the scope of the review to focus on specific diagnoses, rather than the broad definition of eating disorders.

Strengths and limitations

This review aimed to utilise secondary raters at each stage to increase the reliability of the results. A sample of the initial included and excluded papers were given to a secondary rater to cross-reference whether studies should be included based on the criteria. The quality assessment tools for rating the papers were also completed by two raters. However, the data extraction stage was not completed by two or more raters, which may have introduced a level of bias into the results. During the screening process, four of the papers that may have been appropriate for inclusion were not obtainable. This was due to the papers not being obtainable online or through the local libraries. This was mainly due to the age of the papers, with them being too old to be retrieved. These papers may have included valuable information that would have contributed to this review.

A further limitation of this study relates to the previous review conducted by Tatham (2011). To ensure that relevant papers were not missed during the literature search, a citation search of this previous review could have been conducted. At the time of writing, twenty-eight papers have cited this previous review. A rudimentary citation search conducted after the completion of the systematic review found that Pennesi & Wade (2018), Dugue et al. (2018), Zhou et al. (2020), and Zhou & Wade (2020) had each cited this previous review in their papers. However, there may have been other studies that fit the inclusion criteria of our review that may have been missed. Further development of this systematic review, or further reviews in this area in the future, would benefit from including a planned citation search at the initial stages of the review.

Conclusions and recommendations

The papers analysed in this systematic review appeared to lack power considerations in their sample sizes. Power calculations are essential to ensure studies detect a clinically relevant treatment effect (Hickey et al., 2018), and therefore should be included in research studies where possible. There were also issues around assessment of fidelity of the interventions offered, with only 42% planning and using some form of fidelity checks. Materials were only explicitly made available in 25% of studies, and no protocols were referred to or described in the other studies. Although making materials available for an intervention which may rely heavily on conversational interactions may be difficult, examples of questions or scripts can benefit future researchers when considering replication. These factors combined may lead to difficulties with replicating these studies, something which is essential if confidence in psychological research is to be developed and maintained (Earp & Trafimow, 2015). Future studies should aim to remedy these limitations to make replication easier.

Estimates vary on the true range of people in the UK having an eating disorder, from 700,000 (BEAT, 2015) to 1.6 million (Sweeting et al., 2015). These rates clearly demonstrate the need for timely access to eating disorder services, and appropriate time-efficient interventions. Imagery-based interventions show effect sizes that are comparable to existing interventions such as CBT-E and CBT-T, with added advantages of generally shorter interventions and lower dropout rates, and therefore may be appropriate for use in clinical services. Imagery-based interventions can be delivered in single session format, or slightly longer, with an average duration of 4.5 weeks. This is significantly shorter than established interventions. There are few high-quality studies investigating imagery-based interventions, and more randomised control trials are needed to truly establish whether these are either able to

replace existing interventions, or provide an alternative for people that may not respond to interventions such as CBT-E and CBT-T.

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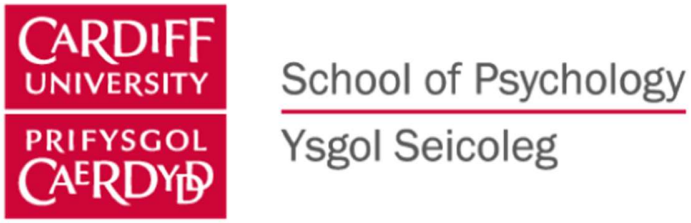

The effect of mental imagery processing on anxiety in a population demonstrating obsessive-compulsive behaviours

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Abstract

Background

Obsessive compulsive disorder (OCD) can be a chronic and disabling condition. Current treatments for OCD, such as cognitive behavioural therapy (CBT), are well-established, typically focussing on people's reactions to verbal cognitions, but studies have shown that efficacy rates can be low, and relapse is likely (Eisen et al., 2014). Greater understanding of processing in OCD could help to identify new or augmented treatment approaches. Mental imagery provides one area that may be of interest to OCD research but there is no research investigating verbal versus imagery cognitions within the context of OCD.

Methods

Seventy-two participants completed a measure of obsessive-compulsive tendencies (obsessive compulsive inventory; OCI) before completing an online task. Participants completed two conditions in a repeated measures design. The conditions targeted verbal and imagery processing. A measure of anxiety was administered at three time points to assess whether participants anxiety levels were differentially affected by verbal processing versus mental imagery.

Results

A median split was used to create two groups: a high OCI and low OCI group. Results found that those who scored higher on OCI measures were not significantly more affected by imagery processing than those in the low OCI group. There was also no significant difference in the effect of imagery and verbal processing among the complete sample.

Conclusions

Although those with high OCD tendencies scored highly on a measure of visual processing, imagery processing as compared to verbal processing did not have a significant effect on their anxiety ratings. Explanations for this result and suggestions for further research are discussed.

Keywords

Mental imagery; imagery; obsessive compulsive disorder; quantitative

Introduction

Obsessive compulsive disorder and mental imagery

Obsessive compulsive disorder (OCD) can be a chronic and disabling disorder that is characterised by intrusive thoughts and images and behavioural or cognitive responses to these (Veale & Roberts, 2014). Obsessions are frequent, unwanted, and difficult to control (Veale, 2007). An example of an obsession would be experiencing a repeated unwanted thought of harm coming to a loved one through contamination (such as a baby encountering harmful germs). A compulsion would be the resulting action based on the obsession, for example, touching a surface a certain number of times or repeating words in their own mind. Although some obsessional thoughts may be common worries for a typical population, people with OCD will often ascribe a different meaning to these thoughts, believing that they must act in some way to prevent the obsessive thought from happening (Einstein & Menzies, 2004). NICE estimates that around 1 – 2% of the UK population will suffer with OCD at any one time, although some estimates have been higher, reaching around 3% (National Institute for Care and Excellence, 2005).

Individuals with OCD believe they can and should prevent harm from occurring and often have an exaggerated sense of responsibility (Salkovskis & Warwick, 1985; Ladouceur et al., 1996; Menzies et al., 2000), which leads to putting significant effort into compulsions and avoidance behaviours. OCD is typically associated with an anxiety emotional response (Hezel & Simpson, 2019), although research has also found disgust (Berle & Phillips, 2006; Sprengelmeyer et al., 1997; Olatunji et al., 2011) and shame (Glazier et al., 2015; Szentágotai-Tătar et al., 2020) may also underly certain types of OCD. There is no definitive list of OCD subtypes, although some effort has been made to distinguish between OCD

diagnoses, such as categorising people as 'checkers' and 'non-checkers' (Cougle et al., 2007; Foa et al., 2002), or focussing more on the content such as contamination, perfection, harm, or forbidden thoughts (Haslam, et al., 2005; Sookman et al., 2005). The aetiology of OCD appears to be poorly understood. There is some appreciation of biological factors such as having first-degree relatives with OCD (Brakoulias et al., 2018), although this could also be explained through learnt behaviour. Supporting this, behavioural models suggest the obsessions are learnt fear responses which are reinforced by avoidance and compulsions (Salkovskis, 1999). The impact of traumatic experiences has also been explored in the development of OCD, with Miller & Brock (2017) finding that past trauma is associated with more severe OCD symptoms, particularly when considering compulsions. Certain types of interpersonal trauma, such as sexual abuse or physical violence, have been found to be more damaging than non-interpersonal traumas (Breslau, 2009). Badour et al. (2013) suggest that victims of sexual abuse may experience higher levels of disgust, and therefore may be more likely to engage in behaviours of experiential avoidance.

Psychological treatments for OCD have primarily focussed on the appraisal of thoughts (Abramowitz, 2006; Salkovskis, 2007). An intrusive thought of hurting another person may lead to an appraisal of 'I'm a dangerous person', and lead to safety and neutralising behaviours. The main goal of cognitive behaviour therapy (CBT) is to evaluate these appraisals via activities such as behavioural experiments and thought diaries (Salkovskis, 2007). Exposure and response prevention (ERP) is commonly delivered as part of a course of CBT (McKay et al., 2015). ERP requires people to be exposed to the feared object or situation and to inhibit their ritualistic or checking behaviour. People receiving CBT with ERP will experience a reduction in symptoms in 50 – 60% of cases, although complete symptom reduction is uncommon (Abramowitz, 2006). The current recommended treatment depends on the severity of the presentation, with pharmacological input such as selective serotonin reuptake inhibitors (SSRI) delivered alongside CBT with ERP being the treatment of choice for severe OCD (Reid et al., 2021). Rates of

recovery have been shown to vary, with Eisen et al. (2014) tracking 213 adults with primary OCD across a five-year period and finding that 39% experienced either a partial or full remission. There is also a high rate of relapse in those with OCD, with the same study finding that of those that experienced remission, 59% subsequently relapsed. As there is a population of people with OCD that do not respond to conventional treatments (Middleton et al., 2019), alternative or augmented treatment strategies need to be developed to target those who may not respond to current interventions (Kathmann et al., 2022). The area of mental imagery may provide one alternative solution for those with OCD that are considered treatment resistant.

Mental imagery has been defined as the experience of thoughts that are related to sensory properties, and therefore resemble actual perceptual experience (Holmes & Mathews, 2010). In simple terms, it is the experience of imagining a scenario and having a perceptual response. These bodily responses can involve visual, olfactory, gustatory, auditory, and tactile modalities (Tiggemann & Kemps, 2005; Nanay, 2018). The ability to conjure mental imagery varies from person to person, with some people being completely unable to experience mental imagery (a condition known as aphantasia; Zeman et al., 2015). People with aphantasia may have poorer working memory (Keogh & Pearson, 2011) and poorer episodic memory (Dawes et al., 2020), suggesting that mental imagery plays an important role in memory recall. Memory deficits have been found in people with OCD, although this may be attributed to major depression as a comorbidity (Wilhelm et al., 1997), rather than linking memory deficits to the ability to produce mental imagery. Research has also found that people with OCD have lower confidence in their memory, perception, and other cognitive functions, and the lower confidence may lead to poorer performance on memory tasks (Dar et al., 2022). Nevertheless, mental imagery ability may be particularly important when considering people with ‘checking’ OCD, as they often report they are unable to remember whether they have completed a behaviour such as locking a door (Cougle, et al.,

2007). Conversely, people with greater levels of mental imagery (hyperphantasia) have been shown to be more at risk of developing conditions such as schizophrenia (Sack et al., 2005).

Mental imagery may have a closer connection to emotional responses, with Conway (2001) suggesting that imagery is the preferred form in which highly affective experiences are recalled. Holmes & Mathews (2005) explore the link between imagery and emotions in depth, conducting an experiment whereby participants processed emotionally threatening stimuli through either imagery or verbal processing. Participants in the imagery condition reported higher increases in anxiety in response to the stimuli than those in the verbal condition. Furthermore, people who report little or no mental imagery have been shown to have dampened emotional responses to fear-based stimuli, supporting the hypothesis that mental imagery has a purpose of making thoughts more emotionally evocative (Wicken, et al., 2021). The idea of mental imagery being an emotional amplifier has been applied to specific diagnoses, such as post-traumatic stress disorder (PTSD; Ehlers & Clark, 2000), social phobia (Clark et al., 2006), and bipolar disorder (Holmes et al., 2008), where the increased presence of mental imagery can cause greater distress in relation to their symptoms.

Mental imagery may also increase the probability of events and the resulting emotional impact. Renner et al. (2019) found that people who completed a 'motivational imagery' session were likely to report higher levels of motivation, anticipated pleasure, and anticipated reward than controls, where controls were presented with either an activity reminder or no reminder. As well as facilitating positive behaviour change, the strength of mental imagery can also have potentially harmful effects, with Holmes et al. (2007) suggesting that if patients think about committing suicide in the form of an image rather than verbally, then this can increase the risk of suicide being completed. This may be particularly

important when considering disorders that have high suicide risk, such as borderline personality disorder (Paris, 2019) and PTSD (Fox et al., 2021). Differences in the utilisation of mental imagery can appear in prospective imagery, with people with higher levels of anxiety reporting pre-experiencing events as more intrusive and personally relevant, and rating future scenarios as more vivid and more probable (Deeprose & Holmes, 2010). People with OCD are also at high risk of suicide, with an estimated 14.2% of people attempting suicide, and significantly more experiencing suicidal ideation (Albert et al., 2019). Probability judgements that future negative events will happen to a person can be affected by mental imagery. The simulation heuristic states that people may determine the likelihood of an event based upon how easy it is to picture the event mentally (Kahneman & Tversky, 1981). However, the vividness of the mental picture has not been shown to affect probability ratings, with Raune et al., (2005) finding that increased vividness did not correlate with a person's perception of the likelihood of an event happening.

Speckens et al. (2007) found that people with OCD are likely to experience mental images when having obsessive compulsive symptoms, with their study finding 81% of their sample of 37 patients with OCD reported that they experienced strong mental imagery during these times. Most mental images were either memories of the adverse events that they had experienced, or images related to them. Furthermore, Moritz et al. (2014) found that three in four people with OCD report somatic symptoms linked to their obsessions, for example, being able to feel dirt on their fingers when they imagine they have touched a dirty surface. Klein & Moritz (2014) examined the content of mental imagery in people with OCD and found that the predominant sensory channels were somatic, visual, and tactile, and that the strength of these perceptions were highly correlated with a lack of insight into their illness. This suggests that intrusive thoughts in OCD may be more related to body sensations such as the feeling of

germs on hands or having to repeat a task until something feels 'just right'. Hirsch & Holmes (2007) also highlight that as well as the presence of unpleasant intrusive images that are ego-dystonic, people with OCD may also rely on mental imagery to produce neutralising images in response to negative images, such as repeating religious imagery to reduce distress. This may mean that mental imagery can be part of the underlying problem, but also a person's strategy to try and manage their symptoms.

Imagery based interventions have been trialled in treatment for OCD, such as imagery rescripting (ImRs). ImRs uses mental imagery to 'modify the meaning of distressing autobiographical memories associated with current psychological problems' (Strachan et al. 2020). For a full overview of techniques used in ImRs, see Holmes et al. (2007). Veale et al. (2015) found that 7 out of 12 people with intrusive memories showed a clinically significant reduction in scores on the Yale-Brown obsessive compulsive scale (Y-BOCS) after one session of ImRs. Furthermore, Maloney et al. (2019) also found that 12 of 13 participants achieved a 35% symptom reduction on the Y-BOCS, with six only requiring a single session of imagery ImRs, and the remaining six requiring between two and five sessions. The clinical implications of these results may mean that ImRs is more efficient than traditional CBT with ERP, or is a useful adjunct to the existing therapy, and may also offer an alternative treatment for those who are currently considered treatment resistant. Although OCD is understood to involve intrusive thoughts and images, the relative importance of mental imagery in comparison to verbal thoughts in OCD is not currently understood, and this study will explore the nature of this relationship.

Current study

Building upon her previous work in Holmes & Mathews (2005), Holmes et al. (2008) conducted a study whereby participants in one condition were asked to imagine the combinations of pictures and words

(one picture and one word would be presented per trial). In the other condition, participants were asked to look at the same stimuli but to make sentences that combined the pictures and word. This created two conditions – imagery processing and verbal processing. The word presented with the pictures was neutral in itself but alongside the image could either be designated as being negative or benign. For example, an image of a cliff could be presented with the word 'view' or the word 'jump'. The first would be considered benign, whilst the second negative. Results found that the imagery processing condition led to greater changes in anxiety after negative combinations than after the verbal processing condition. This suggests that those who processed stimuli through imagery rather than verbally had greater emotional responses.

The methodology for this study was based on Holmes et al. (2008), but with a focus on OCD. We used words and images which in themselves are neutral but which in combination may be expected to generate anxiety provoking associations in mental images among people with high OCD tendencies e.g., a picture of a plate accompanied by the word 'dirty'. If, like in Holmes (2008), images do produce a stronger anxiety reaction than verbal thoughts, then in OCD we would expect a sample that scores higher on OCD tendencies to be more affected by imagery processing than a comparative sample that score lower on OCD tendencies. Based on the previous evidence, we would also expect that all participants, regardless of OCD traits, would have higher anxiety ratings when processing stimuli through imagery when compared to verbal processing. Our study has two hypotheses: that stimuli processed via imagery would lead to increased rates of anxiety in the full sample, and those who score higher on the measure of OCD tendencies would be more affected by imagery processing than those who scored lower on the measure of OCD tendencies.

Methods

Ethical approval for this study was gained through Cardiff University Board of Ethics (EC.21.08.10.6384).

Participants

Eighty-five participants were recruited through two separate systems. One was an electronic system for psychology undergraduates, who were required to complete psychological studies in return for course credit. A separate online system, 'callforparticipants', was also used to increase the number of participants recruited. Participants recruited through 'callforparticipants' were awarded a £10 voucher for their participation. Thirteen participants were removed from the final data set, eight for giving nonsensical answers during the verbal task and five for not having English as their first language. This left a total of seventy-two participants. Demographic information regarding age, gender, and occupation was not obtained. All participants completed this study anonymously to adhere to ethical guidelines.

Materials

As there were no previous sets of stimuli available to use from studies such as Holmes et al. (2008), a pilot study was conducted to determine an appropriate set of stimuli for this experiment. Participants for this pilot study were recruited via email in a healthcare service. Fifteen participants rated their anxiety reactions to a set of twenty-five images and twenty-five words, and images and words that exceeded a set criterion (over 20% agreement that the individual stimulus induced over a moderate anxiety response) were excluded from the main study.

The criteria for selecting relevant images was that the image should be of an area where contamination is possible. For example, an image of a toothbrush would be selected as the toothbrush would likely have residual germs on it after being used. Similarly, objects such as a door handle would also be appropriate as there is the possibility for the transfer of germs from person to person by contact. The words used in the pilot study were also generated by using synonyms of words that could imply contamination or elicit an emotional reaction. For example, the word 'dirt' had relevant synonyms of 'filth' and 'grime'. The researchers acknowledge that there may be an element of bias apparent in the selection of stimuli, however, it was hoped that the pilot study would remove as much bias as possible in the selection process. Five images and five words were excluded, leaving twenty images and twenty words for the main experiment. The full set of stimuli, along with the discarded stimuli can be seen in Appendix F.

Measures

Several measures were used to gather relevant information about the participants.

Obsessive Compulsive Inventory – Revised (OCI-R; Foa et al., 2002)

The OCI-R is an eighteen-item questionnaire that assesses the severity and type of symptoms that a person with possible OCD may have. These eighteen items are categorised into six factors, these being: checking, washing, ordering, hoarding, obsessing, and neutralising. Participants are given statements such as 'I check things more often that necessary', and these statements are responded to on a 5-point Likert scale (ratings from 'Not at all' to 'Extremely'). These answers are converted into a numerical score ranging from 0 to 72. Typically, scores above 20 are strong indicators of potential OCD. However,

research has shown that a four-factor model, as opposed to the original six-factor model, may also be appropriate.

A modified version of the OCI-R has been proposed by Abramovitch et al. (2021). This measure, the OCI-12, removes six of the items from the OCI-R that relate to hoarding and neutralising behaviours. Hoarding has now been recognised as a distinct category of disorder in the DSM-5, and studies that have removed this subscale have found a better conceptual fit to their data (Angelakis et al., 2017; Khosravani et al., 2020). Furthermore, neutralising behaviour questions on the OCI-R have been criticised, with all three questions relating to numbers rather than more general behaviours (Abramowitz & Deacon, 2006), and Abramovitch et al. (2021) suggesting that neutralising may be more appropriately defined as an ineffective coping strategy, as opposed to a primary dimension of the OCI-R.

For this study, the OCI-R was administered, and then the 6 items were removed to give an OCI-12 score. This score was used in the analysis. Seventy-two participants completed the OCI-R, with Cronbach's alpha value for OCI-R being $\alpha = .925$, and the value for Cronbach's alpha for the OCI-12 being $\alpha = .912$.

State-Trait Anxiety Inventory (STAI; Laux, Glanzmann, Schaffner, & Spielberger, 1981)

The original STAI is a 40-item self-report assessment that has 20 items assessing state anxiety, and 20 assessing trait anxiety. State anxiety is defined as being transient and can change relatively quickly depending on the situation a person is in. Trait anxiety is more rigid, being more akin to a person's disposition. For this experiment, we were interested in state anxiety in response to the stimuli,

therefore the questions assessing trait anxiety were not needed. A version of the STAI without the trait anxiety questions was used for this experiment.

The modified STAI is a 20-item self-report assessment that presents 20 short statements (such as 'I feel calm' or 'I feel secure') and asks participants to answer on a 4-point Likert scale (answers ranging from 'Not at all' to 'Very much so'). The questionnaire focusses on how people are feeling in the present moment, making the STAI an appropriate choice for assessing participant's reactions throughout the current study. The STAI was administered at three time points, these being an initial baseline measure, post-verbal block, and post imagery block. Cronbach's alpha was α = .890, .923, and .928 for the initial, post-verbal, and post-imagery measures, respectively.

Spontaneous Use of Imagery Scale (SUIS; Reisberg, Pearson, & Kosslyn, 2003)

The SUIS was employed to assess the extent to which participants were able to visualise images in their minds. Approximately 1% of the population may have a condition called aphantasia (Zeman et al., 2015), which is described as an inability to experience voluntary mental imagery. A higher SUIS score would indicate a greater use of mental imagery. Cronbach's alpha for the SUIS was α = .857.

Procedure

This study was conducted through the Qualtrics online survey system. Covid-19 restrictions prevented this study from being held in a laboratory. The 20 images and 20 words from the pilot study were used for this experiment. The images and words were randomly paired using a Microsoft Excel random

number generator. This process involved listing both sets of images and words in separate cells, and then randomly generating a numbered list that would be ordered numerically to create the pairs. A visual check was then conducted after the pairing to ensure the word-image pairs were sensible. This differed from the Holmes et al. (2008) study that this study was based upon, as Holmes et al. (2008) deliberately selected pairings that would elicit a negative affect. This appears to have been based upon researcher opinion. The full set of stimuli used for this experiment can be found in Appendix F.

Participants were presented with information about ethical approval, informed consent, and contact details of the researchers. Participants then completed the three outcome measures: the OCI-R, the STAI, and the SUIS. All outcome measures used throughout the experiment used 'force response' meaning that participants were unable to skip any questions. Participants then completed the verbal and imagery conditions. These were counterbalanced to control for order effects.

Verbal processing block

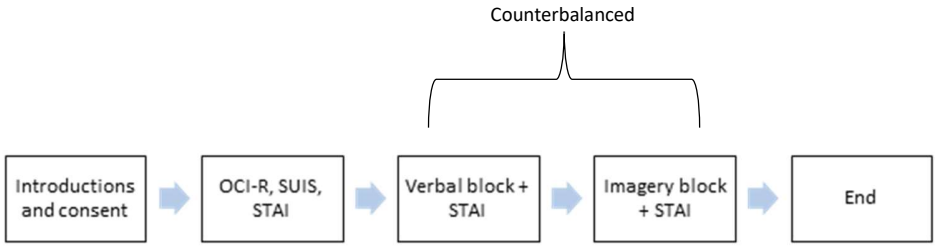
Following the methodology from Holmes et al. (2008), participants were presented with 20 word and image pairings. Each pairing was presented on a separate slide, meaning that participants would only see one image paired with one word at a time. The instruction presented to participants was to 'create a sentence which combines the image and word'. A text entry box was presented below the word-image pairing to allow participants to answer. This text box had a minimum character limit of fifteen characters to prevent participants from proceeding without entering a valid sentence length. A time limit of 15 seconds was imposed before the participant could continue.

At the end of the block, participants completed the STAI measure. A mandatory two-minute break was then imposed. Two minutes was the minimum length of time a participant needed to take for a break, but they were informed that they could take longer if they so wished. This was to help participants return as close to baseline as possible before completing the next part of the experiment.

Mental imagery processing block

Participants were again presented with the same 20 word and image pairings in the same conditions as the verbal processing block. However, the instruction differed in this condition, and participants were instead asked to 'create a mental scenario that combines the image and word'. There was no requirement to enter an answer, as we wanted to prevent participants from verbally processing the stimulus. Again, a time limit of 15 seconds was imposed before the participant could continue. Participants again completed the STAI after this block, and a two-minute mandatory break was imposed.

Diagrammatic representation of participant flow



Data analytic plan

To create two groups of high OCD tendency and low OCD tendency, a median split was applied to the OCI-12 scores. The median score was 13.5, which allowed the creation of two equal groups of 36 participants. An a priori power analysis was conducted via G*Power (Faul et al., 2007) to obtain a minimum number of participants needed to test the study hypotheses. Results indicated the required sample size to achieve 80% power for detecting a medium effect, at a significance criterion of α = .05, was N = 54 for a mixed ANOVA. Thus, the obtained sample size of N = 72 is adequate to test the study hypotheses. Although Holmes et al. (2008) found a large effect size for their experiment, it was decided that due to the differences in study and disorder area, a more reserved medium effect size would be chosen for this study. There appear to be few previous studies that would be able to inform effect size selection for the area of mental imagery in OCD. A mixed analysis of variance test was used due to the presence of two independent variables (one between-subjects, one within-subjects) and one continuous dependent variable at three separate time points.

Assumptions for mixed analysis of variance

To ensure the data was appropriate for a mixed ANOVA, the data was examined to ensure it met the underlying assumptions for the statistical test. The data met the basic assumptions of dependent variable being continuous; within-subjects factor consisting of at least two categorical related groups or matched pairs; between-subjects factor consisting of at least two categorical independent groups; and no significant outliers in any groups of within-subjects' factors or between subjects-factor.

The dependent variable (measurement on the STAI) was shown to be normal in all cases. The independent variable of OCI-12 scores violated the assumption of normality, however, the parametric test is robust enough to counter this violation. We would also expect to see a positively skewed score on an outcome measure such as the OCI-12, as typically we would only expect 1 - 3% of the population to be scoring above the clinical cut-off. Furthermore, the data does not violate the assumption of homogeneity of intercorrelations, with Box's test of equality of covariances matrices showing a p value of 0.453. Homogeneity of variances was also shown, with Levene's test of equality of error variances being p = 0.967, 0.545, and 0.102, for the initial, verbal, and imagery STAI's, respectively. Mauchley's test of sphericity indicated that the assumption of sphericity had not been violated, $\chi^2(2) = 2.539$, $p = .281$.

Assumptions for an independent samples t-test

An independent samples t-test was required to assess a difference between SUIS scores for low and high OCI groups. The data met the assumptions for the statistical test, with observations being independent,

no significant outliers within the two groups, data for each group being normally distributed, and homogeneity of variances apparent. Normality graphs can be seen in Appendix G.

Results

Descriptive statistics

Table 1

Descriptive statistics of outcome measures used

Outcome measure	Low OCD (n = 36)		High OCD (n = 36)		Full sample (n = 72)	
	Mean	SD	Mean	SD	Mean	SD
OCI-12	7.667	4.243	22.778	7.849	15.22	9.856
SUIS	31.278	9.220	35.944	8.786	33.61	9.246
Initial STAI	43.78	9.837	52.06	9.896	47.92	10.445
Verbal STAI	42.42	10.651	52.03	10.213	47.22	11.435
Imagery STAI	41.33	11.497	52.00	10.000	46.67	11.971

Statistical analysis

Pre-analysis checks

The amount of time a participant spent on each condition was measured to explore whether there were any differences in processing time. A paired samples t-test found a significant difference in time spent in each condition, $t(1439) = 10.532$, $p < 0.001$. Participants spent longer on the verbal condition (average time, 32.7 seconds), than the imagery condition (average time, 20.7 seconds).

Pre-analysis checks were undertaken to assess whether those who scored higher on the OCI measure were more likely to report increased use of mental imagery. An independent samples t-test found that those in the high OCI group were significantly more likely to report usage of mental imagery, $t(70) = -.190$, $p = 0.004$.

Main analysis

To test whether people who score higher on measures of OCD are more affected by imagery processing than those scoring low on OCD, and whether imagery processing regardless of OCD tendencies will increase anxiety, a mixed analysis of variance (ANOVA) was conducted. A mixed ANOVA consists of both between-subjects and within-subjects measures. This was necessary as there was a between-subjects variable (scores on the OCI which formed two distinct groups), and a within-subjects variable (the STAI repeated at multiple time points during the study. Therefore, as well as a between-subjects analysis of OCI scores, there was also a repeated measures element in this study.

There was no significant main effect of verbal or imagery processing on STAI scores, $F(2, 69) = 14.199$, $p = .245$, $\eta_p^2 = .040$. There was a significant difference between groups on STAI scores, with those scoring above the median on the OCI-12 scoring significant higher on STAI measures overall than those who scored below the median, $F(1, 70) = 17.188$, $p < 0.001$, $\eta_p^2 = .197$. There was no significant interaction between group and processing type, meaning that the effect of processing type did not differ for those with high OCI-12 scores when compared to low OCI-12 scores, $F(2, 69) = 1.311$, $p = .276$, $\eta_p^2 = .037$.

Discussion

The aim of this study was to explore whether those who had higher OCD tendencies would be more likely to be affected by imagery processing compared to verbal processing. To assess this, participants completed outcome measures including the OCI-12, the SUIS, and the STAI, and then completed two conditions that facilitated either imagery or verbal processing. A measure of anxiety (the STAI) was used to assess emotional changes in response to the stimuli and processing type. This study had two hypotheses: that stimuli processed via imagery would lead to higher scores on an anxiety-based measure, and that those who scored higher on the OCI would be more affected by imagery processing than those who scored lower on the OCI. These hypotheses were not supported by the results. Participants who scored higher on the OCI also scored significantly higher on the SUIS, indicating that those who have higher obsessive-compulsive tendencies may also be more likely to use mental imagery. Considering the nature of OCD and how intrusive images can often play a part in the development and maintenance of the disorder, one interpretation of this result could be that those who are predisposed to spontaneously using mental imagery may be more susceptible to developing OCD.

Other interesting results were apparent from the data. Surprisingly, the rate of people scoring above the clinical cut-off for a validated measure of OCD was incredibly high. We would expect 1 – 3% of our sample to score higher than the clinical cut-off for the OCI-12 (National Institute for Care and Excellence, 2005). Although the OCI-12 is not diagnostic, scores of 11 or above would indicate the presence of OCD and would require further assessment by a qualified clinician. Forty-six out of the sample of seventy-two scored above the clinical cut-off, a rate of approximately 64%, over 20 times the highest estimate from previous population surveys. Of course, the OCI-12 is not a diagnostic measure, and further follow-up

from a qualified clinician would be necessary, but this still indicates that there is potentially a much larger population of those who are suffering from, or are vulnerable to developing, OCD.

This study was conducted during the covid-19 pandemic from the months of March 2022 to May 2022. Research has found that people with OCD largely reported a worsening of symptoms during the covid-19 pandemic. Jelinek et al. (2021) found that 72% of people with OCD reported an increase in their symptoms in a 3-month period from March to May 2020, with this increase significantly more pronounced in those who engaged in hand-washing behaviours, although the increase was prevalent across all domains. These findings have been replicated in other studies (Alonso et al., 2021; Wheaton et al., 2021). A systematic review of the effect of covid-19 on young people also found similar negative effects, with Cunning & Hodes (2022) finding that five out of six papers reviewed showed evidence of OCD symptoms being exacerbated during the covid-19 pandemic. Guzick et al. (2021) systematically reviewed the available literature on OCD severity change during the covid-19 pandemic and found that overall, most studies found a worsening of symptoms during the initial stages of the pandemic, especially for those with contamination-related fears. Vulnerable individuals may also be likely to develop OCD and contamination-based phobias from the measures put in place from covid-19, with Samuels et al. (2021) finding that those who complied stringently to the covid-19 prevention measures were significantly more likely to develop contamination obsessions. The results from the current study support the notion that there has been a large increase of contamination and OCD-type behaviours and beliefs during the covid-19 period.

Strengths and limitations

There are some confounding factors in this study that may have affected the results. First, this study may have attracted those who have higher tendencies of OCD, as the study was listed in both the university system and the 'callforparticipants' database as 'Mental imagery in obsessive compulsive disorder'. It is also unknown whether students who choose to study psychology have higher rates of OCD than the general population, as no studies appear to have assessed this. However, there are gender difference to be accounted for in psychology undergraduate courses, with students more likely to be female than male (Fowler et al., 2018). Younger females typically score higher on measures relating to neuroticism and intense emotional reactions than their male counterparts (Lynn & Martin, 1997; Schmitt, 2007), and given that mental imagery may have important links to emotion (Conway, 2001; Holmes & Mathews, 2005), this may have affected results by overrepresentation of females. Due to the anonymity of results from this study, we were unable to fully assess the demographic information of participants. This information may have clarified these results in a greater context, as mental health problems appear to be rising in younger populations (NHS Digital, 2014), and most common mental disorders are established by the age of twenty-five (Kessler et al., 2005). Information about age and student status could therefore have provided clarity around risk factors in developing OCD. Future studies should aim to incorporate demographic information more clearly.

Another factor that may have affected the results is that we may have been targeting a different emotional response. Research has found that disgust, rather than anxiety, may underlie contamination-based OCD (Berle & Phillips, 2006; Sprengelmeyer et al., 1997; Olatunji et al., 2011). Although the methodology of this study was based on Holmes et al. (2008), it may have been useful to either replace the STAI or add a measure of disgust in alongside. Disgust propensity measures, such as the Questionnaire for the Assessment of Disgust Propensity (QADP; Schienle et al., 2002) may have also provided vital data on how sensitive a person is to experiencing disgust. The STAI was conducted at the

end of each processing block. This was decided as the STAI is a 20-item questionnaire, and it would be unfeasible to ask participants to complete this after every trial. However, other measures could have targeted time-points with greater specificity. Other physiological measures of anxiety or bodily responses could have been used if covid-19 restrictions were not in place, such as heart rate monitors or pulse oximeters. Anxiety has a well-established physiological response (Hoehn-Saric & McLeod, 2000) and therefore physiological measures may have provided more insight into a participant's experience.

Again, due to covid-19 restrictions, this study was unable to take place under laboratory conditions. This meant that participants completed the study on their own devices in uncontrollable conditions. The Qualtrics software allows participants to complete the study on mobile devices, and although it is unlikely participants would have used a mobile device due to accessing the study link through a university system, we are unable to say with certainty that all participants completed the study on a computer rather than a mobile phone. Although efforts were made to ensure participants were completing the tasks, we were unable to add validity checks, such as Holmes et al. (2008) asking participants to describe their visual experience of mental imagery out loud whilst completing the imagery condition. We were able to determine which participants had been paying attention due to the timing records recorded by the system. Each slide was presented for fifteen seconds, and then participants could proceed. As an example, timing values of 100 seconds would indicate that participants were not completing the task. After removal of records for nonsensical answers to the verbal condition, and those for whom English was not their first language, no further records needed to be removed for excessive timing.

Studies such as Holmes et al. (2008) conducted a manipulation check for the imagery condition, whereby participants who completed the study under lab conditions were required to describe their image out loud to the examiner. However, due to Covid-19 restrictions and this study being online, it was deemed unfeasible to conduct a similar manipulation check through this medium. There was the possibility of asking participants to describe their images through a text box, but this was decided to be inappropriate as there could be cross-contamination between the verbal and imagery conditions. Future studies could easily remedy this limitation by following the previous manipulation check procedures used in studies such as Holmes et al. (2008) whilst conducting the study in face-to-face laboratory conditions. The researchers would not recommend replication of this study in an online environment, but, if necessary, online video conferencing could be used throughout the duration of the experiment and participants could detail their imagined experiences to a researcher through this medium instead.

Clinical implications

Despite the limitations of this study, there appeared to be no difference in anxiety response when stimuli were processed either verbally or through imagery. Current treatment interventions for OCD focus on SSRI medication and CBT (National Institute for Care and Excellence, 2005), of which imagery exercises can be a part of (Arntz & Weertman, 1999), with exercises such as imaginal exposure in exposure and response prevention tasks. Consistent with the current study finding that those with high OCI scores showed strong visualisation, there is evidence that imaginal exposure may be as effective as real-life exposure to feared stimuli in OCD, however, treatment gains may not be maintained with imaginal exposure alone, as a higher rate of relapse may be apparent (Foa et al., 1980).

The exceptionally high rate of OCD indicated by the current study suggests to a need for increased services for post-pandemic. Abba-Aji et al., (2020) found a large increase in a Canadian sample of people reporting OCD symptoms on the Brief Obsessive-Compulsive Scale (BOCS), with rates reaching 60.3% of people reporting onset of OCD symptoms. However, this also leads to a question of whether the OCI-R, and by extension, other measures of OCD such as the BOCS, are appropriate measures in a 'post-covid' world, as behaviours that may have been considered excessive before are now commonplace. Furthermore, we are yet to understand the impact of covid restrictions easing, as this may have a natural effect of reducing contamination worries. There is also the possibility that people will habituate to pandemic anxiety over time, and this again may reduce anxiety rates and OCD tendencies (de Abreu Costa, 2022). Therefore, further investment in services may either not be needed, or will need to specifically target certain populations that have been greatly affected by the pandemic and demonstrate lasting effects.

Research implications

The research implications of this study are that despite the wealth of research on imagery and emotion, imagery processing did not have a significant effect on the anxiety ratings of participants. This contradicts the current evidence base, with studies such as Holmes et al. (2008) finding that anxiety ratings are affected by imagery processing. However, as we are looking at a relatively novel area of understanding how imagery processing affects those with OCD tendencies, this may be an explanation for the result, as OCD tendencies may impact the anxiety a person experiences.

It is difficult to induce imagery processing in a research setting, as despite giving instructions on how to approach the task, different processing strategies may be employed. As shown in Keogh & Peterson

(2011), poor imagers often employ different cognitive strategies to counter a poorer ability to produce mental imagery. This study asked participants to process stimuli either verbally or through imagery, but verbal processing may have also included an imagery processing component. Conversely, people processing through imagery may have also used some element of verbal processing during this task. As these two types of processing are likely to overlap, it is difficult to truly separate these and explore the effects this may have. Different methods have been used to try to separate these two types of processing, and studies have included training components to further facilitate the use of verbal or imaginal processing (e.g., Behar & Borkovec, 2020; Stokes & Hirsch, 2010), but no reliable method has yet been found. Given that there are also individual differences in the way people process and perceive the world (Boogert et al., 2018), and differences in factors such as intelligence (Conley, 1984; Conway & Kovacs, 2013), research may need to be more encompassing of individual differences to truly assess the impact of various types of processing.

The counterbalancing of the current study was used to counteract order effects, such as boredom or habituation. In hindsight, a habituation effect may be an interesting area to explore, as repeated exposure to negative stimuli is a core component of exposure and response prevention. A wealth of ERP literature focusses on thoughts in verbal form, and ERP itself encourages people to keep thought records and diaries to rate and challenge thoughts. Although there is strong evidence for this, interventions such as imagery rescripting have also been shown to be powerful interventions. There may be a subset of the population who would benefit from either combined verbal and imagery processing during ERP, or a stepped pathway, completing verbal-based ERP first and then moving on to imagery-based processing.

Future research into imagery processing in OCD may benefit from further exploration into the underlying emotion the person may be experiencing, rather than solely focussing on anxiety. As mental imagery has been likened to an 'emotion amplifier', it may be that other emotions are underlying different types of OCD, such as disgust underlying contamination-based OCD. The relaxation of covid-19 restrictions has allowed laboratory research to be undertaken once more. The added reliability and validity checks, such as asking a participant to describe their mental image, may lead to a different empirical result. More time-specific measures may also be helpful in determining a person's emotional reaction to the presented stimulus. The impact of covid-19 on the general population's tendencies to score higher on measures such as the OCI needs to be understood, as it may be that these measures are no longer valid in a 'post-covid' world.

Conclusions

This study explored the effect of imaginal processing on anxiety levels in those with high and low OCD tendencies. We hypothesised that those with higher OCD tendencies would be more affected by imaginal processing, however, this hypothesis was not supported. We also hypothesised that the full sample would show a difference in verbal and imagery processing, with higher anxiety ratings expected when the stimulus was processed via imagery. Again, this hypothesis was not supported. The statistical analysis did not return a significant result for our main hypotheses, however, a Mann-Whitney U test did show a significant difference between high and low OCD tendencies and mental imagery usage, as measured by the SUIS. This means that those with higher OCD tendencies were more likely to report spontaneous usage of mental imagery in everyday life. This study contrasts with existing research on the effects of imaginal processing, as other studies have found that imaginal processing increases anxiety in

response to certain stimuli. A high proportion of our sample scored over the clinical cut-off for OCD on the OCI-R and modified OCI-12, suggesting that increased, or better targeted, services may be needed, as OCD rates may have been exacerbated by the covid-19 pandemic. Future research should aim to address some of the limitations of this research, such as the difficulties with using laboratory conditions and measures of other emotions, such as disgust.

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Appendix

Appendix A: Author guidelines for Behaviour Research and Therapy journal

BEHAVIOUR RESEARCH AND THERAPY

AUTHOR INFORMATION PACK

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DESCRIPTION

The major focus of *Behaviour Research and Therapy* is an experimental psychopathology approach to understanding emotional and behavioral disorders and their prevention and treatment, using cognitive, behavioral, and psychophysiological (including neural) methods and models. This includes laboratory-based experimental studies with healthy, at risk and subclinical individuals that inform clinical application as well as studies with clinically severe samples. The following types of submissions are encouraged: theoretical reviews of mechanisms that contribute to psychopathology and that offer new treatment targets; tests of novel, mechanistically focused psychological interventions, especially ones that include theory-driven or experimentally-derived predictors, moderators and mediators; and innovations in dissemination and implementation of evidence-based practices into clinical practice in psychology and associated fields, especially those that target underlying mechanisms or focus on novel approaches to treatment delivery. In addition to traditional psychological disorders, the scope of the journal includes behavioural medicine (e.g., chronic pain). The journal will not consider manuscripts dealing primarily with measurement, psychometric analyses, and personality assessment.The Editor and Associate Editors will make an initial determination of whether or not submissions fall within the scope of the journal and/or are of sufficient merit and importance to warrant full review.

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For clinical psychologists, psychiatrists, psychotherapists, psychoanalysts, social workers, counsellors, medical psychologists, and other mental health workers.

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The etiology/maintenance and evidence-based treatment of substance misuse (especially Alcohol, Marijuana) and Dual diagnoses (especially with anxiety disorders)

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Psychopathology and Treatment outcome of eating disorders and Obesity with a focus on implementing this research into real-world settings, Work on prevention of eating disorders and obesity

Valentina Cardi, University of Padua Department of General Psychology, Padova, Italy

Eating disorders, online therapy, e-health, virtual reality, adolescence

Per Carlbring, Stockholm University, Stockholm, Sweden Psychology

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Obsessive-compulsive disorder, Body dysmorphic disorder, Anxiety disorders, Treatment outcome

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Psychotherapy, Meta-analysis, Mental disorders, Randomized trials, Prevention

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Nature and exposure-based treatment of anxiety, critical analysis of the validity and utility of biomedical approaches to psychological problems

Sona Dimidjian, University of Colorado Boulder, Boulder, Colorado, United States of America

Clinical psychology,Psychology of women,Behavior therapy

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Iris M. Engelhard, Utrecht University, Utrecht, Netherlands anxiety disorders,trauma,PTSD,OCD

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Jay Fournier, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States of America Randy Frost, Smith College, Northampton, Massachusetts, United States of America OCD, Hoarding, Perfectionism

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Anxiety, Social anxiety, Dental anxiety, Cognitive behavioral therapy

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Therapy, Anxiety disorders, Mood disorders, Cognitive behavioral therapy, Treatment mechanism, Neuroscience

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Psychology,health psychology,applied cognitive experimental psychology,eating behaviour

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Anxiety disorders, Obsessive compulsive related disorders, Cognitive-behavior therapy

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Melissa Norberg, Macquarie University, Sydney, New South Wales, Australia

Obsessive-compulsive disorder, Hoarding disorder, Compulsive buying shopping disorder, Anxiety, Cognitive behaviour therapy

Bunmi Olatunji, Vanderbilt University, Nashville, Tennessee, United States of America

OCD, Anxiety, ERP, CBT, Experimental psychopathology of anxiety and related disorders, Emotion

Lars-Göran Ost, Stockholm University, Stockholm, Sweden

Michael L. Perlis, University of Pennsylvania, Philadelphia, Pennsylvania, United States of America

Jacqueline Persons, Oakland Cognitive Behavior Therapy Center, Oakland, California, United States of America cognitive behavior therapy,case conceptualization,treatment outcome,change process in treatment

Mark B. Powers, The University of Texas at Austin, Austin, Texas, United States of America

Adam S. Radomsky, Concordia University, Montréal, Quebec, Canada

OCD, Anxiety disorders, Experimental psychopathology, Cognitive therapy, CBT, Treatment development

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Ronald M. Rapee, Macquarie University Department of Psychology, Sydney, Australia

Eric G. C. Rassin, Erasmus University Rotterdam, Rotterdam, Netherlands

Decision making, Bias, Thought control

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Andrea Reinecke, University of Oxford, Oxford, United Kingdom

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Experimental psychopathology, Cognitive Behavioural Therapies, mental imagery, Schema Therapy, Single-Case Experimental Designs

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Psychopathology, Anxiety, Research methods, Fear, Stress, Climate anxiety, Affective science, Attentional bias, Threat processing

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Sanne T.L. Houben, Maastricht University, Maastricht, Netherlands

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with a focus on associative learning and strengthening (cognitive) control

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Shin-ichi Ishikawa, Doshisha University Faculty of Psychology Graduate School of Psychology, Kyotanabe, Japan

Child anxiety, Adolescent anxiety, School prevention, Asia

Katharina Kircanski, National Institute of Mental Health, Bethesda, Maryland, United States of America irritability, mood and anxiety disorders, cognitive behavioral therapy, experimental psychopathology, affective neuroscience

Naomi Koerner, Toronto Metropolitan University, Toronto, Ontario, Canada

Janice R. Kuo, Toronto Metropolitan University, Toronto, Ontario, Canada

Richard LeBeau, University of California Los Angeles David Geffen School of Medicine, Los Angeles, California, United States of America

sexual and gender minorities, LGBTQ, anxiety, depression, trauma, RCT, evidence-based treatments, assessment, training, supervision

Stuart B. Murray, University of Southern California Keck School of Medicine, Los Angeles, California, United States of America

Kristin Naragon-Gainey, The University of Western Australia, Perth, Western Australia, Australia

emotion regulation,depression,anxiety,mindfulness,ecological momentary assessment,assessment,personality

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Allison J. Ouimet, University of Ottawa, Ottawa, Ontario, Canada

Yujia Peng, Peking University, Beijing, China

Computational Psychiatry, Depression, Anxiety, RDoC, Cognitive Neuroscience, Social Cognition, Developmental Psychology, Artificial Intelligence

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Eating disorders, Overeating, Exposure therapy, Extinction, Sleep

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Anxiety, OC Spectrum Conditions, Transdiagnostic Risk

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INTRODUCTION

The major focus of *Behaviour Research and Therapy* is an experimental psychopathology approach to understanding emotional and behavioral disorders and their prevention and treatment, using cognitive, behavioral, and psychophysiological (including neural) methods and models. This includes laboratory-based experimental studies with healthy, at risk and subclinical individuals that inform clinical application as well as studies with clinically severe samples. The following types of submissions are encouraged: theoretical reviews of mechanisms that contribute to psychopathology and that offer new treatment targets; tests of novel, mechanistically focused psychological interventions, especially ones that include theory-driven or experimentally-derived predictors, moderators and mediators; and innovations in dissemination and implementation of evidence-based practices into clinical practice in psychology and associated fields, especially those that target underlying mechanisms or focus on novel approaches to treatment delivery. In addition to traditional psychological disorders, the scope of the journal includes behavioural medicine (e.g., chronic pain). The journal will not consider manuscripts dealing primarily with measurement, psychometric analyses, and personality assessment.

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If there is more than one appendix, they should be identified as A, B, etc. Formulae and equations in appendices should be given separate numbering: Eq. (A.1), Eq. (A.2), etc.; in a subsequent appendix, Eq. (B.1) and so on. Similarly for tables and figures: Table A.1; Fig. A.1, etc.

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A concise and factual abstract is required with a maximum length of 200 words. The abstract should state briefly the purpose of the research, the principal results and major conclusions. An abstract is often presented separately from the article, so it must be able to stand alone. For this reason, References should be avoided, but if essential, then cite the author(s) and year(s). Also, non-standard or uncommon abbreviations should be avoided, but if essential they must be defined at their first mention in the abstract itself.

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Van der Geer, J., Hanraads, J. A. J., & Lupton, R. A. (2010). The art of writing a scientific article.

Journal of Scientific Communications, 163, 51–59. https://doi.org/10.1016/j.sc.2010.00372.

Reference to a journal publication with an article number:

Van der Geer, J., Hanraads, J. A. J., & Lupton, R. A. (2018). The art of writing a scientific article. *Heliyon*, *19*, Article e00205. https://doi.org/10.1016/j.heliyon.2018.e00205.

Reference to a book:

Strunk, W., Jr., & White, E. B. (2000). *The elements of style* (4th ed.). Longman (Chapter 4).

Reference to a chapter in an edited book:

Mettam, G. R., & Adams, L. B. (2009). How to prepare an electronic version of your article. In B. S. Jones, & R. Z. Smith (Eds.), *Introduction to the electronic age* (pp. 281–304). E-Publishing Inc.

Reference to a website:

Powertech Systems. (2015). *Lithium-ion vs lead-acid cost analysis*. Retrieved from http://www.powertechsystems.eu/home/tech-corner/lithium-ion-vs-lead-acid-cost-analysis/. Accessed January 6, 2016 Reference to a dataset:

[dataset] Oguro, M., Imahiro, S., Saito, S., & Nakashizuka, T. (2015). *Mortality data for Japanese oak wilt disease and surrounding forest compositions*. Mendeley Data, v1. https://doi.org/10.17632/ xwj98nb39r.1.

Reference to a conference paper or poster presentation:

Engle, E.K., Cash, T.F., & Jarry, J.L. (2009, November). *The Body Image Behaviours Inventory-3: Development and validation of the Body Image Compulsive Actions and Body Image Avoidance Scales*. Poster session presentation at the meeting of the Association for Behavioural and Cognitive Therapies, New York, NY.

Reference to software:

Coon, E., Berndt, M., Jan, A., Svyatsky, D., Atchley, A., Kikinzon, E., Harp, D., Manzini, G., Shelef, E., Lipnikov, K., Garimella, R., Xu, C., Moulton, D., Karra, S., Painter, S., Jafarov, E., & Molins, S. (2020, March

25). *Advanced Terrestrial Simulator (ATS) v0.88 (Version 0.88)*. Zenodo. https://doi.org/10.5281/zenodo.3727209.

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In addition, you can link to relevant data or entities through identifiers within the text of your manuscript, using the following format: Database: xxxx (e.g., TAIR: AT1G01020; CCDC: 734053; PDB: 1XFN).

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To foster transparency, we encourage you to state the availability of your data in your submission. This may be a requirement of your funding body or institution. If your data is unavailable to access or unsuitable to post, you will have the opportunity to indicate why during the submission process, for example by stating that the research data is confidential. The statement will appear with your published article on ScienceDirect. For more information, visit the Data Statement page.

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Appendix B: Pilot study results

A pilot study was conducted to assess the emotional valence of images and words that would be selected as stimuli. For the main study, it was necessary that the images and words presented should elicit a minimal (if any) emotional reaction when presented on their own. The scenario created by combining the word and image should elicit an emotional response.

There were no previous sets of stimuli available for use, therefore the stimuli for this study had to be created. The pilot study was therefore a way of increasing the reliability and validity of the main study. Selection criteria for appropriate stimuli to be used in the further study was set at having 80% of participants having either no anxiety or low anxiety in response to each stimulus.

Participants

Fifteen participants completed the pilot study (11 female, 4 male; mean age 26.2, SD 8.2). Participants were recruited through a mass email directed towards staff in three different healthcare organisations (a supported living service, an NHS learning disability service, and an NHS early intervention for psychosis service).

Materials

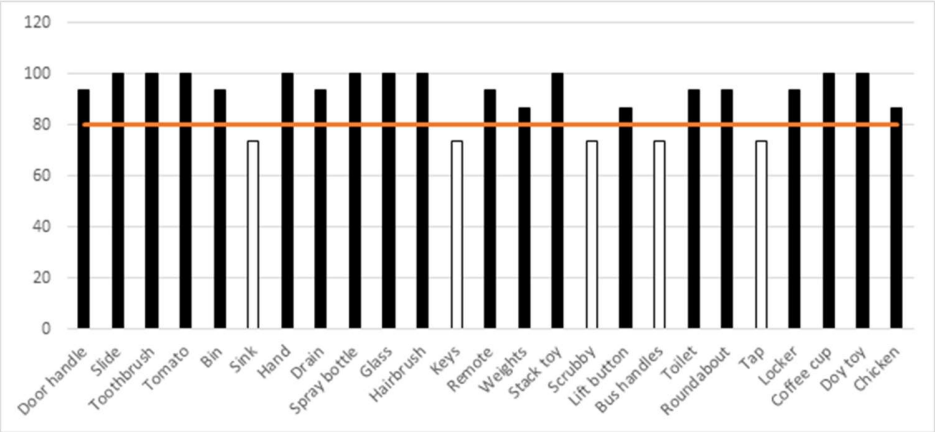
The pilot study was conducted through Qualtrics online survey software. Images were gathered from an online resource bank (Shutterstock), and the words were developed through use of synonyms. Word-image pairs were randomly created through a random number generator.

Procedure

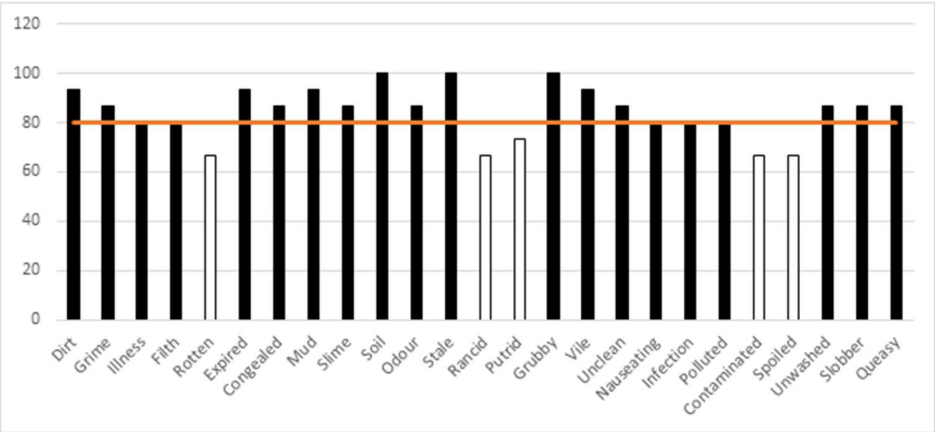
Participants were required to rate their emotional responses to 25 images and 25 words. These were presented on individual slides to ensure that there was no cross-contamination of emotional responses. The 'images' block and the 'words' block were randomly counterbalanced to control for order effects. Participants were provided with a prompt to 'Rate your emotional response to the image/word', and then selected a response on a 5-point Likert scale. The options were as follows: 'No anxiety response', 'Low anxiety response', 'Moderate anxiety response', 'High anxiety response', and 'Extreme anxiety response'. The forced response option was activated within the Qualtrics software to ensure participants answered all questions.

Results of pilot study

All participants completed the study and answered all questions, therefore there was no missing data. The selection criteria was having 80% of participants either select 'No anxiety response' or 'Low anxiety response' for the presented stimuli. An image or word that did not meet these criteria was discarded. Five images and five words were discarded based on these criteria, leaving 20 images and 20 words to use for the main study. Figure 1 represents the ratings for the images, whilst figure 2 represents the ratings for the words. The stimuli discarded can be found in appendix 2.



Percentage of people rating each image as either 'no anxiety response' or 'low anxiety response'. Target line represents the selection criteria limit.



Percentage of people rating each word as either 'no anxiety response' or 'low anxiety response'. Target line represents the selection criteria limit.

Appendix C: Main study information sheet

Information sheet

Study name: The effect of mental imagery processing on anxiety and OCD behaviours

Introduction
You are being invited to take part in a research study to help us to learn more about the role of mental imagery processing in anxiety and OCD.

Before agreeing to take part, it is important that you read this information and make your own decision about whether you would like to be involved or not.

Please ask us if you have any questions or would like further information.

The researchers
The research project is being carried out by Alex Willcox (Trainee Clinical Psychologist) who is on the South Wales Doctoral Programme in Clinical Psychology. The research is being undertaken as part of the university course. The project is being supervised by Dr Louise Waddington (Research Tutor, South Wales Doctoral Programme in Clinical Psychology) and Dr James Gregory (Research Tutor, South Wales Doctoral Programme in Clinical Psychology).

What is the research project about?
An important relationship between imagery and emotion has been established in previous research, and images are prevalent in OCD and appear to play a role in people's experiences of OCD. However, we don't know how important they are in comparison to other types of intrusions, such as verbal or cognitive. The main aim of this study is to explore whether there is any evidence for the importance of imagery in OCD.

Why are you doing the research project?
We are interested in knowing more about what it was like to receive the brief ACT training and how you then applied these newly learnt concepts in order to deliver an intervention for students. We are keen to better understand what facilitates or inhibits learning these psychological ideas and what impact they may have on different areas of your life. This information will help to shape psychological interventions for children and how these interventions are delivered in the future.

What will I be doing if I decide to take part?
This research will involve completing a series of tasks online. Instructions on how to complete these tasks will be given during the study. This research be conducted by a Trainee Clinical Psychologist and will take around 40 minutes to complete.

You will be asked to complete a standardised questionnaire at the beginning of the study (the Obsessive Compulsive Inventory; OCI). You will also be asked to complete the State Trait Anxiety Inventory (STAI) at certain points during the study.

Do I have to take part?
No, it is up to you whether you want to take part or not.

What if I decide to take part but change my mind later on?
Due to the nature of this study, no identifying information will be held alongside your results. This means that upon completion of the study, it will not be possible for the researcher to identify which results are yours, meaning that you will not be able to withdraw your anonymised results. However, if you wish to withdraw during the study, you have the right to do so without incurring any penalty.

How will my information be used?

Consent forms will contain the names of participants and will need to be retained for five years in accordance with Data and Record Management. These will be held securely and separately from the study data.

Your results from the online tasks will be used as part of a research study into the role of mental imagery in anxiety and OCD. This data will be statistically analysed and a report will be created. Depending on the outcome of the study, this data may then be disseminated through various means, such as through posters or journal articles.

The research project is being completed as part of a Doctorate of Clinical Psychology (university course for postgraduate students). The information will be used in a written report (which may later be used for teaching/training or published for wider audiences to read).

The data controller is Cardiff University and the Data Protection Officer is Matt Cooper CooperM1@cardiff.ac.uk. The lawful basis for the processing of the data you provide is consent**.**

What can I do if I have concerns about the research project?
You can speak directly to a member of the research team, and they can be contacted using the contact information below. Alternatively, you can contact the Director of the Doctoral Programme in Clinical Psychology. Address: 11th Floor, School of Psychology, Tower Building, 70 Park Place, Cardiff, CF10 3AT. Telephone: 02920 870582

Who has reviewed the study?
The research project has been approved by Cardiff University School of Psychology ethics committee. They have reviewed the study to ensure we are running it in a way which protects your rights and your safety.

If you have any questions relating to ethical issues and how this study is reviewed to ensure the well-being of the individuals who participate, please contact the Cardiff University School of Psychology Ethics Committee:
School of Psychology Research Ethics Committee
Email: psychethics@cardiff.ac.uk
Tel: 029 20870360

Are there any risks or disadvantages to taking part?
This study may cause you to have an emotional reaction to the stimulus presented. You have the right to withdraw from the study at any time if you feel overwhelmed, and you will incur no penalty or loss of course credit for doing so.

What are the benefits of taking part?
The data gathered from this study will hopefully inform future research and interventions for people who are living with OCD. You will also obtain course credit which will count towards your undergraduate degree.

Contact details

Alex Willcox
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Cardiff University
Tower Building,
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Cardiff
CF10 3AT

Privacy Notice:

The information provided will be held in compliance with GDPR regulations. Cardiff University is the data controller and James Merrifield is the data protection officer (inforequest@cardiff.ac.uk). The lawful basis for processing this information is public interest. This information is being collected by Alex Willcox.

The information on the consent form will be held securely and separately from the research information. Only the researcher will have access to this form and it will be destroyed after 7 years.

The research information you provide will be used for the purposes of research only and will be stored securely. Only the researcher, Alex Willcox, will have access to this information. Immediately after the study, the data will be anonymised (any identifying elements removed) and this anonymous information may be kept indefinitely or published.

Appendix D: Main study consent form

School of Psychology, Cardiff University

The effect of mental imagery processing on anxiety and OCD behaviours

Consent Form – Confidential data

I understand that my participation in this project will involve completing two series of tasks which will involve looking at images of scenarios which will contain potential contamination fears. These tasks will each require about 20 minutes of my time (40 minutes in total).

I understand that participation in this study is entirely voluntary and that I can withdraw from the study at any time without giving a reason and without loss of course credit. I also understand that I can withdraw my data from the study up until the point the data in anonymised by contacting the researcher.

I understand that I am free to ask any questions at any time. I am free to withdraw or discuss my concerns with the researcher, Alex Willcox or the supervisors, Dr Louise Waddington and Dr James Gregory.

I understand that the personal data will be processed in accordance with GDPR regulations (see privacy statement below).

I understand that at the end of the study I will be provided with additional information and feedback about the purpose of the study.

I, _____(NAME) consent to participate in the study conducted by Alex Willcox, School of Psychology, Cardiff University with the supervision of Louise Waddington and James Gregory

Signed: _____

Date: _____

Privacy Notice:

The information provided will be held in compliance with GDPR regulations. Cardiff University is the data controller and James Merrifield is the data protection officer (inforequest@cardiff.ac.uk). The lawful basis for processing this information is public interest. This information is being collected by Alex Willcox.

The information on the consent form will be held securely and separately from the research information. Only the researcher will have access to this form and it will be destroyed after 7 years.

The research information you provide will be used for the purposes of research only and will be stored securely. Only the researcher, Alex Willcox, will have access to this information. Immediately after the study, the data will be anonymised (any identifying elements removed) and this anonymous information may be kept indefinitely or published.

Appendix E: Main study debrief forms

Debrief following involvement in study on imagery processing

Study: The effect of mental imagery processing on anxiety and OCD behaviours

Thank you
Thank you for participating in this research study. The results you have provided will allow us to greater understand the role of imaginal processing and its effects on anxiety levels and OCD behaviours. We hope this information will inform future interventions for those experiencing difficulties with contamination fears.

What was this study about?

During this study, you were asked to complete a series of tasks. Half of these tasks asked you to visually create a scenario in your mind that combined the word and picture presented, whilst the other half asked you to create a sentence that combined the word and picture instead. Our aim was to stimulate different types of processing (visual and verbal) and explore whether this influences anxiety levels and behavioural urges. Mental imagery processing refers to our ability to visualise a scenario in our mind, and our body may react to the imaginal scenario as though we were actually there.

Previous research has suggested that people with OCD may be more likely to process feared stimulus through mental imagery than the general population. It may also be that people with OCD have stronger mental imagery than others. The results of this study will hopefully allow us to assess the role of mental imagery in anxiety and OCD.

Do the results of this study mean that I have OCD?

No, they do not. This test is not diagnostic in any way, and your responses to the stimulus presented may be completely normal. We have primarily used a student population for this study, meaning that we would expect the prevalence rate of OCD to be similar to the general population (1.2%; OCDorg.uk).

However, we understand that completing this study may have caused you to worry about your responses to the stimulus presented. You may already be aware of your own anxieties and may even have a pre-existing diagnosis of OCD. If you have any concerns about your involvement in the study, please do not hesitate to contact the researchers involved (contact details are at the end of this form). We have also included some resources that may be helpful. If you wish to pursue these issues further

with a medical professional, we recommend that you contact your general practitioner and discuss these concerns with them.

What happens next?

Your data will be held anonymously and analysed by the researcher when the study has been completed. The data will be analysed using a quantitative approach, meaning that there will be a statistical analysis to see whether there is a difference between the two conditions (mental imagery processing vs verbal processing). The results of this study will be written up as part of the researcher's large scale research project, which may be published in future.

Contact details

If you would like any further information or have any questions, please contact us using the information below:

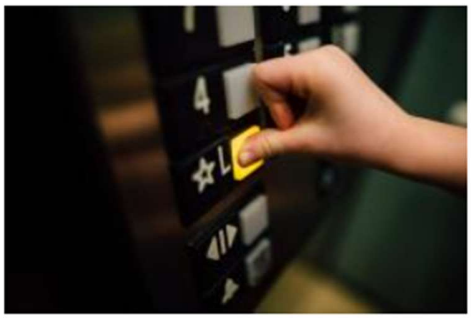
Alex Willcox	Dr Louise Waddington	Dr James Gregory
Trainee Clinical Psychologist	Research Tutor	Research Tutor
WillcoxA2@cardiff.ac.uk 02920 870582	WaddingtonL1@cardiff.ac.uk 02920 870582	GregoryJ8@cardiff.ac.uk 02920 870582
School of Psychology, Cardiff University Tower Building, 70 Park Place Cardiff CF10 3AT	School of Psychology, Cardiff University Tower Building, 70 Park Place Cardiff CF10 3AT	School of Psychology, Cardiff University Tower Building, 70 Park Place Cardiff CF10 3AT

If you have any questions relating to ethical issues and how this study is reviewed to ensure the well-being of the individuals who participated, please contact the Cardiff University School of Psychology Ethics Committee:

School of Psychology Research Ethics Committee
Email: psychethics@cardiff.ac.uk
Tel: 029 20870360

Appendix F: Stimulus used in main experiment

Imagine a scenario which combines the following image and word



Dirt

Imagine a scenario which combines the following image and word

Grime

Imagine a scenario which combines the following image and word

Illness

Imagine a scenario which combines the following image and word

Filth

Imagine a scenario which combines the following image and word

Expired

Imagine a scenario which combines the following image and word

Congealed

Imagine a scenario which combines the following image and word

Mud

Imagine a scenario which combines the following image and word

Slime

Imagine a scenario which combines the following image and word

Soil

Imagine a scenario which combines the following image and word

Odour

Imagine a scenario which combines the following image and word

Stale

Imagine a scenario which combines the following image and word

Grubby

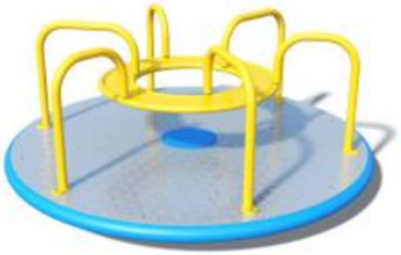
Imagine a scenario which combines the following image and word

Vile

Imagine a scenario which combines the following image and word

Unclean

Imagine a scenario which combines the following image and word



Nauseating

Imagine a scenario which combines the following image and word

Polluted

Imagine a scenario which combines the following image and word

Infection

Imagine a scenario which combines the following image and word

Unwashed

Imagine a scenario which combines the following image and word

Slobber

Imagine a scenario which combines the following image and word

Queasy

Create a sentence which combines the image and word

Grime

Create a sentence which combines the image and word

Vile

Create a sentence which combines the image and word

Infection

Create a sentence which combines the image and word

Expired

Create a sentence which combines the image and word

Illness

Create a sentence which combines the image and word

Filth

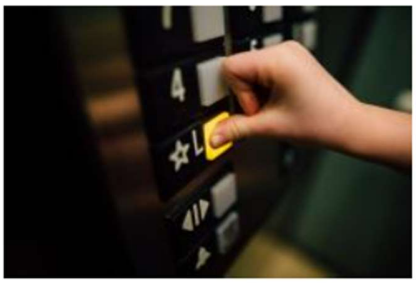
Create a sentence which combines the image and word

Odour

Create a sentence which combines the image and word

Slobber

Create a sentence which combines the image and word



Dirt

Create a sentence which combines the image and word

Unwashed

Create a sentence which combines the image and word

Slime

Create a sentence which combines the image and word

Queasy

Create a sentence which combines the image and word

Congealed

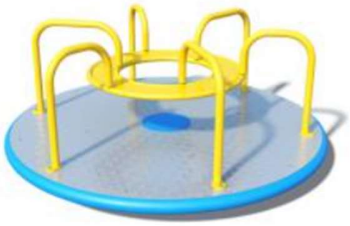
Create a sentence which combines the image and word

Grubby

Create a sentence which combines the image and word

Mud

Create a sentence which combines the image and word



Nauseating

Create a sentence which combines the image and word

Soil

Create a sentence which combines the image and word

Unclean

Create a sentence which combines the image and word

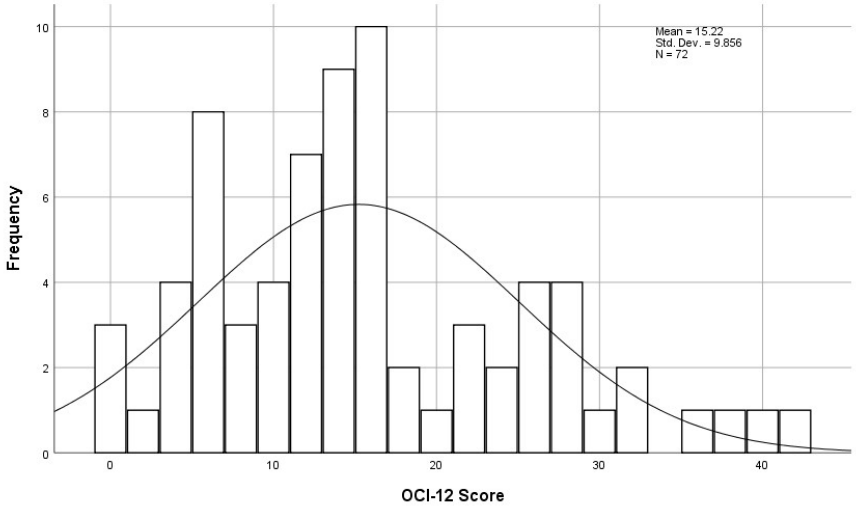
Polluted

Create a sentence which combines the image and word

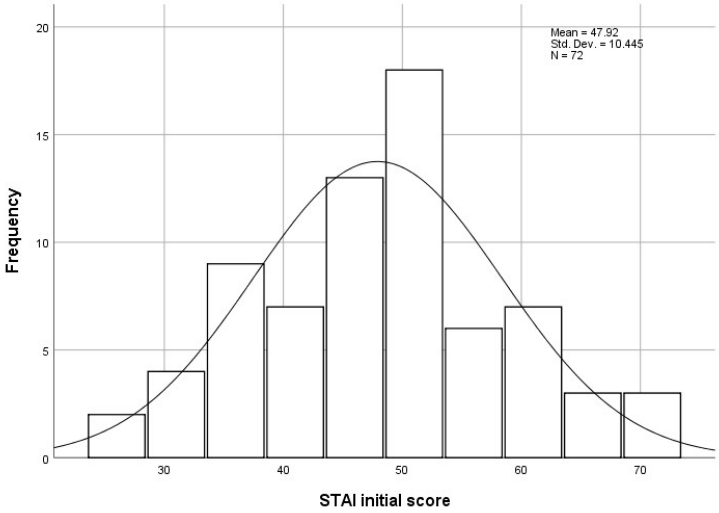
Stale

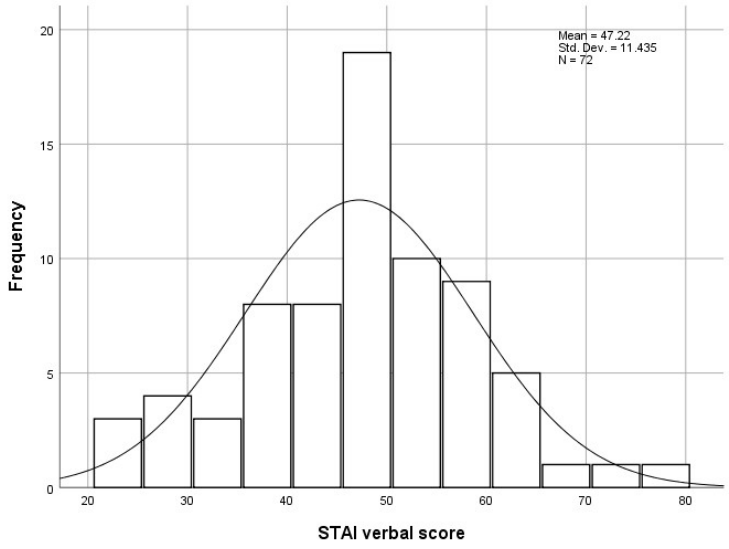
Appendix G: Normality graphs for statistical assumptions

Normality for independent variables



Normality for dependent variables

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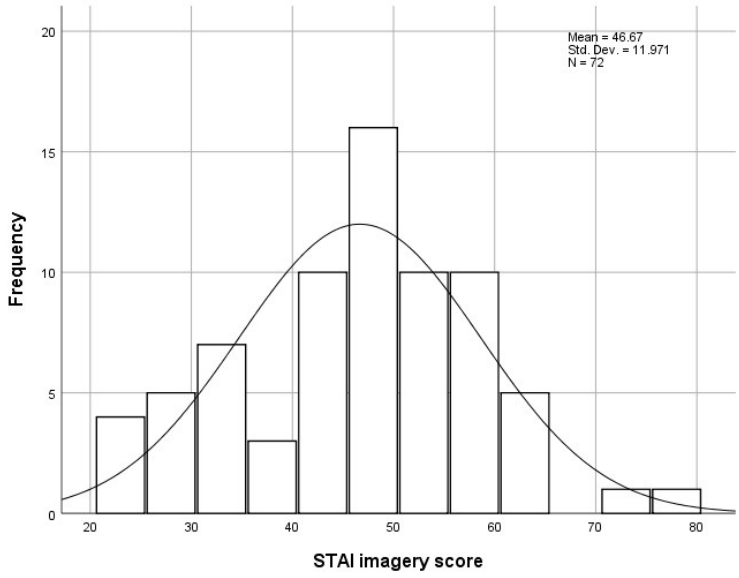
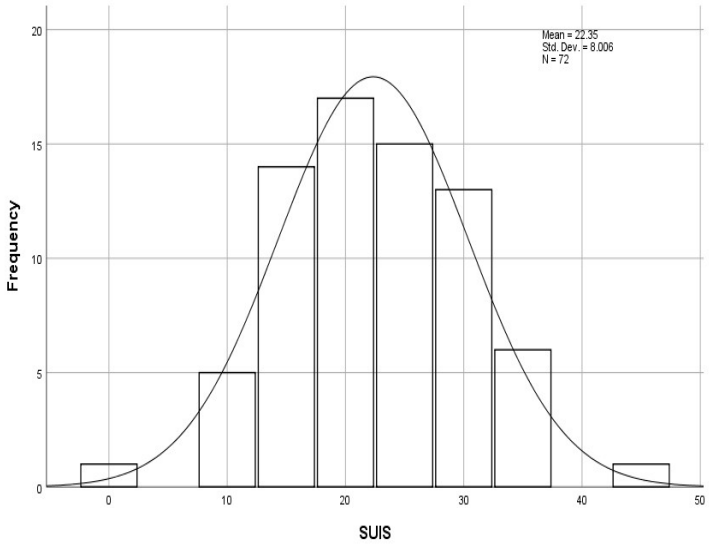
Std. Dev. = 11.435
N = 72
Frequency
STAI verbal score


Mean = 46.67
Std. Dev. = 11.971
N = 72
Frequency
STAI imagery score


Mean = 22.35
Std. Dev. = 8.006
N = 72
Frequency
SUIS
0
5
10
15
20
0
10
20
30
40
50