Cognitive Behavior Therapy for Multiple Chemical Sensitivity: A Single Case Experimental Design

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Abstract

Multiple chemical sensitivity (MCS) is a syndrome with multiple medically unexplained symptoms attributed to odors common in everyday life. The condition causes distress and may severely impair sufferers’ quality of life. The aim of this study is to test the efficacy of a cognitive behavioral intervention (CBT) for MCS, using a replicated AB single case experimental design (N=5). Outcome measures were chemical sensitivity, number of symptoms, symptom distress, catastrophizing, functional impairment, avoidance behavior, life satisfaction and perceived health. Visual inspection, Nonoverlap of All Pairs (NAP) and Tau-U were used to analyze the data. The results show preliminary support for the intervention with significant decreases in symptom distress, functional impairment and catastrophizing. Further, three out of five participants show a reliable change in the hypothesized direction on chemical sensitivity. A decrease in number of symptoms was also seen in three out of five participants. No improvements could be seen on avoidance behavior. The treatment was feasible and patient satisfaction was high. Overall, the intervention indicates effects for some of the participants, and further research is needed to account for the individual differences obtained in the study.

Keywords: Multiple chemical sensitivity, cognitive behavior therapy, single case experimental design
Cognitive Behavior Therapy for Multiple Chemical Sensitivity; a Single Case

Experimental Design

For most people, the odors one encounters in the environment does not constitute an obstacle in everyday life. For a notable amount of people, however, encountering relatively common odors can be a distressing experience. In some cases, the sensitivity to odors is so severe it causes considerable suffering. Multiple Chemical Sensitivity (MCS) is a crippling syndrome characterized by multiple medically unexplained symptoms attributed to very low levels of odors, causing sufferers considerable distress and impairment (Cullen, 1987). Avoidance of social situations, where everyday chemicals might be present, further contributes to the major impairment in the quality of life of MCS individuals (Karvala, Sainio, Palmquist, Nyback & Nordin, 2018). Despite this, the possibility to receive treatment or alleviation are today very limited (Dantoft, Andersson, Nordin & Skovbjerg, 2015). The amount of exposure to the chemicals that in MCS patients gives rise to symptoms are considered to be harmless and in doses far lower than those that would give any physiological impact on other people.

Depending on how MCS is conceptualized and measured, the prevalence varies. In a Swedish study, as many as 33% of the population reported a general odor sensitivity for odorants common in everyday life (Johansson, Brämerson, Millqvist, Nordin, & Bende, 2005). Further, in the Swedish population, 12.2% have a self-reported intolerance to chemicals (Karvala et al., 2018) and 3.3% fulfill the criteria for MCS (Nordin, Söderholm, Palmquist, Andersson, Claeson, & Nordin, 2012). Moreover, women are overrepresented in the MCS population (Dantoft et al., 2015).

People suffering from MCS report a large range of symptoms, with the most prevalent being a general feeling of unease and tiredness, as well as headache, eczemas and dyspnea. Further, symptoms related to the central nervous system, gastrointestinal tract,
dermal, musculoskeletal, respiratory, mucosal and cardiovascular are reported. Common triggers of symptoms are cleaning supplies, tobacco smoke, pesticides, perfumes and vehicle fumes. These odors do not share the same chemical components and the odors reported as triggers vary between different individuals (Dantoft et al., 2015).

MCS is a phenomenon that goes by many names. Among the more accepted terms in the field, besides MCS, are severe Chemical Intolerance (CI) and Idiopathic Environmental Intolerance (IEI) related to chemicals. The term IEI has been put forward as a replacement for the term MCS by several leading researchers in the field, however, all researchers have not customarily used this definition and in the literature IEI and MCS are interchangeably used. The term IEI is used by many scholars as an umbrella term for many different environmental syndromes such as electromagnetic hypersensitivity syndrome, infrasound hypersensitivity as well as MCS. In this thesis the term “MCS” will be used, alternatively, the nomenclature of the studies reviewed will be adopted. There is currently no diagnostic tool available for MCS and therefore the condition is established through a criteria definition (Dantoft et al., 2015). Cullen’s (1987) definition criteria is one of the most widely used.

Table 1.

*Definition criteria of MCS derived from Cullen (1987)*

<table>
<thead>
<tr>
<th>Number</th>
<th>Criteria</th>
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<tbody>
<tr>
<td>1</td>
<td>Initial symptoms occur following an identifiable environmental exposure(s) such as pesticide poisoning, respiratory tract irritation, or solvent intoxication.</td>
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<tr>
<td>2</td>
<td>Symptoms involve more than one organ system and almost always include the central nervous system.</td>
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<tr>
<td>3</td>
<td>Symptoms recur and abate in response to predictable stimuli, particularly perceived environmental exposure.</td>
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<tr>
<td>4</td>
<td>Symptoms occur in response to low-level exposure to multiple agents of varying structural classes.</td>
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<tr>
<td>5</td>
<td>The doses of these agents are at least two odors of magnitude lower than the established thresholds for acute health effects.</td>
</tr>
<tr>
<td>6</td>
<td>Tests of physiologic function are unable to explain the symptoms.</td>
</tr>
<tr>
<td>7</td>
<td>The pattern of symptoms cannot be explained by any other organic disorder.</td>
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</tbody>
</table>
MCS and lifetime psychiatric disorders

Studies of epidemiological and clinical samples have shown an overlap between lifetime psychiatric disorders and MCS. The most common being somatic symptom disorder, formerly known as somatoform disorder (SFD) as well as anxiety disorders and mood disorders (Black, 2000). Bailer, Rist, Witthöft, Paul & Bayerl (2004) and Bailer, Witthöft, Bayerl & Rist (2007) conducted studies to explore if MCS could be a subtype of somatoform disorder (SFD). If so, MCS individuals could be assumed to share some of the same attributes as individuals with SFD, such as symptom patterns, trait anxiety, and increased vigilance towards bodily sensations. The results showed that MCS and SFD are similar to some degree and share common predictors for somatic symptoms. However, some predictors discriminated the two conditions and MCS can thus be seen as a syndrome separate from SFD.

Further, Caress & Steinemann (2003) examined, as one of several things, the relationship between MCS and other psychiatric problems over time. In this self-report study, 1.4% of the respondents reported having mental or emotional problems prior to the onset of their hypersensitivity, and 37.7% reported some emotional or mental distress after the onset of their hypersensitivity. Thus, individuals experienced elevated psychological distress after MCS was manifested. The authors speculate that these findings might indicate a physiological etiology of MCS. However, the etiology of MCS is disputed in the scientific community and is to date not fully understood. Several theories have been put forward, both physiological as well as psychological.

Pathophysiological perspectives on MCS

Since MCS individuals report physiological symptoms, pathophysiological theories have naturally been proposed to explain the etiology of MCS. Different theories suggest for instance that the immune system, the central nervous system as well as olfactory and
respiratory systems might be involved, but there is no consensus reached in the field (Dantoft et al., 2015). One reasonable hypothesis would be that individuals with MCS might have enhanced olfaction compared to others. Women have been found outperforming men in some aspects of recognizing, identifying and categorizing odors (Brand & Millot, 2001) and women are also clearly overrepresented in the MCS population (Dantoft et al., 2015).

However, findings by Papo et al. (2006) showed that the olfactory functions, chemosensory functions and cognitive olfactory information in fact were equal between individuals with MCS and healthy controls in a sample of both men and women.

Sensitization has also been put forward as a mechanism involved in MCS. According to Andersson, Bende, Millqvist & Nordin (2009), the term sensitization is used widely and can represent both physiological reactions at neuronal level as well as psychological processes. Bell, Baldwin, Fernandez & Schwartz (1999) describe neural sensitization as the development of a propensity for more intense neural responses, which can affect different bodily functions when repeatedly exposed to stimuli such as chemicals. Another kind of physiological sensitization process proposed as a mechanism in MCS is central sensitization, which manifests itself as a hypersensitivity to pain caused by increased neural signaling within the central nervous system (Woolf, 2011).

Finally, individuals with MCS might have a dysregulation in the immune system, caused by a specific pattern of a group of proteins called cytokines (Dantoft et al., 2014). However, the authors state that the clinical relevance of the results is unclear, since findings from previous research have been unable to find a consistent pattern of a specific immunological deficit in MCS. Likewise, the findings might as well be correlations and thus, no causal inference can be made. In summary, several pathophysiological hypotheses have been put forward to contribute to the understanding of MCS. However, no pathophysiological
theory nor a combination of pathophysiological theories, has to date to been able to fully explain the development and maintenance of MCS.

A clear relationship between MCS, exposures to chemicals and physiological dysfunction has not been found. In a systematic review, Das-Munshi, Rubin & Wessely (2006) concluded that no exposure study yet has been able to show an established link between the proposed chemicals and somatic pathology and/or dysfunction. Further, the occurrence of mixed symptoms arising from exposure to various substances which, in turn, do not have any correlation in a chemical sense, indicates that it is not a case of a peripheral toxicological effect. Taken together, the dearth of evidence for a toxicological effect as well as the uncertainty of the etiology, one might hypothesize that MCS falls under the umbrella of medically unexplained symptoms (MUS), a condition characterized by the manifestation of symptoms in the absence of obvious pathology (Deary, Chalder & Sharpe, 2007). This condition includes syndromes such as irritable bowel syndrome (IBS) and chronic fatigue syndrome (CFS) (Deary et al., 2007). Several authors have hypothesized the possibility to apply a psychological perspective on MUS and hence psychological treatments may be effective (Deary et al., 2007; Hutton, 2005; Kirmayer, Groleau, Looper, Dao, 2004). Further, Ongaro & Kaptchuk (2018) argue that the medical field should pay attention to how symptoms are perceived, and that symptom perception plays an important part in predicting the body’s health. On this account, psychological mechanisms have been put forward as an alternative explanation model for the cause and the maintenance of MCS symptoms.

**The Role of Psychology in MCS**

In a review by Deary et al. (2007) the theoretical and empirical evidence for a cognitive behavioral model of MUS is put forward. Psychological mechanisms such as conditioning of symptoms as well as attention, attribution and beliefs are considered to be perpetuating factors of MUS.
**Conditioning.** MCS can be seen in light of Pavlovian conditioning (Otto & Giardino, 2001). Conditioning refers to an associative learning process where organisms learn to pair a stimulus with another one. Before the learning process has taken place, an unconditioned stimulus evokes an unconditioned response without any prior learning, the response is thus a reflex. When a neutral stimulus is experienced repeatedly and simultaneously with an unconditional stimulus that is followed by an unconditioned response, the neutral stimulus becomes a conditioned stimulus. The conditioned stimulus then alone provokes a response without the unconditioned stimulus (Siegel & Kreutzer, 1997).

Kirk-Smith, Van Toller & Dodd (1983) conducted a pioneer study establishing that odors can be conditioned. In the experiment an undetected odorant, that is, an odorant not salient enough to be detected consciously, was linked with a stressful task presumed to affect mood and attitudes negatively. The results showed that when the odorant was re-encountered without the task, the odorant alone could affect mood and attitudes. Zucco, Paolini & Schaal (2009) replicated and enhanced the original study since the study had received methodological critique. The authors confirmed the results and reached the same conclusions, that odorants can produce unconscious unpleasant reactions through a conditioning process. These studies demonstrate what may happen in everyday life: an odorant can accidentally be associated with a distressing event, thus triggering negative emotions when re-experienced. On this account, conditioning has been put forward as a possible psychological explanation model for the cause of MCS symptoms.

Van den Bergh and colleagues have in numerous experimental studies (Van den Bergh, Stegen & Van de Woestijne, 1998; 1997; Van den Bergh, Kempynck, Van de Woestijne, Baeyens & Eelen, 1995) demonstrated how non-noxious odors can operate as potent conditioned stimuli in individuals, eliciting somatic symptoms. In one of these experimental studies (Van den Bergh, Stegen, Van Diest, Raes, Stulens, Eelen & Nemery,
the result indicates that after three respiratory trials, an odor can be associated to an unconditioned stimulus and afterwards alone provoke somatic symptoms and altered respiratory behaviors in healthy participants. The experiment used diluted ammonia or butyric acid as conditioned stimulus, two harmless yet odorous chemical substances. As unconditioned stimulus, CO₂ enriched air was used. Inhaling CO₂ enriched air causes a physiological response with symptoms such as pounding heart, sweating, tingling sensations and fast breathing. Hence a harmless yet odorous chemical substance can produce symptoms if it has been associated with a challenging physiological state, which originally produced the symptoms. Further, the study examines if symptoms related to the conditioned stimulus can be diminished by extinction according to the Pavlovian paradigm. The result indicates that learned symptoms can be reduced when a conditioned stimulus is presented without the unconditioned stimulus after conditioning has taken place. Using the same experimental design, it has also been demonstrated that symptoms acquired in response to one repugnant odor easily can spread to other odors (Devriese et al., 2000).

Research by Devriese et al. (2004) has also shown that prior beliefs and expectations play an important role in the process of conditioning. Findings from experimental studies with MCS patients suggest that an elevation of symptoms occurs only when subjects are aware of the fact that an exposure to an odor has taken place. Prior beliefs about the harmfulness of the chemical exposure also seems to be more critical for the onset of symptoms than the actual association between co-occurring odors and symptoms.

Assuming the framework of Pavlovian conditioning as an explanatory model for the development of MCS arises a crucial question, why does not everybody develop MCS? Most people are exposed to chemical odors that provoke symptoms in MCS individuals. Latent inhibition has been put forward as one explanatory model for this. Latent inhibition takes place when the subject has encountered the stimulus repeatedly beforehand. Therefore, a
novel stimulus is more likely to be conditioned compared to a familiar stimulus. For instance, individuals who beforehand have been exposed to an odor preceding a noxious conditioning event, could be less vulnerable to develop conditioned aversion to the specific odor or similar odors (Otto & Giardino, 2001).

**Cognitive mechanisms.** Cognitive mechanisms and their influence on MCS have been explored in several studies (Bailer et al., 2007; Bailer et al., 2004; Witthöft, Gerlach & Bailer 2006; Witthöft, Rist & Bailer, 2009; Andersson et al., 2009). Authors argue that individuals with MCS may have specific so-called cognitive schemas, that is, patterns of thoughts that are used to organize information. Similarly, specific cognitive perceptual styles, i.e. how individuals think and perceive the world, are suggested to be present in MCS. These cognitive schemas and styles may for example include misled attribution and misbeliefs about stimuli and symptoms. Findings by Bailer et al. (2004) showed that one of the strongest psychological predictors for somatic symptoms in MCS participants was cognitions concerning environmental threat. The fact that the strongest predictors for MCS symptoms are general environmental sensitivity and negative cognitions about environmental threats indicate a special cognitive-perceptual style regarding these threats. The same result was also obtained in a study by Bailer et al. (2007). These certain illness beliefs and attributions to threats in the environment are specific for MCS participants. The authors speculate that MCS individuals may have specific cognitive schemas thought to be elicited both by internal triggers, such as misinterpretations of vague bodily symptoms as symptoms of MCS, and external triggers, such as hearing and reading about harmful chemicals in the environmental (Bailer et al., 2007). Further, it has also been shown that symptoms related to odors and chemical substances are easily learned when newspapers warn about environmental pollution. Subjects receiving warnings about the potential harmful environmental pollution associate
both foul- and pleasant-smelling odors to symptoms and declare more symptoms compared to subjects who have not received any information (Winters et al., 2003).

Other processes possible included in these cognitive schemas and cognitive styles are attention biases. Attention biases can be described as a heighten attention towards certain stimuli or information. Selective attention is a form of attention bias where stimuli is filtered: selected stimuli are acknowledged, and unselected stimuli are ignored. Witthöft et al. (2006; 2009) found that MCS individuals reacted to symptom words and words of environmental threat very negatively and that they found these words arousing and highly unpleasant compared to the healthy controls. A cognitive schema including attention biases and selective attention may explain this negative automatic association. Similarly, findings by Andersson et al. (2009) indicated that the process of attention bias occurs when MCS individuals are exposed to chemosensory stimuli. That is, when MCS individuals are presented with a foul smell, the individuals may have a hard time concentrating on another task that demand cognitive effort.

Somatosensory amplification has also been suggested as a process in the specific cognitive schemas or perceptual styles of MCS individuals (Bailer et al. 2004; 2007; Skovbjerg, Zachariae, Rasmussen, Johansen & Elberling, 2010). Van Ravenzwaaij et al. (2010) describe somatosensory amplification as the process in which a physical sensation emerges and is followed by increased attention to this sensation. The sensation is then amplified by specific cognitions, attributions and affects, which in turn triggers a vicious cycle. According to Barsky, Goodson, Lane & Cleary (1988, p 510), this cycle results in “the tendency to experience somatic sensation as intense, noxious, and disturbing”.

Somatosensory amplification has been found a significant predictor for MCS-like symptoms in several studies (Bailer et al. 2004; 2007; Skovbjerg et al. 2010).
Taken together, there does seem to be some evidence for specific cognitive perceptual styles and specific cognitive schemas including attention bias, misled attribution, misbeliefs and somatosensory amplification, as integral parts of symptom maintenance in MCS. However, as mentioned above, there is no clear answer to how MCS is developed and maintained.

A complex interaction

MCS seems to be a complex phenomenon, probably including both psychological and physiological mechanisms (Staudenmayer, Binkley, Leznoff, & Phillips, 2003). These mechanisms may be difficult to clearly separate. With this in mind, Andersson et al. (2009) conducted an experimental conditioning study, examining sensitization and attention bias to chemical exposure in self-reported chemical sensitive individuals (CS). The aim of the study was twofold. Leaning on previous research, which hypothesized that sensitization in the limbic circuits of the brain was a mechanism for medically unexplained conditions, the authors first sought to investigate if responses to chemicals are intensified by sensitization. Thereafter, they aimed at investigating whether CS individuals showed attention bias toward chemical exposure. The results indicated that a sensitization process occurs, since CS individuals do not habituate to the exposure. The results also show that an attention bias was present. The authors claim that the consequences of an attention bias combined with sensitization may result in CS individuals allocating environmental threats faster. Further, the authors propose than an interaction between negative bias and sensitization might occur, where negative biases could trigger a sensitization process, a process that in turn may evoke symptoms. This result goes in line with the Deary et al. (2007) review, where sensitization is proposed as one of many perpetuating factor of somatic symptoms in MUS. Deary et al. (2007) state that MUS, in the light of their findings, can be seen as a complex condition involving multiple factors from different domains. Thus, MCS may be viewed as a complex
interaction between physiological and psychological mechanisms. Andersson et al. (2009) speculate that psychological processes may trigger physiological processes. In light of this, as well as the substantial findings of the importance of psychological factors in the development and maintenance of MCS, psychological treatment approaches to MCS have not received substantial attention.

**Psychological treatments of MCS**

A recent systematic literature review was conducted by Menon, Rajan, Kuppili & Sarkar (2017) to investigate if CBT was effective intervention for MUS. They reached the conclusion that CBT interventions had a moderate effect. However, the authors conclude that this result must be interpreted with caution, due to the limited amount of studies in the area, as well as the methodological limitations of the review. Further, it should be noted that no study included in the review investigated an MCS sample.

Regarding MCS, few previous studies have examined psychological treatment approaches. For example, early research by Guglielmi, Cox & Spyker (1994) attempted to treat MCS with psychological interventions. The interventions were biofeedback-assisted in vivo exposure and cognitive restructuring based on the assumption that classical conditioning can be seen as a conceptual model for MCS. The result indicated that MCS may be treated with these interventions, however the sample consisted of only three participants and the authors call for further research to investigate the efficacy of behavioral interventions for MCS. Later research regarding treatment for MCS has been carried out by Hauge et al. (2015). The authors conducted a randomized controlled trial to test the efficacy of a mindfulness-based cognitive therapy (MBCT) for MCS individuals. The results showed no effect on the impact of MCS on daily life, symptoms or reactions following chemical exposures, but there were positive changes found in emotional and cognitive representations such as enhanced sense of personal control and concern with MCS.
To date there is undoubtedly too few psychological treatment studies conducted for this patient group and the need for evidence of effectiveness of psychotherapeutic interventions has been prompted (Das-Munshi, Rubin and Wessely, 2007). One reason for the absence of treatment studies is simply that researchers debate over the etiology of MCS and thus also what kind of treatment that should be offered. Another reason is the lack of a comprehensive model that encompasses all the psychological mechanisms contributing to MCS and demonstrates how these different mechanisms interact and affect each other. This is needed in order to carry out an adequate psychological treatment that targets specific components contributing to the maintenance of MCS. However, the research in the field have in recent years accumulated new findings and a new integrated model has recently been presented.

**A new comprehensive model of MCS**

A new model has been put forward by Van den Bergh, Brown, Petersen, & Witthöft (2017). The aim of the model is to create a coherent picture of the psychological processes that generate and maintain symptom experience in IEI, as well as outline how these processes interrelate. As mentioned above, IEI is an umbrella term which includes MCS. Van den Bergh et al. (2017) have critically reviewed the entire field of research on IEI, and this model is based on the last decades of evidence. The findings of specific cognitive schemas fit well into the theoretical framework that the model entails, which builds on the concepts of the Bayesian brain model, predictive coding and symptom perception. According to the Bayesian brain model, human perception is an interaction between bottom-up processes and top down processes. The theory implies that what we perceive is not the world as it “actually” is, rather it is the brain’s assumption of it, frequently modifying to incoming sensory evidence (Ongaro & Kaptchuk, 2018).
According to the model, the generation and maintenance of symptoms in IEI can be illustrated in two different stages. In stage 1 (see Figure 1), a symptom is explained to be generated in a three-step fashion. Firstly, the individual has a set of priors, i.e. predictions about the presence of a symptom. Strong priors can be generated by experiences of actual toxic exposure in the history or be learned by information about threats from other sources, such as trusted friends or the media. Secondly, a comparison is made between the prior and the sensory input from the environment, which generates a prediction error (i.e. the difference between what the individual expected and what actually occurred). One explanation given for the occurrence of prediction errors is a faulty activation of the HPA-axis, a set of organs controlling stress hormones and other body processes. This gives rise to an inability to correctly interpret bodily sensations. Thirdly, a cognitive error minimization takes place, in order to reduce the difference between the prior and the sensory input, resulting in a posterior model, which is comprised of the symptoms that the individual actually experience. For example, a person with MCS might unconsciously expect, based on prior beliefs and experiences, to experience symptoms such as headache when encountering odors. In light of the belief that odors cause headache, a misinference of sensory input takes place. The faulty inference is then experienced as actual headache. Moving on to stage 2 of the model, IEI symptoms are experienced, as described in stage 1. This contributes to the furthering of beliefs of the dangers of environmental stimuli. These beliefs lead to a feedforward process that gives rise to a more frequent perceiving of exposure to said dangers. An important component in this process is the so-called nocebo effect, where negative thoughts and expectancies affects the symptoms and intensify them. Attention biases further affect this feedback loop. For example, experiencing headache when encountering odors strengthens the belief that odors causes headache, which in turn increases the likelihood to perceive odors more frequently and intensely. The unconscious act of selectively paying more attention to
odors compared to other stimuli, as well as substantially focusing on them, contributes to the feedback loop.

In this section, the new comprehensive model by Van den Bergh et al. (2017) has been outlined. This thorough model covers a range of psychological mechanisms contributing to MCS, elucidates how these mechanisms may interact and suggest potential treatment strategies. However, the clinical value and the utility of the model have not yet been investigated.

**Figure 1.** A version of the theoretical model of IEI proposed by Van den Bergh et al. (2017).

**Aim of The Current Study**

The new model put forward by Van den Bergh et al. (2017) provide several possibilities for psychological interventions but has not yet been clinically implemented or evaluated. Individuals suffering from MCS experience severe distress and impairment in their
quality of life, but there are today very limited possibilities to receive treatment or alleviation (Dantoft et al., 2015). The aim of this study is therefore to test the efficacy of a cognitive behavioral intervention (CBT) for MCS, based on the theoretical model by Van den Bergh et al. (2017). Chemical sensitivity and symptomatology are considered primary outcome measures, while impairment in daily functioning, life satisfaction and perceived health are considered secondary outcome measures. With this in mind, the following research questions were formulated:

(1) what effect does the intervention have on participants’ chemical sensitivity, including symptoms?

(2) what effect does the intervention have on important outcomes such as impairment in daily functioning, life satisfaction and perceived health?

(3) what effect does the intervention have on possible perpetuating factors such as catastrophizing, symptom distress and avoidance behaviors?

This study provides an original contribution to the research field of psychological treatment approaches to MCS.

Method

Design

A single-case experimental AB design (SCED) was conducted and replicated across five subjects. A SCED builds on repeated measures and was chosen since it is a method well suited for evaluating the effect of an intervention on an individual level (Kazdin, 2011). Repeated measures were attained during a three-week baseline phase with no treatment (A), and a nine-week treatment phase with 6-8 sessions (B). In a single-case AB design, the baseline (A) serves the same purpose as a no treatment control group. Hence, changes taking place during the treatment phase (B) may be attributed to the intervention (Kazdin, 2011). By including more than one participant, there is a possibility that the results will be replicated,
and, in such case, the external validity is strengthened (Barlow, Nock & Hersen, 2009). No randomization to multiple baselines was done due to time limitations. Pretreatment and posttreatment measurements were conducted, and a follow-up assessment will be administered six months after treatment finish. During both the baseline assessment and the treatment phase, the participants were asked to respond daily to five questions about symptoms and disability. The questions 1 and 2 were rated on a scale between 0-10 (0=not at all, 10=very much) and were “today my symptoms have bothered me”, “today I have worried about my future health associated to my symptoms”. Question 3 and 4 were rated on a scale between 0-8 (0=not at all impaired, 8=very much impaired) and were “because of my distress associated with smell, my work ability” and “because of my symptoms, my social activities (with other people) are”. The last question was rated on a scale between 1-4 (1=never, 4=all the time) and was “how often do you avoid situations, places, objects, and activities due to fear of symptoms or occurrence of symptoms?”.

<table>
<thead>
<tr>
<th>Baseline A: 3 weeks</th>
<th>Intervention B: 6-8 sessions during 8 weeks</th>
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<tbody>
<tr>
<td>Repeated measurements</td>
<td></td>
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</table>

Week 0---------1---------2---------3---------4---------5---------6---------7---------8---------9---------10---------11
Pre-measure          Middle-measure       Post-measure

*Figure 2. Overview of measurement time points*

**Participants**

A total of seven females were included in the study. Two participants decided not to complete the treatment, and dropped out after the first and second session, respectively. Although not obliged to give a reason, both participants reported they did not feel a need for the treatment. Hence, the final sample consisted of five participants. The participants in the final sample were between 32-61 years old and the mean age was 53.2 years. In order to be included in the study, participants had to report a presence of at least one symptom scoring ≥
3 on the Idiopathic Environmental Intolerance Inventory (IEII), and not reach a clinically significant level on any of the subscales of the Hospital Anxiety and Depression Scale (HADS). The participants underwent a clinical interview with an experienced psychologist and a medical assessment to ensure that inclusion criteria were met and that there were no grounds for exclusion. One participant had been diagnosed with sensory hyperreactivity syndrome (SHR), which is described as an overreaction in the lower airways causing chronic cough (Millqvist, Bende & Löwhagen, 1998). No form of compensation was offered for participation.

**Procedure**

Participants were recruited from the area around a mid-sized Swedish city. Recruitment was done through information on Örebro University’s homepage and advertisement in social media (Facebook and Instagram). A total of 19 (18 females and one male) individuals showed interest in the study by completing an electronic screening tool (Appendix 1). The screening aimed to include people with clinically significant levels of odor sensitivity, as well as exclude individuals suffering from severe psychiatric problems. All 19 participants were contacted by telephone and notified whether or not they proceeded to a clinical interview with an experienced psychologist and a medical assessment. The aim of the clinical interview was to ensure that inclusion criteria were met and that there were no grounds for exclusion. During the interview the participants were informed about the study and what participation would entail. A total of nine participants completed the clinical interview and seven were finally included in the study. The treatment was delivered at the Department of Occupational and Environmental medicine at Örebro University Hospital. The participants were randomized to one out of two therapists. Therapists were two clinical psychology students in their last year of training. The therapists were supervised by a licensed psychologist with experience of the current patient group. One week before the start
of the baseline, an envelope containing the baseline daily measurements and the pre-
treatment measurements was sent to the participants by mail. On the first session of
treatment, the participants received information about the study and filled in a form of
informed consent (Appendix 14). At two time points, before baseline and after treatment, the
participants were asked to respond to a more extensive battery. The same extensive battery
will be filled out at follow up six months after treatment finish.

Recruitment through advertisement in social media

Showed interest in the study by completing an
electronic screening tool (n=19)

Offered to proceed to the clinical interview (16)

Completed the clinical interview (n=9)

Completed pre-treatment measurements and
three-week baseline (n=7)

Filled in informed consent (n=7)

Received treatment (n=7)

Completed treatment and posttreatment
measurement (n=5)

Included in analysis (n=5)

Did not meet inclusion criteria (n=3)

Declined participation or unable to reach (n=7)

Excluded after clinical interview due to other psychiatric problems (n=2)

Did not complete treatment (n=2)
Figure 3. Flowchart of the recruitment and treatment participation.

Treatment

The treatment was a structured, cognitive behavioral intervention based on the theoretical model and interventions suggested by Van den Bergh et al. (2017). Each session lasted 45 minutes and all participants received eight sessions, except one participant, who received six sessions. Four participants met the therapist for face-to-face sessions while one participant received the treatment via Skype. Main components were psychoeducation, and exposure to triggering chemicals and odors as well as developing an acceptance approach to odors and symptoms. Psychoeducation was mainly delivered during the first two sessions. Van den Bergh et al. (2017) suggest psychoeducation as a way to help patients understand how attributing symptoms to a chemical cause can produce a self-fulfilling prophecy, where anticipation of symptoms increases their perception of threat. Exposure was done in between sessions and thereafter discussed and worked with in sessions. Van den Bergh et al. (2017) suggest that exposure to chemicals can serve as disconfirmatory evidence and change patients’ cognitions and symptom experiences. In the end of each session, participants received a homework assignment. Over the three first sessions participants also received handouts with psychoeducational information. An overview of the treatment plan can be viewed in Appendix 15. Table 2 shows number of sessions and form of treatment.

Table 2.
Number of sessions and form of treatment for each of the five participants

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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td>Number of sessions</td>
<td>8 sessions</td>
<td>8 sessions</td>
<td>6 sessions</td>
<td>8 sessions</td>
<td>8 sessions</td>
</tr>
<tr>
<td>Treatment period</td>
<td>9 weeks</td>
<td>9 weeks</td>
<td>9 weeks</td>
<td>9 weeks</td>
<td>9 weeks</td>
</tr>
<tr>
<td>Form of treatment</td>
<td>Skype</td>
<td>Face-to-Face</td>
<td>Face-to-Face</td>
<td>Face-to-Face</td>
<td>Face-to-Face</td>
</tr>
</tbody>
</table>
Measures

An extensive assessment battery was administered prior to treatment and after treatment finish. Swedish versions of all measures were used.

Screening measures.

Symptoms. To measure IEI symptoms, an inventory was constructed, based on the Idiopathic Environmental Intolerance Symptom Inventory (IEISI). IEISI is a brief self-report screening questionnaire divided into five symptom categories. The categories are “airway, mucosa and skin symptom”, gastrointestinal symptom, head-related symptom, cardiac, nausea and dizziness symptoms and cognitive and affective symptom. The participants are asked to report which symptoms they experience, choosing from a list consisting of 27 symptoms. Each category also includes an open-ended symptoms box. IEISI has demonstrated good validity and reliability, with a KR20 value of .84 and test-retest reliability of r = .80 (Andersson, Andersson, Bende, Millqvist & Nordin, 2009). For the purpose of this study, seven items were removed, and two other items were added. Further, the close-ended symptoms questions were developed so that the participants could rate symptom intensity on a 4-point Likert scale (0=not at all, 4=a lot). This was done to evaluate if the participants experienced symptoms on a clinically significant level.

Anxiety and depression. The Hospital Anxiety and Depression Scale (HADS) was used to measure participants level of anxiety and depression. HADS is a brief self-report screening scale consisting of 14 items, of which seven measure depression (HADS-D) and seven measure anxiety (HADS-A). The scale consists of two subscales each containing seven items in order to capture the two dimensions depression and anxiety. The items are rated on a 3-point Likert scale from 0 (not at all) to 3 (most of the time) (Zigmond & Snaith, 1983). Participants scoring 7 or below in any of the subscales presumably do not have anxiety or depression of clinical significance. The scale has shown good internal reliability and validity.
The mean of Cronbach’s α was .83 for HADS-A and .82 for HADS-D (Bjelland, Dahl, Haug, & Neckelmann, 2002).

**Repeated measurements.** For the purpose of this study, a daily measurement was constructed. The daily measurement consisted of five items and aimed to cover bothersomeness of symptoms, catastrophizing about symptoms, functional impairment and avoidance. Item 1, “today, my symptoms have bothered me...” and 2, “today I have worried about my future health associated to my symptoms...” were rated on a scale between 0 to 10 (0=not at all and 10=very much). Item 3 and 4 were rated on a scale between 0 to 8 (0=not at all impaired, 8=very much impaired) and were “because of my distress associated with odors, my work ability is...” and “because of my symptoms, my social activities (with other people) are...”. The last item was rated on a scale between 0-4 (0=never, 4=all the time) and was “how often do you avoid situations, places, objects, and activities due to fear of symptoms or occurrence of symptoms?”. The participants were asked to answer the questions of the daily measurement every day during both the baseline phase and the treatment phase. An overview of the daily measure can be seen in Table 3.

**Table 3.**

*Overview of the repeated measurement.*

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale</th>
<th>Concept aimed to measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Today my symptoms have bothered me…</td>
<td>0-10</td>
<td>Symptom distress</td>
</tr>
<tr>
<td>2. Today I have worried about my future health associated to my symptoms...</td>
<td>0-10</td>
<td>Catastrophizing</td>
</tr>
<tr>
<td>3. Because of my distress associated with odors, my work ability is...</td>
<td>0-8</td>
<td>Functional impairment</td>
</tr>
<tr>
<td>4. Because of my symptoms, my social activities (with other people) are...</td>
<td>0-8</td>
<td>Functional impairment</td>
</tr>
<tr>
<td>5. How often do you avoid situations, places, objects, and activities due to fear of symptoms or occurrence of symptoms?</td>
<td>0-4</td>
<td>Avoidance</td>
</tr>
</tbody>
</table>
**Pre-, and posttreatment measurements**

**Symptoms.** To measure participants’ symptoms, The Environmental Hypersensitivity Symptom Inventory (EHSI) was used. The EHSI consist of 34 items divided into the five subscales air symptoms; skin and eye symptoms; cardiac, dizziness and nausea symptoms; head-related and gastrointestinal symptoms and cognitive and affective symptoms. The participants were asked to report the symptoms they have experienced at least once a week during the last three months. The EHSI has demonstrated satisfying face validity and good reliability, with a KR20 value of .85 (Nordin, Palmquist, Claeson & Stenberg, 2013).

**Symptom catastrophizing.** To measure symptom catastrophizing, the subscale ‘catastrophizing’ from The Safety Behaviors and Catastrophizing Scale (SBCS) was used. The subscales consist of six items and participants were asked to indicate on a 5-point Likert scale (1=do not agree at all, 5=completely agree) to what degree they agree on statements such as “When I experience symptoms, I cannot stop thinking about them”. The scale has shown good validity and internal reliability, with a Cronbach’s α of .84 for catastrophizing (MacDonald, Linton & Jansson-Fröjmark, 2008).

**Chemical sensitivity.** CSS-SHR is a short version of the Chemical Sensitivity Scale (CSS) and is a self-report, 11-item scale that originally was developed to measure symptoms associated with odors or pungent chemicals among patients with sensory hyperreactivity (SHR). Participants were asked to rate how applicable they found statements such as “I find it hard to relax in a place that evokes odor/pungent sensations”. Three different scales were used, one scale ranged from 0=agree strongly to 5=disagree strongly, another scale range from 0= completely deter me to 4= not at all important and the last scale range from 0= always to 5=never. The cutoff score for clinically significant SHR was ≥ 43. The CSS-SHR has demonstrated equivalent psychometric properties as the CSS, with satisfying internal
reliability (Cronbach’s α=.76-.84), good test-retest reliability (r=.87), and predictive and concurrent validity (Nordin, Millqvist, Löwhagen, & Bende, 2004).

**Functional impairment.** The Work and Social Adjustment Scale (WSAS) was used to measure participants self-reported degree of functional impairment. Participants were asked to rate, on an 8 point-scale ranging from 0 (not at all impaired) to 8 (very severely impaired), how impaired they felt in different areas of their life. The WSAS consist of five items, such as “Because of my [problem] my ability to work is impaired”. A score above 20 indicates moderately severe pathology, a score between 10 and 20 indicates some functional impairment and a subclinical population score 10 or less (Mundt, Marks, Shear & Greist, 2002). The WSAS has shown to be a useful measure of social and work adjustment with good psychometric properties. Cronbach’s α ranged from .78 to .94 over time and test-retest reliability for the total WSAS score was r=.73 (Mundt, Marks, Shear & Greist, 2002).

**Life satisfaction.** Participants self-reported life satisfaction was measured using Life Satisfaction, LiSat-11. When completing LiSat-11, participants were asked to rate how satisfying different aspects of their lives were, on a 6-point scale ranging from 1 (very dissatisfying) to 6 (very satisfying). Examples of the different domains measured are family life, somatic health and economy. Items, such as “My psychological health is” and “My contact with friends and acquaintances is” are constructed as unfinished sentences that participants are asked to finish. LiSat-11 has shown adequate psychometric properties with a Cronbach’s α of .85. (Fugl-Meyer, Melin, & Fugl-Meyer, 2002).

**Perceived health.** To measure participants perceived health status, one out of two components of the Health-related quality of life (EQ-5D) was used. The original questionnaire includes both a description of health state and an evaluation. For the current study, only the evaluation part, EQ-VAS, was used. EQ-VAS consists of a visual analogue scale where participants are asked to evaluate their overall health status. A picture of a
thermometer is presented, and the participants are asked to determine how good or bad one's health condition is by drawing a line to the number they think describe their health status. Best possible health condition is marked as 100 and worst possible health condition as 0. The EQ5-VAS has been shown a reliable and valid measure of perceived health (Hurst, Kind, Ruta, Hunter & Stubbings, 1997).

**Pre- and mid treatment measure.** The credibility/expectancy questionnaire (CEQ) was used to measure participants’ expectancies of the treatment outcome as well as the treatments credibility. CEQ is a brief scale with six items divided into two sets, where the first set targets the participants’ *thoughts*, and the second set targets the participants’ *feelings*. In the first set, participants were asked to answers questions such as “At this point, how logical does the therapy offered to you seem?” by marking on a 9-point scale the option that best correspond to their beliefs (1=Not at all logical, 9=Very logical). In the second set, participants were asked questions such as “At this point, how much do you really feel that therapy will help you to reduce your symptoms?” by marking on a 9-point scale the option that best correspond to their beliefs (1=Not at all, 9=Very much). The CEQ has proved satisfying internal reliability with a standardized $\alpha$ ranging from .84 and .85 for the whole scale and good test-retest reliability with $r=.82$ for expectancy and $r=.75$ for credibility (Devilly & Borkovec, 2000).

**Posttreatment measure only.** A questionnaire consisting of four items was constructed to measure possible adverse effects of treatment. Participants answered the question “Have you experienced that the treatment involved something you did not want (e.g. unexpectedly much discomfort, impaired mood or impaired life situation?)”. If the participants answered yes on the above stated question, they had the possibility to further describe the unwanted effects.
Data analysis

Before the analysis was conducted, the decision not to replace missing data points was reached. Replacing missing data may indicate correlations or trends not supported by the data, which could lead to faulty conclusions (Peng, Harwell, Liou & Ehman, 2006). For the daily measurement, a mean score for each week was calculated.

**Visual inspection.** Since SCED is a design with different prerequisites than between-group designs, analyzing SCED data demands different methods than the statistical procedures used in between-group designs (Barlow et al., 2009). The standard practice for managing data in SCED is visual inspection (Kazdin, 2011). Visual inspection is done by compiling data from the repeated daily ratings into graphs, which are then analyzed based on specific guidelines. The visual inspection begins with studying the trend of the data. A trend can be described as a pattern of increases or decreases in the data over time. Further, visual inspection includes investigating change in mean between phase A, baseline, and phase B, treatment. A change in mean in the desired direction may indicate that the intervention has had the intended effect. The level of the data is obtained by comparing the possible shift between the last measure point in the baseline and the first measure point in the intervention phase. Another part of the visual inspection is to consider the latency of the data. The latency refers to how fast or slow a possible change takes place after the intervention has been introduced. A short latency between the onset of the intervention and the change in data indicates that the intervention may have been responsible for the change. Finally, it is important to analyze the variability in the data. Large amounts of variability, particularly in the baseline, makes it difficult to interpret the data and thus draw any conclusions (Kazdin, 2011). To increase reliability, the visual inspection of the graphs was done by the authors as well as two other independent raters with prior experience of working with visual analysis in SCED. The raters were familiar with, but not involved in, the project.
**Nonoverlap of All Pairs (NAP).** Further, NAP scores were calculated. NAP is a suitable method to use when estimating effect size in a SCED, and are preferably chosen over the previously more used *Percentage of nonoverlapping data* (PND) and *The Percentage of Data Points Exceeding the Median of the Baseline Phase* (PEM) (Parker & Vannest, 2009). According to Parker and Vannest (2009, p.358), “NAP summarizes data overlap between each phase A datapoint and each phase B datapoint, in turn. A nonoverlapping pair will have a phase B datapoint larger than its paired baseline phase A datapoint. NAP equals the number of comparison pairs showing no overlap, divided by the total number of comparisons.” Parker and Vannest (2009) propose guidelines for how to interpret NAP scores: scores between 0–.65 are considered weak effects, scores between .66–.92 are considered medium effects, and scores between .93–1.0 are considered large or strong effects. An online calculator, available for free at http://www.singlecaseresearch.org, was used to calculate the NAP scores.

**Tau-U.** In addition to NAP, Tau-U scores were calculated. Tau-U is a method that, similarly to NAP, shows improvement of data points from baseline to intervention. In addition, Tau-U calculates between- and within-phase trends and provide the possibility to control for possible baseline trends. A trend in the hypothesized direction of the intervention before the intervention has taken place indicates that the participant would have improved even without the intervention. Ignoring this trend in the baseline risks misguided conclusions about the cause of change (Parker, Vannest, Davis & Sauber, 2011). Significance testing and calculation of confidence intervals is applied to Tau-U. A significant Tau-U result indicates a treatment effect and Tau-U is comparable to other effect sizes ranging from −1 to 1. The same online calculator was used for both NAP and Tau-U.

**Reliability Change Index (RCI) scores** were calculated to see whether there was a clinically significant difference between the pretreatment measurement and the posttreatment
measurement (Jacobson & Truax, 1991). RCI is calculated by dividing the difference between the two measurement points with the standard error of the difference. To be able to calculate the standard error of the difference, the standard deviation for the chosen measurements are needed. An RCI score of 1.96 or higher is considered a clinically significant change. For the current study, RCI was only applicable to use with CSS-SHR. For the other measurements, there were either no required data available, or the outcome variables were categorical and could therefore not generate standard deviations or means.

To calculate the RCI for chemical sensitivity, data from Nordin et al. (2004) were used. The standard deviation was 8.73 and test-retest reliability was r=.87. In addition, clinically significant improvement (CS) was assessed and a change in a subject’s score of two standard deviations from the mean of the current sample was considered be the cut-off criterion. The standard deviation from above mention study was used for this calculation.

**Comparison with Cutoff.** To analyze if the change was clinically relevant, each individual's points were compared with the cutoff described for CSS-SHR. Both the pretreatment points and the posttreatment points were compared to cutoff scores.

**Percentage of change.** Finally, the percentage of change from pretreatment to posttreatment was calculated for each individual. The percentage of change does not take any cut off scores into account and should therefore only be seen as an indication.

**Ethical Considerations**

The current study has been approved by the regional board of ethics in Uppsala [dnr 2018/128]. The study also follows the ethical guidelines of the Swedish research council that emphasis four research principles regarding information, consent, confidentiality and utilization (Vetenskapsrådet, 2002). Participation was voluntary and information about the purpose of study was rendered. Prior to giving informed consent the participants were inquired to partake in a clinical interview as part of the selection process. All participants
were verbally informed about the study and what participation would imply during the interview. This included their right to withdraw consent at any time without explaining why and the information they had provided up until that point would then not remain in the study. The written informed consent was signed by all participants before the first treatment session. No affiliation was noted or suspected between the participants of the study and the researchers/practitioners involved. Extra discretion was taken to ensure anonymity due to the small sample size.

Results

From the repeated measurement, item number 3 was excluded in the analysis due to misinterpretation. This item covered functional impairment in work-related activities, and the participants did not answer the question on weekends or when they were absent from work. This resulted in multiple missing data, and the item was therefore excluded.

Changes in chemical sensitivity and symptoms

Pre-, and posttreatment measures. Table 4 shows the pre-, and posttreatment scores and RCI as well percentage change on chemical sensitivity and number of symptoms. All participants show a decrease in scores on chemical sensitivity, but the magnitude of the decrease varies. Participants 1, 2 and 3 show a reliable- and clinically significant change. Participants 4 and 5 show only a slight decrease in scores and the change is not reliable or clinically significant. However, regarding cut off criteria for chemical sensitivity, measured by CSS-SHR, all of the participants show a decrease from a clinical level to a subclinical level.

On posttreatment measures, participants 1, 4 and 5 report a decrease in number of symptoms. Participant 2 report the same number of symptoms, while participant 3 report an increase in number of symptoms.
Table 4.

Chemical sensitivity (CSS-SHR) and Number of symptoms (EHSI) at pre-, and posttreatment

<table>
<thead>
<tr>
<th></th>
<th>Pre CSS-SHR</th>
<th>Post CSS-SHR</th>
<th>Change % CSS-SHR</th>
<th>RCI, CSS-SHR</th>
<th>Pre EHSI</th>
<th>Post EHSI</th>
<th>Change in % EHSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>38&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>-24.00%</td>
<td>-2.59*</td>
<td>17</td>
<td>5</td>
<td>-70.58%</td>
</tr>
<tr>
<td>2</td>
<td>47</td>
<td>35&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>-25.53%</td>
<td>-2.68*</td>
<td>9</td>
<td>9</td>
<td>0%</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>32&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>-25.58%</td>
<td>-2.57*</td>
<td>12</td>
<td>15</td>
<td>+25.00%</td>
</tr>
<tr>
<td>4</td>
<td>45</td>
<td>41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-8.89%</td>
<td>0.95</td>
<td>13</td>
<td>10</td>
<td>-23.08%</td>
</tr>
<tr>
<td>5</td>
<td>48</td>
<td>41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-14.5%</td>
<td>-1.53</td>
<td>9</td>
<td>3</td>
<td>-66.67%</td>
</tr>
</tbody>
</table>

Note: RCI calculated with Jacobson and Truax (1991) formula with E–N correction for regression to the mean (Speer, 1992).

<sup>a</sup> Clinical significance = a change of 2 SD (a score of ≤ 40) was considered a significant change

<sup>b</sup> Below the CSS-SHR cutoff for clinical sample ≥43.

*Significance in the hypothesized direction.

Changes in functional impairment, life satisfaction, and perceived health

**Pre-, and posttreatment measurements.** Table 5 shows the pre-, and posttreatment scores and percentage change on functional impairment and life satisfaction. Four out of five participants show a decrease in daily functional impairment from pretreatment to posttreatment. The results are more mixed in the reported levels of life satisfaction.

Participant 5 is the only participant showing a distinct percentage change in life satisfaction, with an increased score at posttreatment. The other participants show either a slight decrease or a slight increase, but these percentage changes are minimal.

Table 5.

Functional impairment (WSAS) and life satisfaction (LiSat-11) at pre-, and posttreatment

<table>
<thead>
<tr>
<th></th>
<th>Pre WSAS</th>
<th>Post WSAS</th>
<th>Change in % WSAS</th>
<th>Pre LiSat-11</th>
<th>Post LiSat-11</th>
<th>Change in % LiSat-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31</td>
<td>15</td>
<td>-51.61%</td>
<td>42</td>
<td>43</td>
<td>+2.38%</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>12</td>
<td>0%</td>
<td>49</td>
<td>51</td>
<td>+6.12%</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>6</td>
<td>-53.85%</td>
<td>53</td>
<td>52</td>
<td>-1.89%</td>
</tr>
<tr>
<td>4</td>
<td>31</td>
<td>25</td>
<td>-19.35%</td>
<td>40</td>
<td>39</td>
<td>-2.50%</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>0</td>
<td>-100%</td>
<td>53</td>
<td>63</td>
<td>+18.87%</td>
</tr>
</tbody>
</table>
Table 6 shows pre-, and posttreatment scores and percentage change on perceived health. Participant 2, 4 and 5 reported an increased perceived health at posttreatment and participant 1 and 3 reported the same level of perceived health at both pretreatment and posttreatment.

Table 6.

<table>
<thead>
<tr>
<th></th>
<th>Pre EQ-5D</th>
<th>Post EQ-5D</th>
<th>Change in % EQ-5D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55</td>
<td>55</td>
<td>0%</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>75</td>
<td>+ 50%</td>
</tr>
<tr>
<td>3</td>
<td>80</td>
<td>80</td>
<td>0%</td>
</tr>
<tr>
<td>4</td>
<td>50</td>
<td>70</td>
<td>+ 40%</td>
</tr>
<tr>
<td>5</td>
<td>80</td>
<td>95</td>
<td>+ 18.75%</td>
</tr>
</tbody>
</table>

Repeated measurements. The daily report of functional impairment was rated on a scale between 0-8 (0=not at all impaired, 8=very much impaired). Visual inspection shows a stable baseline for participant 5 with a slight trend opposite that of the hypothesized treatment direction. Participant 1 shows a stable baseline without trend. Participant 2 shows a stable baseline with a slight trend in the hypothesized treatment direction. Participant 4 and 3 show unstable baselines with a trend in the hypothesized treatment direction. However, Tau-U scores for the baseline trends are not significant and thus do not call for a correction. A small change in level for participant 5 is observed, but no latency. None of the other participants show any change in level or latency. For participant 1, 2 and 5, the visual inspection suggests a treatment effect, which is confirmed by the NAP and Tau-U scores. For participant 4, the visual inspection indicates a treatment effect, but the NAP and Tau-U scores reveal no significant change. The visual analysis does not reveal any treatment effects for participant 3 and this is also confirmed by the NAP and Tau-U scores, which can be seen in Table 7.
Table 7.

Results from repeated measures on functional impairment

<table>
<thead>
<tr>
<th></th>
<th>Baseline M (SD)</th>
<th>Treatment M (SD)</th>
<th>Change in M</th>
<th>NAP</th>
<th>Tau-U</th>
<th>NAP &amp; Tau-U CI 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.87 (0.32)</td>
<td>4.18 (1.19)</td>
<td>-1.69</td>
<td>1*</td>
<td>1*</td>
<td>0.33&lt;&gt;1</td>
</tr>
<tr>
<td>2</td>
<td>2.37 (0.49)</td>
<td>1.29 (0.22)</td>
<td>-1.08</td>
<td>1*</td>
<td>1*</td>
<td>0.33&lt;&gt;1</td>
</tr>
<tr>
<td>3</td>
<td>2.23 (0.71)</td>
<td>1.83 (0.85)</td>
<td>-0.40</td>
<td>0.75</td>
<td>0.50</td>
<td>-0.17&lt;&gt;1</td>
</tr>
<tr>
<td>4</td>
<td>6.37 (0.67)</td>
<td>5.66 (0.68)</td>
<td>-0.71</td>
<td>0.83</td>
<td>0.66</td>
<td>-0.01&lt;&gt;1</td>
</tr>
</tbody>
</table>
| 5 | 1.70 (0.30)         | 0.93 (0.48)        | -0.77       | 0.94*| 0.88* | 0.20<>1

Note. NAP= Nonoverlap of All Pairs. Tau-U= percentage of data showing improvement between phases. CI = confidence interval.
* significant at .05 level
Figure 3. Repeated measures of functional impairment for each participant. The dashed line represents the mean for each phase.

Changes in catastrophizing and symptom distress

Pre-, and posttreatment measures. Table 8 shows the obtained scores from pre- and posttreatment measurements regarding catastrophizing, as well as percentage change. All participants show a decrease in scores on catastrophizing, but the magnitude of the decrease varies. Participants 1, 2, 3 and 5 show a larger decrease compared to participant 4, whose score only show a minimal change.

Table 8.

*Catastrophizing (SBCS-CS) at pre-, and posttreatment measurements*

<table>
<thead>
<tr>
<th></th>
<th>Pre SBCS-CS</th>
<th>Post SBCS-CS</th>
<th>Change % SBCS-CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24</td>
<td>8</td>
<td>-66.67%</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>6</td>
<td>-50%</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>3</td>
<td>-70%</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>15</td>
<td>-6.25%</td>
</tr>
<tr>
<td>5</td>
<td>9</td>
<td>5</td>
<td>-44%</td>
</tr>
</tbody>
</table>
Repeated measurements. The daily report of catastrophizing was rated on a scale between 0 and 10 (0=not at all and 10=very much). Participant 3 reported no catastrophizing at all through the baseline and the intervention phase. Visual inspection shows an unstable baseline with a slight trend in the hypothesized treatment direction for participant 2. However, Tau-U scores for the baseline trend are not significant and thus do not call forth a correction. Participant 4 shows an unstable baseline without trend and participant 1 and 5 show an unstable baseline with a trend opposite that of the hypothesized treatment direction. Participant 1 shows a change in level. No level or latency is observed for any of the other participants. The visual analysis suggests a treatment effect for participant 2, which is also confirmed by the NAP and Tau-U scores. No effect is found for the other participants. The NAP and Tau-U scores are shown in Table 9.

Table 9.

Results from repeated measures on catastrophizing

<table>
<thead>
<tr>
<th></th>
<th>Baseline M (SD)</th>
<th>Treatment M (SD)</th>
<th>Change in M</th>
<th>NAP</th>
<th>Tau-U</th>
<th>NAP &amp; Tau-U CI 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.90 (0.98)</td>
<td>4.21 (1.35)</td>
<td>-0.69</td>
<td>0.63</td>
<td>0.25</td>
<td>-0.42&lt;&gt;0.92</td>
</tr>
<tr>
<td>2</td>
<td>2.93 (0.70)</td>
<td>1.23 (0.37)</td>
<td>-1.70</td>
<td>1*</td>
<td>1*</td>
<td>0.33&lt;&gt;1</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>5.67 (1.42)</td>
<td>4.15 (0.74)</td>
<td>-1.52</td>
<td>0.90</td>
<td>0.79</td>
<td>0.12&lt;&gt;1</td>
</tr>
<tr>
<td>5</td>
<td>1.77 (1.08)</td>
<td>1.81 (0.62)</td>
<td>+0.04</td>
<td>0.48</td>
<td>0.04</td>
<td>-0.71&lt;&gt;0.63</td>
</tr>
</tbody>
</table>

Note. NAP = Nonoverlap of All Pairs. Tau-U= percentage of data showing improvement between phases. CI = confidence interval. * significant at .05 level.

The daily report of symptom distress was rated on a scale between 0 and 10 (0=not at all and 10=very much). Both participant 2 and 3 had stable baselines. Participant 4 had a stable baseline with a slightly trend in the hypothesized treatment direction. However, when calculating the Tau-U scores, this baseline trend is not significant and do not call forth a correction. In contrast, participant 1 and 5 had unstable baselines with a trend opposite that of
the hypothesized treatment direction. Participant 4 and 5 also show a change in level between the baseline and the intervention phase. The other participants showed no change in level. Latency is only observed for participant 5. Visual inspection shows a downward trend in the treatment phase for participant 4 and 5 and may thus indicate a treatment effect. This is consistent with the NAP and Tau-U scores, which reveals significant treatment effects for these participants. The visual analysis does not reveal any treatment effect for participants 1, 2 and 3 and this is also confirmed by the NAP and Tau-U scores. Participant 1 and 4 both show very much variability during the treatment phase. The NAP and Tau-U scores are shown in Table 10.

Table 10.

Results from repeated measures on symptom distress

<table>
<thead>
<tr>
<th></th>
<th>Baseline M (SD)</th>
<th>Treatment M (SD)</th>
<th>Change in M</th>
<th>NAP</th>
<th>Tau-U</th>
<th>NAP &amp; Tau-U CI 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.20 (1.14)</td>
<td>4.44 (1.30)</td>
<td>-0.76</td>
<td>0.65</td>
<td>0.29</td>
<td>-0.38&lt;&gt;0.96</td>
</tr>
<tr>
<td>2</td>
<td>3.17 (0.47)</td>
<td>2.79 (0.48)</td>
<td>-0.38</td>
<td>0.63</td>
<td>0.25</td>
<td>-0.42&lt;&gt;0.92</td>
</tr>
<tr>
<td>3</td>
<td>3.03 (0.30)</td>
<td>2.9 (0.42)</td>
<td>-0.13</td>
<td>0.65</td>
<td>0.29</td>
<td>-0.38&lt;&gt;0.96</td>
</tr>
<tr>
<td>4</td>
<td>7.67 (0.35)</td>
<td>6.35 (0.84)</td>
<td>-1.32</td>
<td>0.94*</td>
<td>0.88*</td>
<td>0.20&lt;&gt;1</td>
</tr>
<tr>
<td>5</td>
<td>4.37 (1.42)</td>
<td>2.45 (1.08)</td>
<td>-1.92</td>
<td>0.92*</td>
<td>0.83*</td>
<td>0.16&lt;&gt;1</td>
</tr>
</tbody>
</table>

Note. NAP = nonoverlap of all pairs. Tau-U = percentage of data showing improvement between phases. CI = confidence interval.
* significant at .05. level
Figure 4. Repeated measures of catastrophizing and symptom distress for each participant. The dashed line represents the mean for each phase.

Changes in avoidance behavior

Repeated measurements. The daily report of avoidance behavior was rated on a scale between 0-4 (0=never, 4=all the time). The visual inspection shows that participants 3 and 5 have stable baselines. Similarly, participants 2 and 4 have stable baselines, but their baselines show a slight trend in the hypothesized treatment direction. Participant 1 has an unstable baseline with a trend opposite the hypothesized treatment direction. Tau-U scores are not significant and thus do not call for a correction. A small change in level could be seen for participant 1 and 4 and a latency is observed for participant 5, with decreasing scores in the intervention phase. No level or latency is observed for the other participants. The visual inspection suggests a treatment effect for participant 5, but the NAP and Tau-U scores show
no significant effect for any of the participants. The NAP and Tau-U scores are shown in Table 11.

Table 11.

*Results from repeated measures on avoidance behavior*

<table>
<thead>
<tr>
<th></th>
<th>Baseline M (SD)</th>
<th>Treatment M (SD)</th>
<th>Change in M</th>
<th>NAP</th>
<th>Tau-U</th>
<th>NAP &amp; Tau-U CI 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.1 (0.36)</td>
<td>2.43 (0.76)</td>
<td>+ 0.33</td>
<td>0.33</td>
<td>0.33</td>
<td>-0.33&lt;&gt;0.33</td>
</tr>
<tr>
<td>2</td>
<td>1.77 (0.29)</td>
<td>1.70 (0.27)</td>
<td>- 0.07</td>
<td>0.52</td>
<td>0.04</td>
<td>-0.63&lt;&gt;0.71</td>
</tr>
<tr>
<td>3</td>
<td>1.87 (0.23)</td>
<td>1.67 (0.21)</td>
<td>- 0.20</td>
<td>0.77</td>
<td>0.54</td>
<td>-0.13&lt;&gt;1</td>
</tr>
<tr>
<td>4</td>
<td>2.53 (0.21)</td>
<td>2.14 (0.32)</td>
<td>- 0.39</td>
<td>0.85</td>
<td>0.70</td>
<td>0.05&lt;&gt;1</td>
</tr>
<tr>
<td>5</td>
<td>2.03 (0.06)</td>
<td>1.58 (0.63)</td>
<td>- 0.45</td>
<td>0.81</td>
<td>0.63</td>
<td>-0.05&lt;&gt;1</td>
</tr>
</tbody>
</table>

*Note.* NAP = Nonoverlap of All Pairs. Tau-U = percentage of data showing improvement between phases. CI = confidence interval. *significant at .05 level*
Figure 5. Repeated measures of avoidance behavior for each participant. The dashed line represents the mean for each phase.

Participants expectancies and the credibility of the treatment

Table 12 shows the participants expectancies of the treatment, as well as the treatments perceived credibility at both pretreatment and midtreatment. The scale ranged from 1 to 9 or 0-100%, and high numbers indicate high credibility or expectations. Participant 1 and 5 found the treatment very logical at both pre-, and midtreatment measurement. Participant 2 and 3 found the treatment logical, but somewhat less than participant 1 and 5. Participant 4 found the treatment less logical than the others. Overall, the participants scores are similar at pretreatment and midtreatment, or changes only slightly. The most notable changes occur for participant 3 and 4 on item 3, where they report being more confident recommending the treatment to a friend at midtreatment than pretreatment. Further, participant 1 and 4 show changes on item 5. Participant 1 report a greater feeling that the therapy will reduce symptoms at midtreatment than at pretreatment, while participant 5 report feeling that therapy will reduce symptoms less at midtreatment than pretreatment.
Table 12.

Results from the credibility/expectancy questionnaire at pre- and midtreatment for each participant

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. At this point, how logical does the therapy offered to you seem?</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>2. At this point, how successfully do you think this treatment will be in reducing your symptoms?</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>3. How confident would you be in recommending this treatment to a friend who experiences similar problems?</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>4. By the end of the therapy period, how much improvement in symptoms do you think will occur?</td>
<td>80%</td>
<td>90%</td>
<td>80%</td>
<td>70%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td>80%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
<td>50%</td>
</tr>
<tr>
<td>5. At this point, how much do you really feel that therapy will help you to reduce your symptoms?</td>
<td>7</td>
<td>9</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>6. By the end of the therapy period, how much improvement in symptoms do you really feel will occur?</td>
<td>80%</td>
<td>90%</td>
<td>80%</td>
<td>80%</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td>80%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Participants evaluation of the treatment

Table 13 shows the participants evaluation of the treatment. All of the participants report being very satisfied or mostly satisfied with the treatment they received. Further, all of the participants report that the treatment helped them deal with their problems more effectively. Overall, the evaluation showed that the participants find the treatment to be a valuable intervention.
Table 13.

*Each of the five participants’ evaluation of the treatment*

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Did you get the kind of help you wanted?</td>
<td>Yes, overall</td>
<td>Yes, overall</td>
<td>Yes, definitely</td>
<td>Yes, overall</td>
<td>Yes, definitely</td>
</tr>
<tr>
<td>2. Did you get enough amount of help?</td>
<td>Mostly satisfied</td>
<td>Very satisfied</td>
<td>Mostly satisfied</td>
<td>Very satisfied</td>
<td>Very satisfied</td>
</tr>
<tr>
<td>3. Have the treatment you received helped you to deal more effectively with your problems?</td>
<td>Yes, a lot</td>
<td>Yes, a lot</td>
<td>Yes, a lot</td>
<td>Yes, a lot</td>
<td>Yes, a lot</td>
</tr>
<tr>
<td>4. How satisfied are you overall with the help you received?</td>
<td>Very satisfied</td>
<td>Very satisfied</td>
<td>Mostly satisfied</td>
<td>Very satisfied</td>
<td>Very satisfied</td>
</tr>
</tbody>
</table>

**Discussion**

The aim of this study was to evaluate the efficacy of a CBT intervention for MCS, based on the theoretical model by Van den Bergh et al. (2017). The first research question was constructed to determine what effect the intervention had on participants’ chemical sensitivity and symptoms. The second research question was constructed to investigate what effect the intervention would have on important secondary outcomes such as impairment in functional impairment, life satisfaction and perceived health. The third research question was constructed to examine what effect the intervention had on possible perpetuating factors such as catastrophizing, symptom distress and avoidance behaviors.

Overall, three out of five participants showed a reliable change as well as a clinically significant improvement (CS) on chemical sensitivity from pre- to posttreatment. Further, three out of five participants decreased in number of symptoms. According to the repeated measurements, four out of five participants showed an improvement during the treatment, but only on one or two of the outcome variables. Significant effects were found on symptom distress, functional impairment and catastrophizing. No effects were found for avoidance behaviors for any of the participants and one participant did not show any improvement on
the outcomes measured by the repeated measurements. Further, results from the pre-, and posttreatment measurements are not always consistent with the results obtained from repeated measurements, even though some of them were hypothesized to measure the same concept. Despite the variability in the results, most participants found the treatment logical and all participants report being mostly satisfied or very satisfied with the intervention.

**The intervention’s effect on chemical sensitivity and symptoms**

The results show that all participants went from a clinical to a subclinical level on chemical sensitivity, measured by CSS-SHR. However, only three participants showed a reliable change and a clinically significant improvement. The majority of participants also show a decrease in number of symptoms, but one participant reports the same number of symptoms and one experience more symptoms at posttreatment. Interestingly, the three participants with a reliable change in chemical sensitivity are not the same participants that report a decrease in number of symptoms, except from participant 1. Hence, there does not seem to be a clear association between reliable change in chemical sensitivity and a decrease in number of symptoms. On the contrary, participant 3 experience more symptoms at posttreatment measurement, but at the same time show a reliable change in chemical sensitivity.

**The intervention’s effect on functional impairment, life satisfaction and perceived health**

According to the repeated measurements, participants 1, 2 and 5 show a significant improvement in function. For participant 4, the visual inspection indicates a treatment effect, but the NAP and Tau-U scores reveals no significant change. No treatment effect is observed for participant 3. According to pre-, and posttreatment measurements, participants 1, 3, 4 and 5 show an improvement in function. Hence, there seems to be an inconsistency in the results between repeated measurements and pre-, and posttreatment measurements.
For example, participant 2, who showed an improvement in function in the repeated measurement but did not report any change in functional impairment from pretreatment to posttreatment. Further, participant 3 showed no improvement in function in the repeated measures, but reported an increased function at posttreatment measures. This inconsistency may be due to several reasons. First, there is always a possibility that self-report measures are interpreted differently, even though they are assumed to capture the same construct. This may be the case for participant 2. Second, there is a possibility that a questionnaire with more than one question has the capacity to capture more dimensions of a construct than a questionnaire with only a single question, and thus result in higher scores. Third, the concept of repeated measurements is different from the concept of pre-, and posttreatment measurement. One advantage of the repeated measurements is the possibility to capture specific behaviors and emotions immediately, contrary to pre-, and posttreatment measurement, which rely on retrospective estimations and thus also relies on a memory effect.

Since no normative data could be found for WSAS, there was no possibility to calculate an RCI and the change is therefore reported in percentage. Hence, the interpretation of pre-, and posttreatment are not statistically valid, and these results consequently need to be interpreted with caution. Nonetheless, three participants show an improvement in function according to the repeated measurements. Impairment in function is one of the most disabling consequences for MCS individuals (Karvala et al., 2018). Therefore, the improvement in function for three participants can be regarded as a promising finding, but further research is needed.

Regarding life satisfaction and perceived quality of health, the results are mixed. One participant reports a medium increase in life satisfaction, two participants report a minimal increase, while two participants report a slight decrease. Overall, the intervention did not
CBT FOR MULTIPLE CHEMICAL SENSITIVITY

seem to affect the participants’ life satisfaction. Since several participants reported an increase in daily function, a reasonable assumption would be that their life satisfaction would increase as well. This assumption is partially supported by the results. According to the repeated measurements, participant 1, 2 and 5 all show significant increase in function and these are the only participants that also report an increase in life satisfaction. However, the increase in life satisfaction for participants 1 and 2 are negligible and therefore, no conclusions can be drawn. Moreover, LiSat-11 measures life satisfaction in several different areas of life and some of them may not directly be effected by such a small change in function.

Regarding perceived health, the results are mixed. Two participants report a large increase at posttreatment measurement and one a medium increase. Two participants report no change at all. One might hypothesize that a decrease in number of symptoms would also produce an increase in perceived health. This could be the case for some of the participants but does not seem to be the case for participant 1, who reported the largest decrease in number of symptom but no change in perceived health.

The intervention’s effect on catastrophizing and symptom distress

The repeated measurements showed a significant decrease in symptom distress for two out of five participants. Further, according to the visual inspection, catastrophizing and symptom distress seem to co-vary for several participants. This indicates an association. No causal inference can be made from the data, but a reasonable hypothesis is that they both affect each other: when experiencing severe symptom distress, the likelihood of catastrophizing increases and when engaging in catastrophizing, there is a higher probability to experience symptom distress.

According to the repeated measurements, only one participant shows a significant decrease in catastrophizing during the treatment. Further, participant 3 did not report any
catastrophizing at all, either during the baseline or the treatment. However, the pre-, and posttreatment measurements show a large percentage decrease in catastrophizing for four out of five participants. The question in the repeated measurements and the SBSC-CS questionnaire both measure catastrophizing and are assumed to conceptually overlap. This inconsistency between repeated measurements and pre-, and posttreatment measurements may be due to several reasons, as mentioned above, when discussing the findings for functional impairment. Since the reports on the second item of the repeated measurement, aimed at measuring catastrophizing, varied a lot compared to the pre- and posttreatment measurements, there might be a possibility that the item instead measured another construct, for example worry. These two constructs are conceptually closely related but differ in some ways. It would have been of value to measure psychometric properties for the repeated measurement, especially construct validity. Finally, since there was no reliable change calculated for SBCS-CS, one should bear in mind that this study only described a percentage reduction in catastrophizing and do not reflect a statistically significant change.

**The intervention’s effect on avoidance behavior**

According to the repeated measurements, the intervention did not seem to have an effect on avoidance behavior. However, participant 5 shows a promising decrease in the later part of the treatment phase. The latency of this improvement is probably the reason why the decrease is not significant in the findings from NAP and Tau-U. Similarly, participant 4 shows a possible treatment effect, but the variability is high in the treatment phase, with a deterioration shortly after the onset of the treatment. Both variability and latency are problematic and complicates the inference (Kazdin, 2011).

The risk of having to experience symptoms contributes to avoidance of social situations where everyday chemicals might be present, which in turn contributes to major impairment in quality life for MCS individuals (Karvala et al., 2018). One might hypothesize
that for participants showing a decrease in symptom distress, a natural effect would be a
decrease also in avoidance. However, according to the results in the present study, this is not
the case. While the intervention did not have any effect on avoidance behavior per se,
changes were found in outcome measures related to patients’ cognitions and emotions about
their symptoms, i.e. symptom distress. A further speculation is the possibility that the
participants’ avoidance might prevent them from decreasing in symptom distress. This
speculation is based on the fact that the only two participants who showed more promising,
but not significant, results on avoidance also are the ones that decreased on symptom distress.

**The results in the light of the theoretical model**

Van den Bergh et al. (2017) propose psychoeducation as a way to explain to
participants how attributing symptoms to a chemical cause can produce a self-fulfilling
prophecy, where anticipation of symptoms increases their perception of threat. Not
perceiving the odors as the cause of symptoms and by extension not regarding them as
threatening are assumed to alleviate symptom distress. This may be the case for the
participants with a decrease in symptom distress. Further, an extension of not perceiving the
odors as the cause of symptoms may lead to a higher acceptance for odors. The decrease in
chemical sensitivity, as measured by CSS-SHR, which was significant for three participants,
may reflect this. Further, exposure to chemicals can serve as disconfirmatory evidence and
change patients’ perceptions about odors (Van den Berg et al., 2017). Although the
participants were instructed to engage in exposure to symptom eliciting odors, it does not
seem like they have taken the leap and incorporated this behavior in their everyday life yet,
since avoidance behavior did not decrease according to the repeated measurements. Hence,
one theory is that the intervention contributed to a change in participants’ cognitions on an
intellectual level, while the participants’ behavior and habits were less affected.
The results in the light of previous research

Conditioning has been suggested as a psychological explanation model for MCS symptoms (Otto & Giardino, 2001; Kirk-Smith et al., 1983; Zucco et al., 2009). Previous experimental studies show that symptoms associated with odors can be acquired through a conditioning process (Van den Bergh et al., 1997; 1998; Van den Bergh et al., 1995). Further, the study by Devriese et al. (2000) demonstrated that symptoms related to an odor can be diminished by the process of extinction. One might hypothesize that when participants repeatedly expose themselves to odors, the process of extinction takes place. In the current study, three out of five participants reported a decrease in number of symptoms. One hypothesis might be that a decrease in number of symptoms may be due to exposure and extinction.

The present findings can also be seen in light of previous research on treatment approaches. The findings by Hauge et al. (2015) showed that a mindfulness-based cognitive therapy (MBCT) for MCS had no effect on the impact on daily life, symptoms or reactions following chemical exposure. However, the current study differs from Hauge et al. (2015) in several ways. For instance, the intervention in the current study focus substantially on exposure, a component that might be crucial to explain the enhanced function and reduced number of symptoms that were found for several participants. This is in line with the findings of Guglielmi et al. (1994), who tested an intervention for MCS based on exposure which in turn showed promising results.

Strengths and weaknesses of the study

A major strength of the current study is its contribution to the research field of MCS. Psychological interventions have been requested by researchers, since the field is relatively unexplored (Das-Munshi et al., 2007). This study provides new promising evidence and the findings have important implications that merits further studies. If future studies were to
confirm these results, it would be of great clinical value and thus of utmost value for the individuals who suffer from MCS. Further, this study has a number of important limitations that need to be considered.

**Self-report and self-referred.** Although the study intended to assess individuals with MCS based on predetermined criteria, these criteria rest on self-report measurements. To overcome this issue, participants conducted a clinical interview with a psychologist and a medical doctor well versed in the field. Further, the effectiveness and the outcome of the intervention rely on self-report measurements, a shortcoming common in the field of psychology. Additionally, participants in this study were self-referred and the results obtained in this study must thus be interpreted with caution. It may not be possible to generalize the findings to all individuals with MCS.

**Design and analysis.** The participants were not randomized to different baselines due to time constraints, which can be considered a weakness of the current study. A randomization to different baselines strengthens internal validity by reducing the threat from factors of time and history (Kazdin, 2011). Moreover, in some cases the participants’ baselines show variability and/or trend. This made it difficult to predict the development of symptoms without treatment. The results could have been strengthened if the treatment had been initiated only after the baseline had been considered stable. However, this was not possible within the framework of this study, which was dependent on certain time frames. Further, there is also disadvantages of having an extended baseline because it requires withholding treatment for some participants which may not be ethically defensible (Barlow et al., 2009). Ultimately, there is always the balancing act of having baselines long enough to be able to observe stability and short enough not to affect the individuals negatively.

Another limitation lies in the choice of a visual analysis method. Visual analysis may increase the risk of type I error, that is, assuming an effect is presented for which there is no
support (Barlow et al., 2009). The visual analysis may have been colored by different expectations of the study result. However, the method is considered to be the best to clearly convey the results of a SCED to the reader. To strengthen the findings of the visual analysis, two other independent raters with prior experience of working with visual analysis in SCED analyzed the graphs. In addition, the statistical methods NAP and Tau-U were used as a complement to the visual inspection. These measures might be considered strengths of the incumbent study.

**Treatment.** In this study, one of the participants received online skype sessions with a therapist. The online treatment was considered to match the face-to-face-session and have the same possibilities for efficacy. The inclusion of the online treatment can be seen both as a strength and a limitation. A treatment demanding face-to-face sessions may be unfeasible for some individuals with MCS, since leaving their homes and remaining in environments where odors exist may be unbearable for them. An alternative for these individuals may be online delivered treatment. A strength with this study was therefore the possibility to receive preliminary results for the efficacy of an online treatment. Since a SCED design is focused on change within individuals, with the subjects operating as their own controls, there is a possibility to comment on the effect of the intervention, even though the terms of treatment differed between participants (Kazdin, 2011).

**Lack of coherent construct.** As mentioned, there is no diagnosis for MCS and the condition is based on definition criteria. This aggravate the conceptualization and operationalization of outcome variables and how to measure them. In this study, MCS was operationalized as chemical sensitivity and symptomatology, since these were considered to fit the definition criteria proposed by Cullen (1987). CSS-SHR and EHSI were chosen as measurements for the primary outcome variables. According to Kazdin (2011), an operational definition may risk simplifying a concept, or capture only a minor part of it. Hence, there is a
risk that this study’s operationalization of MCS simplifies the complex concept that MCS constitutes and/or differs from operationalizations in other studies, which in turn makes it difficult to compare this study’s results with other studies.

Implications and future research

The findings of individual differences in this study is in line with previous research. Deary et al. (2007) highlights the individual differences in the manifestation of MUS, and discuss several factors that may explain these differences. For example, the authors suggest that high neuroticism may be an underlying component that increases the risk for distress intolerance, proneness to conditioning, attention biases and avoidance behavior. According to Deary et al. (2007), these individual differences will in fact generate an individual theoretical explanatory model for each client. Future research should therefore investigate how individual differences affect treatment outcome and which treatment components that are effective for each individual, as well as under which circumstances this is true. Investigating this may also lead to a deeper understanding of the possible patterns and subgroups that may exists within the MCS population. Further, Menon et al. (2017) also discuss the diverse patterns in the manifestation of MUS and suggest that eclectic psychotherapies or combination treatments might be more efficient than CBT alone. Since MCS is a condition with both physiological and psychological symptoms, a multimodal treatment approach might be beneficial to address the more severe cases of MCS.

Conclusions

For MCS individuals, common odors become an obstacle in everyday life, and the syndrome causes considerable distress and impairment. Since there have been very limited possibilities for them to receive any treatment, the lives of MCS individuals can become highly restricted in attempt to avoid distressing symptoms. To address this treatment gap, the current study aimed to test a CBT intervention for MCS. The results show preliminary
support for the intervention. Regarding the repeated measurements, decreases in symptom
distress, functional impairment and catastrophizing were found. Further, three out of five
participants show a reliable change in the hypothesized direction on chemical sensitivity from
pre- to posttreatment. A decrease in number of symptoms was also seen in three out of five
participants. This study provides an original and promising contribution to the research field
of psychological treatment approaches to MCS and future studies on the current topic are
encouraged.
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Appendix

Appendix 1. Screening measures and inclusion and exclusion criteria

<table>
<thead>
<tr>
<th>Idiopathic Environmental Intolerance Inventory (IEII)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Hur känslig är du (dvs. hur starkt reagerar du med symtom) på starka dofter?</strong></td>
</tr>
<tr>
<td>Mindre än 6 månader</td>
</tr>
<tr>
<td><strong>2. Hur starkt stör de följande symtomen på miljöfenomen dig?</strong></td>
</tr>
<tr>
<td>Hosta</td>
</tr>
<tr>
<td>Hosta</td>
</tr>
</tbody>
</table>
| **Nyckeltal: Minskat symtom som skattas 3 eller mer.**

**Inklusion:** Minst ett symtom som skattas 3 eller mer.
3. I vilken utsträckning har din känslighet mot miljöfenomen negativt påverkat följande aspekter av din vardag?

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Hur länge har inverkan på vardagen förekommit?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inte alls</td>
<td>Lite grand</td>
<td>Ganska lite</td>
<td>Ganska mycket</td>
<td>Väldigt mycket</td>
<td>&lt; 6 månader</td>
</tr>
<tr>
<td>Familjeliv</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Äktenskap/partnerskap</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Socialt liv</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Boendesituationen</td>
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</tr>
<tr>
<td>Arbete/karriär</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Fritidsaktiviteter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andra områden:____________________</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Inklusion:** Minst ett område som skattas 3 eller mer.

**HADS**

*Läs varje påstående och sätt ett kryss i rutan till vänster om det svar som kommer närmast hur Du känt Dig under den senaste veckan. Fundera inte alltför länge eftersom det första svar som dyker upp brukar vara det riktigare. Kryssa bara i en ruta för varje påstående.*

4. Jag känner mig spänd eller "uppskruvad".

- [ ] För det mesta
- [ ] Ofta
- [ ] Då och då
- [ ] Inte alls

75. Jag känner mig som om allting går trögt.

- [ ] Nästan jämt
- [ ] Ofta
- [ ] Ibland
- [ ] Inte alls

76. Jag uppskattar fortfarande samma saker som förut.

- [ ] Precis lika mycket
- [ ] Inte riktigt lika mycket
- [ ] Bara lite
- [ ] Nästan inte alls

77. Jag känner mig rädd, som om jag har "fjärilar i magen".

- [ ] Inte alls
- [ ] Någon gång
- [ ] Rätt ofta
- [ ] Mycket ofta

78. Jag känner mig rädd, som om något förfärligt håller på att hända.

- [ ] För det mesta
- [ ] Ofta
- [ ] Då och då
- [ ] Inte alls

79. Jag har tappat intresset för mitt utseende.

- [ ] Helt och hålet
- [ ] Ganska mycket
- [ ] Litet grand
- [ ] Inte alls

80. Jag kan skratta och se saker från den humoristiska sidan.

- [ ] För det mesta
- [ ] Ofta
- [ ] Då och då
- [ ] Inte alls

81. Jag känner mig rastlös, som om jag måste vara på språng.
Exklusion: Kliniskt signifikanta besvär på minst en av delskalorna (ångest eller depression).
Appendix 2. Daily measurement

DAG X, datum:______________________________

DX01. Idag har mina
symtom besvärat mig: 0---1---2---3---4---5---6---7---8---9---10
Inte alls  Väldigt mycket

DX02. Idag har jag oroat
mig för min framtida hälsa
kopplat till mina symtom 0---1---2---3---4---5---6---7---8---9---10
Inte alls  Väldigt mycket

Skatta de följande frågorna på en skala från 0 till 8: 0 betyder ingen försämring och 8 innebär mycket allvarlig försämring.

DX03. På grund av mina besvär är min arbetsförmåga...

<table>
<thead>
<tr>
<th>Inte alls försämrad</th>
<th>Mycket allvarligt försämrad</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
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<tr>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

DX04. På grund av mina besvär är mina sociala fritidsaktiviteter (med andra människor)...

<table>
<thead>
<tr>
<th>Inte alls försämrad</th>
<th>Mycket allvarligt försämrad</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
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<tr>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

DX05. Idag: Hur ofta undvek du situationer, platser, föremål och aktiviteter på grund av rädsla för symtom eller förekomst av symtom?

0  = Aldrig: Jag undvikte inte platser, situationer, aktiviteter eller saker på grund av symtom.
1  = Sällan: Jag undvikte saker någon enstaka gång, men oftast ger jag mig in i situationen eller tolererar föremålet. Mitt sätt att leva påverkas inte.
2  = Då och då: Jag är lite rädd för vissa situationer, platser och föremål, men jag kan hantera det. Mitt sätt att leva påverkas bara lite.
4  = Hela tiden: Undvikandet av föremål, situationer, aktiviteter och platser har tagit över mitt liv. Mitt sätt att leva har påverkats i stor utsträckning och jag ägnar mig inte längre åt saker som jag tidigare tyckte om att göra.
Appendix 3. CSS-SHR

CSS-SHR


1. Jag skulle inte ha något emot att bo på en gata med illaluktande eller stickande (i slemhinnorna) avgaser om lägenheten jag hade var trevlig.

<table>
<thead>
<tr>
<th>Instämmer starkt</th>
<th>Instämmer</th>
<th>Instämmer</th>
<th>Instämmer</th>
<th>Instämmer</th>
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<tbody>
<tr>
<td>(absolut)</td>
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</tbody>
</table>

2. Jag är mer uppmärksam på lukter/stickande ämnen än vad jag brukade vara tidigare.

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<thead>
<tr>
<th>Instämmer starkt</th>
<th>Instämmer</th>
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3. På biografer störs jag av andra personers parfym och rakvatten.

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4. Jag blir ofta på min vakt när jag känner lukter/stickande ämnen.

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5. Jag vänjer mig ganska lätt vid de flesta typer av lukter/stickande ämnen.

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</table>

6. Hur mycket skulle du bry dig om att en lägenhet du var intresserad av att hyra var belägen i närheten av en fabrik som avger luktande/stickande ämnen?

<table>
<thead>
<tr>
<th>Avskräcker mig</th>
<th>Mycket</th>
<th>Viktigt</th>
<th>Lite viktigt</th>
<th>Inte alls</th>
</tr>
</thead>
<tbody>
<tr>
<td>helt och hållet</td>
<td>viktigt</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7. På en allmän plats bryr jag mig inte om ifall det luktar lite cigarettrök.

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<th>Instämmer starkt</th>
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8. Det finns ofta tillfällen då jag vill ha fullständigt luktfritt.

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<table>
<thead>
<tr>
<th>Alltid</th>
<th>Mycket</th>
<th>Ofta</th>
<th>Då och då</th>
<th>Sällan</th>
<th>Aldrig</th>
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<tbody>
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</tbody>
</table>

10. Jag har ingenting emot att bo i en lägenhet som har en svag lukt.

<table>
<thead>
<tr>
<th>Instämmer starkt</th>
<th>Instämmer</th>
<th>Instämmer</th>
<th>Instämmer</th>
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<th>Instämmer</th>
<th>Instämmer</th>
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<tbody>
<tr>
<td>(absolut)</td>
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<th>Instämmer starkt</th>
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</tbody>
</table>
## Appendix 4. EHSI

### EHSI

Ange vilka av följande symtom du har haft minst en gång per vecka under de senaste tre månaderna.

### Luftvägs-, slemhinne- och hudsymtom:
- **12** Astma eller väsande andning
- **13** Tungt i bröstet eller svårt att andas
- **14** Hosta
- **15** Halsirritation/heshet
- **16** Nyssningar
- **17** Irritation/torrhet i näshålans slemhinne
- **18** Nästäppa/rinnande snuva

### Symtom i matsmältningssystemet:
- **28** Gaser i magen
- **29** Uppsvälld mage
- **30** Andra symtom i matsmältningssystemet (t.ex. magsmärtor/kramper)

### Huvudrelaterade symtom:
- **31** Huvudvärk
- **32** Tryck över huvudet
- **33** Tung i huvudet
- **34** Andra huvudrelaterade symtom (t.ex. ömhet i ansikte/bihål)

### Hjärtsymtom, illamående och yrsel:
- **35** Hjärtklappning
- **36** Obehag i bröstet
- **37** Illamående
- **38** Yrsel/svinningskänsla
- **39** Andra hjärtsymtom (t.ex. oregelbundna hjärtslag)

### Tankemässiga och känslomässiga symtom:
- **40** Minnessvårigheter
- **41** Koncentrationssvårigheter
- **42** Tankspriddhet
- **43** Allmänt obehag
- **44** Trötthet
- **45** Störd sömn
- **46** Spändhet/nervositet
- **47** Irritation/retlighet
- **48** Nedstämdhet
- **49** Oro
- **50** Andra tankemässiga eller känslomässiga symtom (t.ex. tappad motivation)

### Övriga symtom:
- **51** Övriga symtom av något slag (t.ex. kraftig svettning eller ledvärk)
Appendix 5. SBCS-CS

**SBCS-CS**

Vi är intresserade av dina tankar och känslor när du upplever symtom. Var vänlig ange nedan i vilken utsträckning du håller med om påståendena, oavsett du har symtom eller inte just nu.

<table>
<thead>
<tr>
<th>När jag upplever symtom...</th>
<th>Håller inte med</th>
<th>Håller med till viss del</th>
<th>Håller med till måttlig del</th>
<th>Håller med till stor del</th>
<th>Håller med helt och hållet</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 Kan jag inte sluta tänka på det</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>53 Tänker jag hela tiden på hur mycket jag skulle vilja bli kvitt problemet</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>54 Blir jag rädd att mina besvär ska förvärras</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>55 Undrar jag om det är något allvarligt fel på mig</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>56 Finns det ingenting jag kan göra för att lindra symtomen</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>57 Tror jag att jag aldrig ska bli kvitt problemet</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Appendix 6. WSAS

**WSAS**

Skatta de följande frågorna på en skala från 0 till 8: 0 betyder ingen försämring och 8 innebär mycket allvarlig försämring.

88. På grund av mina besvär är min arbetsförmåga...

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inte alls försämrad</strong></td>
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<td></td>
</tr>
<tr>
<td><strong>Mycket allvarligt försämrad</strong></td>
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</table>

89. På grund av mina besvär är min förmåga att sköta hemmet (t.ex. städa, handla, laga mat, ta hand om barnen)...

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<tbody>
<tr>
<td><strong>Inte alls försämrad</strong></td>
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<td><strong>Mycket allvarligt försämrad</strong></td>
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</tbody>
</table>

90. På grund av mina besvär är mina sociala fritidsaktiviteter (med andra människor)...

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td><strong>Inte alls försämrad</strong></td>
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91. På grund av mina besvär är mina privata fritidsaktiviteter (som görs på egen hand)...

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<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tbody>
<tr>
<td><strong>Inte alls försämrad</strong></td>
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</table>

92. På grund av mina besvär är min förmåga att skapa och vidmakthålla nära relationer med andra människor (inkluderat de som jag bor med)...

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
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<td><strong>Inte alls försämrad</strong></td>
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Appendix 7. LiSat-11

**LiSat-11**

_Hur tillfredsställd är du med olika aspekter av ditt liv?_

_För var och en av dessa frågor vill vi att du ringar in en siffra från 1 till 6, eller markera med ett kryss i tom ruta (gäller påstående under 8 och 9). Använd skalan nedan för att göra dina val._

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mycket otillfredsställande</td>
<td>Otillfredsställande</td>
<td>Ganska otillfredsställande</td>
<td>Ganska tillfredsställande</td>
<td>Tillfredsställande</td>
<td>Mycket tillfredsställande</td>
</tr>
</tbody>
</table>

93. Livet är i allmänhet

94. Yrkes-/sysselsättningssituationen är

95. Ekonomin är

96. Fritidssituationen är

97. Kontakterna med vänner och bekanta är

98. Sexuallivet är

99. Förmågan att klara mig själv är  
(gäller klädsel, tvätt/bad, gångförmågan o dyl)

100. Familjelivet är

☐ Har ej någon familj

101. Parförhållandet är

☐ Har ej något parförhållande

102. Kroppsliga hälsan är

103. Psykiska hälsan är
Appendix 8. EQ-5D

EQ-5D

104. Termometern till höger är till hjälp för att avgöra hur bra eller dåligt ens hälsotillstånd är. Ditt bästa tänkbara hälsotillstånd har markerats som 100. Ditt sämsta tänkbara hälsotillstånd har markerats som 0.

Appendix 9. CEQ


<table>
<thead>
<tr>
<th>Inte alls logisk</th>
<th>Varken eller</th>
<th>Mycket logisk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Inte alls framgängsrik</th>
<th>Varken eller</th>
<th>Mycket framgängsrik</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Inte alls säker</th>
<th>Varken eller</th>
<th>Mycket säker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>


0 %  10 %  20 %  30 %  40 %  50 %  60 %  70 %  80 %  90 %  100 %

*Känn efter ordentligt och försök att identifiera vad du verkligen känner för den här behandlingen och möjligheten till framsteg. Svara sedan på de följande två frågorna.*


<table>
<thead>
<tr>
<th>Inte alls</th>
<th>Varken eller</th>
<th>Väldigt mycket</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
<td>9</td>
</tr>
</tbody>
</table>


0 %  10 %  20 %  30 %  40 %  50 %  60 %  70 %  80 %  90 %  100 %
**Appendix 10. Evaluation**

**Utvärdering**

Vi uppskattar dina ärliga svar. Ringa in det svarsalternativ som passar dig bäst.

1. **Fick du den typ av hjälp du ville?**

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nej, definitivt inte</td>
<td>Nej, egentligen inte</td>
<td>Ja, i allmänhet</td>
<td>Ja, definitivt</td>
<td></td>
</tr>
</tbody>
</table>

2. **Upplever du att du har fått tillräckligt mycket hjälp?**

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ganska missnöjd</td>
<td>Likgiltig eller lätt missnöjd</td>
<td>Mest nöjd</td>
<td>Mycket nöjd</td>
<td></td>
</tr>
</tbody>
</table>

3. **Har behandlingen hjälpit dig att hantera dina problem mer effektivt?**

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ja, det hjälpte en hel del</td>
<td>Ja, det hjälpte något</td>
<td>Nej, det hjälpte verkligen inte</td>
<td>Nej, det tycktes göra saken värre</td>
<td></td>
</tr>
</tbody>
</table>

4. **Hur nöjd är du sammantaget med den behandling du har fått?**

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Väldigt nöjd</td>
<td>Mestadels nöjd</td>
<td>Inte så nöjd</td>
<td>Inte alls nöjd</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 11. Adverse effects of treatment

Oönskade effekter av behandling

111. Har du upplevt att behandlingen inneburit något du inte önskat (exempelvis oväntat mycket obehag, försämrat mående eller försämrad livssituation?)

☐ Ja  ☐ Nej

112. Om ja, beskriv kortfattat vad du upplevt?

___________________________________________________________________________________________________________
___________________________________________________________________________________________________________
___________________________________________________________________________________________________________
___________________________________________________________________________________________________________

Hur har ditt mående påverkats av denna upplevelse?

113. I stunden eller kort efter att det först upplevts

\[
\begin{array}{c|c|c|c|c|c|c}
 & 0 & 1 & 2 & 3 & 4 & 5 \\
\hline
Inte alls negativt & Inte alls negativt & Mycket negativt
\end{array}
\]

114. Senaste veckan

\[
\begin{array}{c|c|c|c|c|c|c}
 & 0 & 1 & 2 & 3 & 4 & 5 \\
\hline
Inte alls negativt & Inte alls negativt & Mycket negativt
\end{array}
\]
Appendix 12. Advertisement and information on Örebro University’s web page

Är du doftkänslig?
Vi söker dig som:
- Är 18-70 år och upplever obehag när du kommer i kontakt med starka dofter.
- Vill få psykologisk behandling för att bättre kunna hantera dina besvär


Psykologisk behandling vid doftkänslighet
Är du intresserad? Vi söker just nu deltagare till en forskningsstudie där vi testar effekten av en psykologisk behandling för personer med doftkänslighet.

Vi söker deltagare som:
- Är mellan 18 och 70 år och upplever obehag när de kommer i kontakt med dofter.
- Vill ta del av en psykologisk behandling som bygger på kognitiv beteendeterapi (KBT) för att bättre kunna hantera dina besvär.
- Inte är gravid.
- Har möjlighet att komma till Universitetssjukhuset i Örebro en gång i veckan under två månader hösten 2018.

För vem?

Vad handlar projektet om?

Hur går deltagande till?
Behandlingen är individuellt och kommer att pågå under två månader i slutet av hösten 2018. Deltagandet innebär en veckovis kontakt med behandlare. Vi kommer ge kunskap, tips och verktyg som kan vara till hjälp, och stöttar dig när du testar på att använda dem i din vardag.

Som deltagare i studien kommer du att ombes besvara fem frågor om dina symtom, funktion
och mående på daglig basis under 12 eller 13 veckor. Vid tre tillfällen under hösten och ett tillfälle sex månader efter avslutad behandling kommer du att ombes besvara mer omfattande frågeformulär om symtom, funktion och mående samt förväntningar på behandlingen och eventuella negativa effekter av behandlingen. Detta är för att du och vi ska se om denna behandling hjälper dig. Så snart som du har anmält intresse kommer vi att kontakta dig.

**Var?**
Besök hos behandlare äger rum på Arbets- och miljömedicin, Universitetssjukhuset Örebro.

**Finns några risker med att delta?**
Psykologiska interventioner innebär så gott som alltid att deltagare utsätts för ett visst obehag då det är en viktig del av behandlingen öva hantering av obehagliga känslor och upplevelser. Alla deltagare får en aktiv behandling som leds av psykologstudent. Behandlingen är grundad i experimentell forskning om doftkänslighet, men effekterna av behandlingen har aldrig utvärderats vetenskapligt.

**Vilka får reda på hur jag mår och vad jag svarar?**
Resultaten kommer att presenteras på gruppnivå så att det inte går att identifiera någon enskild individ. Alla uppgifter som kommer oss till del kommer att behandlas på ett sådant sätt att inga obehöriga får del av dem.

**Fler frågor?**
Om du undrar något så kontakta gärna:

Huvudansvarig forskare:
Sofia Bergbom, Centrum för hälso- och medicinsk psykologi, Örebro universitet (e-post: sofia.bergbom@oru.se)

Övriga medverkande:
Professor Katja Boersma, Centrum för hälso- och medicinsk psykologi, Örebro universitet (e-post: katja.boersma@oru.se)

Patrik Hennings, leg. psykolog, Arbets- och miljömedicin, Universitetssjukhuset Örebro (e-post: patrik.hennings@regionorebrolan.se)

Jennifer Amin och Sanna Forslund, psykologstudenter och behandlare (e-post: doftkanslighet@gmail.com)
Appendix 13. Information to participants after scheduled interview

Hej XX!

Här kommer vidare information angående den psykologiska behandling av doftkänslighet som du visat intresse för.


Mötet kommer att äga rum på Arbets- och miljömedicin, adressen är:

Universitetssjukhuset Örebro
701 85 Örebro
Entré F, våning 2

Du kan ta dig dit via både buss, tåg eller bil.
Buss: Den närmaste busshållplatsen för stadsbussarna heter USÖ Huvudentré. Turlista finns hos länstrafiken.
Tåg: Från Resecentrum/Centralstationen är det cirka 10 minuters promenad. Ta gångtunneln under Östra Bangatan och fortsätt rakt fram längs Järnvägsgatan till USÖ:s huvudentré.

Om du har några frågor eller behöver avboka kan du kontakta Patrik Hennings via mail eller telefon:
Telefon: 019-602 24 81
Mail: patrik.hennings@regionorebrolan.se

Varmt välkommen!
Appendix 14. Informed consent

Psykologisk behandling vid doftkänslighet - Information om projektet

Bakgrund och syfte


Hur går studien till?


Som deltagare i studien kommer du att ombes besvara fem frågor om dina symtom, funktion och mående på daglig basis under 12 eller 13 veckor. Vid tre tillfällen under hösten och ett tillfälle sex månader efter avslutad behandling kommer du att ombes besvara mer omfattande frågeformulär om symtom, funktion och mående samt förväntningar på behandlingen och eventuella negativa effekter av behandlingen.

Var?

Besök hos behandlare äger rum på Arbets- och miljömedicin, Universitetssjukhuset Örebro.

Vilka är riskerna?

Psykologiska interventioner innebär så gott som alltid att deltagare utsätts för ett visst obehag då det är en viktig del av behandlingen att öva hantering av obehagliga känslor och upplevelser. Alla deltagare får en aktiv behandling som leds av en psykologstudetn i slutet av sin utbildning. Behandlingen är grundad i experimentell forskning om doftkänslighet, men eventuella effekter av behandlingen har aldrig utvärderats vetenskapligt.
Hantering av data och sekretess

Hur får jag information om studiens resultat?
Genom att kontakta Sofia Bergbom, Örebro universitet, på telefon 019-30 39 67 eller e-post sofia.bergbom@oru.se kan du få ta del av både dina individuella svar samt resultatet av hela studien.

Ersättning
Ingen ersättning erfordras.

Frivillighet
Ditt deltagande är frivilligt, och du kan när som helst och utan att ange orsak avbryta ditt deltagande. Du har då rätt att begära att dina svar på frågeformulär förstörs. Om du väljer att inte påbörja eller avbryta ditt deltagande kommer det inte att påverka sedvanlig behandling eller omhändertagande.

Ansvariga
Forskningshuvudman och personuppgiftsansvarig är Arbets- och miljömedicin, Universitetssjukhuset Örebro.

Huvudansvarig forskare är fil.dr. Sofia Bergbom. Mer information om studien kan lämnas av Sofia Bergbom, 019-30 39 67 eller sofia.bergbom@oru.se.
**Samtyckesformulär**

Samtycke till deltagande i forskningsstudie om doftkänslighet, samt till behandling av personuppgifter**

*Genom min underskrift intygar jag*

☐ Att jag informerats om studien, fått tillfälle att ställa frågor och fått eventuella frågor besvarade

*Genom min underskrift samtycker jag till*

☐ Att delta i studien

☐ Att mina enkätsvar och uppgifter om namn och personnummer behandlas såsom beskrivet nedan.

Jag är medveten om att mitt deltagande är frivilligt, och jag kan när som helst och utan att ange orsak avbryta mitt deltagande.

________________________________________

Datum

________________________________________________________________

Namn

________________________________________________________________

Namnförtydligande

*Samtycke fylls i när vetenskapliga studier genomförs, och när enskilda individer lämnar uppgifter.

**Med personuppgifter avses dina svar på frågeformulär samt namn och personuppgifter. Dina svar på frågeformulär kommer att förvaras som journalhandling av Sofia Bergbom, Örebro universitet. Uppgifterna aidentifieras så att dina svar i frågeformulär inte kan kopplas ihop med dina personuppgifter.
Appendix 15. Overview of treatment

Session 1

- Presentation av agenda
- Skriva under informerat samtycke
- Information om behandlingen och KBT
- Patientens symptomhistorik och livssituation
  - När började dina problem/symptom och hur ter de sig?
  - Vilka situationer blir det jobbigt i?
  - Berätta kort om hur ditt liv ser ut idag och hur det påverkas av din doftkänslighet.
- Psykoedukation
  - Generellt hur doftkänslighet kan uppkomma
  - Modellen för vidmakthållande
- Hemuppgift
  - Ta tid för handouts

Session 2

- Presentation av agenda
- Återkoppling hemuppgift
- Repetera och fördjupa psykoedukation från session 1 vid behov
- Psykoedukation: ACT, neutralt förhållningssätt i mötet med dofter och andning. Beskrivning av ett stressreducerande förhållningssätt för att vända den negativa spiralen som vidmakthåller doftkänsligheten.
- Andningsövning
- Hemuppgifter: Gör någon av övningarna Andas i fyrkant och Gå igenom kroppen med hjälp av andning 3-5 gånger per dag. (Syftet är att de ska ha ett verktyg för att bli lugn och avslappnad vid exponering för att minska kroppens automatiska system, inte direkt att de ska bli generellt mindre stressade).

Session 3

- Presentation av agenda
- Återkoppla hemuppgift
- Psykoedukation: exponering
- Skapa exponeringshierarki
  - Hur mycket utsätts patienten i sin vardag
  - Viktiga aktiviteter som hen undviker
  - Svårighetsgrad av omständigheter
- Hemuppgift: Kartläggning av tankar, känslor och beteenden i exponeringssituation
Session 4-7

- Presentation av agenda
- Återkoppling hemuppgift: jobba med specifika exponeringssituationer från veckan för att hjälpa patienten att tydliggöra tankar, känslor och beteenden i exponeringssituationer samt utveckla ett mer neutralt förhållningssätt till dofter.
- Repetera och fördjupa psykoedukation vid behov
- Hemuppgift: Planerad exponering samt kartläggning av tankar, känslor och beteenden i exponeringssituation

Session 8

- Presentation av agenda
- Genomgång av hemuppgift
- Sammanfattning av behandling
- Återfallsprevention/Vidmakthållandeplan
  - Vad har du lärt dig av behandlingen?
  - Vad tar du med dig?
  - Hur ska du fortsätta för att bibehålla dina framsteg?