Predictors of Obsessive-Compulsive symptomology: Mind wandering about the past and future

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Abstract

Obsessive and compulsive tendencies are known to occur in the general population and involve worry around specific concerns (obsessions) and an urge to resolve the concern with thoughts or behaviours (compulsions). Spontaneous, but not deliberate, mind wandering experiences (when attention turns to internal mentation), have been found to predict obsessive-compulsive tendencies [Seli, P., Risko, E.F., Purdon, C. & Smilek, D. (2017). Intrusive thoughts: linking spontaneous mind wandering and OCD symptomatology. *Psychological Research, 81*, 392–398. https://doi.org/10.1007/ s00426-016-0756-3]. Recent cognitive theory suggests a particular role for future-oriented spontaneous thought in obsessive-compulsive (OC) symptoms. Thus, we hypothesised that future-oriented spontaneous mind wandering would provide a unique and additional contribution to predictive models of OC symptoms. In a nonclinical sample of 104 adults, we replicated the finding that OC symptoms are predicted by the frequency of spontaneous (but not deliberate) mind wandering, with an underlying positive relationship. Additionally, we show for the first time that future-oriented spontaneous thought significantly predicts OC symptoms, over and above variance explained by spontaneous mind wandering. Specifically, for the *need for symmetry/completeness* dimension of OC symptoms, increases in future-oriented spontaneous thought were associated with increases in OC symptoms. The present study adds to recent conceptual debates regarding mind wandering and highlights the role of future-oriented spontaneous thought in anxiety. We suggest new cognitive and methodological approaches to enhance the clinical understanding of obsessive-compulsive disorder.

Keywords: spontaneous thought; obsessive compulsive disorder; compulsions; obsessions; mental time travel

Predictors of Obsessive-Compulsive symptomology: Mind wandering about the past and future

Obsessive compulsive disorder (OCD) is considered a highly debilitating condition which affects around 1.3% of the global population (Fawcett, Power & Fawcett, 2020). Clinically, this disorder involves two main aspects: Firstly, obsessions revolving around a perceived problem which causes heightened anxiety and, secondly, compulsions which consist of behaviours or thoughts aimed at resolving the problem and/or anxiety (Challacombe, Oldfield and Salkovskis, 2011). Obsessions can take the form of intrusive imagery (e.g., "I left the house but forgot to turn off the oven which could cause a fire"), which can then trigger compulsions to think or act (e.g., "I must return to the house and check all dials on the oven") in order to relieve anxiety (American Psychiatric Association, 2013). The full clinical presentation of OCD is evident when anxiety caused by these intrusive thoughts - and the subsequent acts to quell them - are so frequent that they significantly impact a person's daily life.

In a less severe form, obsessive and compulsive tendencies are also known to occur in the general population (Abramowitz, Deacon, Olatunji, Wheaton, Berman et al., 2010). When considered at an individual difference level in the general population, obsessive-compulsive tendencies are linked with mind wandering (MW) experiences (Seli, Risko, Purdon and Smilek, 2017). The link is explained by the conceptual overlap in these constructs; MW is characterized by a turning of attention to our inner cognitions rather than the outside world (which can include memories, daydreams, semantic knowledge and future thoughts), as are OCD tendencies, and both can occur unexpectedly (Abramowitz et al., 2020; Seli, Risko, Purdon and Smilek, 2017). More specifically, the intrusive nature of OC (obsessional-compulsive) thoughts (Rachman, 1997; Salkovskis, 1985) overlaps with the concept of *spontaneous mind wandering* – referring to

cognitions that arise with no intention and little control over its content (Seli, Carriere, & Smilek, 2013; see also Christoff, Irving, Fox, Spreng, Andrews-Hanna, 2016; Cole & Kvavilashvili, 2019a). In a recent study, spontaneous, *but not deliberate,* MW, predicted the type and extent of OCD symptoms in a non-clinical student population (Seli, Risko, Purdon and Smilek, 2017), further demonstrating conceptual differences between deliberate and spontaneous MW, and providing new avenues for research into OCD[1].

The distinction between spontaneous and deliberate MW has also been accompanied by a wider theoretical discussion on the need to distinguish different types of MW (Seli, Kane, Smallwood, Schacter, Maillet et al., 2018; Murray et al., 2020). Here, we explore these distinctions further by looking into the temporal orientation of MW (see Baird, Smallwood & Schooler, 2011), and its relationship with OCD symptomatology. Temporality is particularly important to understand OCD, as recent findings have highlighted the salient role that future-oriented feared outcomes play in the disorder (e.g., "If I don't return home, a fire will burn through the street harming my neighbours", see Gehrt, et al., 2020; Zermatten et al., 2008). Furthermore, future-oriented MW has been associated with important functions, such as goal-directed cognitions and creativity (Baird, Smallwood & Schooler, 2011; Baird, Smallwood, Mrazek, Kam, Franklin et al. 2012; Stawarczyk, Majerus, Maj, Van Der Linden & D'Argembeau, 2011). Thus, maladaptive future-oriented MW may have an important role in the difficulties experienced by people living with OCD symptoms. In this study, we provide the first analysis of

[1] It is worthy of mention that other related types of spontaneous thought have also been examined, often in their own right, are *involuntary autobiographical memories* (Berntsen, 2009), *mind-pops* (Kvavilashvili & Mandler, 2004) and, *spontaneous future cognition* (Cole & Kvavilashvili, 2019a).

this relationship, by assessing whether spontaneous MW about future further explains the link between MW and OCD.

In sum, aims of the present study were twofold; (1) to replicate the aforementioned link between spontaneous thought patterns and OCD symptomology found by Seli and colleagues (2017) and (2) to provide the first examination of whether the temporality of spontaneous thought (specifically the future component) is a key variable that will help us explain how increases in MW confer an increase in obsessive-compulsive thoughts. Thus, aim two will enable to us to examine further why a link between spontaneous MW and OCD symptomology exists.

A better understanding of MW about the past and future will shed light on possible 'cognitive risk factors' and lead to a better clinical understanding of the emergence and maintenance of OCD.

Mind Wandering: An Overview

A Definition of Mind Wandering

Although there are several conceptualisations of MW (Christoff, Mills, Andrews-Hanna, Irving, Thompson et al., 2018; Seli, Carriere, & Smilek, 2013; Seli, Kane, Smallwood, Schacter, Maillet et al., 2018), it is generally defined as an attentional shift away from the here-and-now (including engagement in ongoing tasks), toward unrelated inner thoughts, feelings, memories, plans or wishes (Seli, Kane, Smallwood, Schacter, Maillet et al., 2018; Smallwood & Schooler, 2006; Smallwood & Schooler, 2015[2]). It has been found to be a relatively common human

[2] Mind wandering has variously been referred to as *self-generated thought* (Smallwood & Schooler, 2015), *task-unrelated thought* (Raichle, Macleod, Snyder, Powers, Gusnard & Shulman, 2001), *stimulus-independent thought* (Antrobus, Singer & Greenberg, 1966), and *daydreaming* (Singer, 1966). Nevertheless, the most commonly used term across time and different authors has been *mind wandering* (Smallwood & Schooler, 2006, 2015). For a description of terminology in this field see

experience, occupying 25-50% of waking life (Kane, Brown, McVay, Silvia, Myin-Germeys et al., 2007; Killingsworth & Gilbert, 2010).

Seli and colleagues (Seli, Carriere, & Smilek, 2014; Seli, Risko, Smilek & Schacter, 2016) have argued that an important binary distinction should be made when examining MW. Specifically, they identify two types: *Spontaneous mind wandering*, which occurs with no intent and *deliberate mind wandering*, which an individual generates intentionally. Research has demonstrated that spontaneous and deliberate MW are differentially affected by personality traits (e.g., *motivation*, Seli, Cheyne, Xu, Purdon, & Smilek, 2015) and states (e.g., *high task difficulty*, Seli, Risko & Smilek, 2016) indicating that the distinction is not superficial but instead signifies a meaningful difference. Theoretically, the distinction between intentional and unintentional processes has also been applied to explain important differences between spontaneous and deliberate future thinking (Cole & Kvavilashvili, 2019b). General theoretical frameworks – known as dual process accounts (Evans, 2008; Kahneman, 2011) - have been utilized to explain some of the differences between spontaneous and deliberate MW (see Cole & Kvavilashvili, 2019b; Seli, Risko, Smilek & Schacter, 2016).

Theoretical Approaches to Mind Wandering

Theories of MW coalesce around one of two foci; theories of the cognitive processes associated with MW experiences and theories of the functions of MW (in short, whether MW is beneficial or indicative of a maladaptive mind).

Smallwood & Schooler, 2015, and see Seli, Kane, Smallwood, Schacter, Maillet et al., 2018, Christoff, Mills, Andrew-Hanna, Irving, Thompson et al., 2018; and Seli, Kane, Smallwood, Schacter, Maillet et al., 2018b for a recent debate

Cognitive approaches generally take one of two positions: Firstly, that MW does not require executive resources but interrupts and disrupts ongoing tasks (the *executive-control failure hypothesis*, Kane & McVay, 2007). Indeed, studies have demonstrated that people with low working memory capacity experience higher frequency of MW, regardless of whether MW was measured by questionnaires, diary recordings or laboratory tasks (Kane & McVay, 2012; Kane & McVay, 2007; McVay & Kane, 2009). The executive-control failure hypothesis explains the disruption to current task performance (e.g., increasing errors in high working memory-demanding tasks) by MW distracting rather than consuming cognitive resources (Kane & McVay, 2007). Revisions of this hypotheses proposed that MW was a failure of inhibition, especially in the context of external cues which triggering goal-related thoughts (McVay & Kane, 2010).

In contrast, proponents of the *decoupling hypothesis* (Smallwood & Schooler, 2006) assert that cognitive resources are necessary (and consumed) when MW is brought into consciousness (Smallwood & Schooler, 2006). A central tenet of this view is that decoupling from one's current environment, and subsequent 'cognitive hijacking' of executive resources, acts to service other, self-relevant, goals (Smallwood & Schooler, 2006). Although the *executive-control failure* and *decoupling hypothesis* posit that MW experiences can be triggered or activated automatically (Smallwood & Schooler, 2006; McVay & Kane, 2010), the conflict remains in how the two hypotheses view the cognitive demands of MW experiences. Interestingly, a more recent proposal (*process-occurrence framework*, Smallwood, 2013) resolves these two approaches by separating cognitive processes of MW associated with activation and maintenance, linking only the latter with resource demands (Smallwood, 2013).

Although the debate about whether MW is functionally adaptive has been less focused than those concerning cognitive mechanisms (see Smallwood & Schooler, 2006; McVay & Kane, 2010), two broad perspectives can nevertheless be identified. The first hypothesis assumes MW largely obstructs normal goal completion and task performance (Kane & McVay, 2007; McVay & Kane, 2010). Thus, MW is the cause of errors, slowing and poor comprehension (Kane & McVay, 2012; Schooler, Reichle, & Halpern, 2004; Szpunar, Moulton & Schacter, 2013) – in other words, MW is a form of distraction that should be curtailed.

The opposing perspective focusses on the adaptive *content* of MW. The adaptive content perspective often starts with the intuitive notion that such a prevalent mental phenomenon (occupying up to 50% of mental content, Killingsworth & Gilbert, 2010) must *by necessity* serve a useful purpose (Baars, 2010; Klinger, Marchetti, & Koster, 2018). This is consistent with the Darwinian idea of ultimate causation of functional neurobiological systems through evolution. Studies examining the content of MW have shown that MW contains multiple types of information (e.g., *self, social*, *future-related*, Linz, Pauly, Smallwood, Engert, 2019). Of relevance here is how MW content can be conceptualized temporally as either past-, present- or future-oriented (Baird, Smallwood & Schooler, 2011; Stawarczyk, Cassol & D'Argembeau, 2013). This is central to the function debate because several studies have found that the majority of MW experiences are future-oriented (Smallwood & Schooler, 2011; Song & Wang, 2010, see Cole & Kvavilashvili, 2019a for a review), and where they are future-oriented, they are more likely concerned with creative problem-solving, autobiographical planning and long-term goals (Baird, Smallwood & Schooler, 2011; Baird, Smallwood, Mrazek, Kam, Franklin et al. 2012; Stawarczyk, Majerus, Maj, Van Der Linden & D'Argembeau, 2011). The idea that MW is important for future goals and behaviour (outside of the immediate) context is consistent with the

work of Klinger (1971, 2013), who has outlined a detailed theoretical account of adaptive MW in the *goal theory of current concerns*. Nevertheless, maladaptive or dysfunctional aspects of MW have also been highlighted, often associated with certain clinical groups or individual difference variables (Klinger, Marchetti, & Koster, 2018). It is these maladaptive forms of MW to which we turn below.

Mind Wandering: Temporality and its Relation to Mental Health and OCD Symptoms

We now consider MW, and specifically its temporal orientation, in its relationship with poor mental health (see MacLeod, 2016 for a related review). First, we summarise recent cognitive approaches to understanding differences between anxiety and depression. Secondly, the relationship between different types of psychopathology and MW is reviewed. We then focus on cognitive approaches to anxiety and OCD, which highlights that the future-oriented component of MW may be especially important in OCD.

Turning first to anxiety, in those with anxiety disorders researchers have observed an *over-representation of emotionally negative future events* (MacLeod & Byrne, 1996), but not a decrease in positive future events. Thus, in a verbal fluency task comparing anxious, mixed (anxious and depressed) and control participants, anxious individuals only differed from controls by generating a greater number of negative future events (MacLeod & Byrne, 1996). Participants with combined anxiety and depression differed from purely anxious individuals only by reporting fewer positive future events (MacLeod & Byrne, 1996). This negative-future cognitive bias in anxiety is observed in specific anxiety disorders, such as social anxiety disorder reflected in content-specific thoughts and hyper-vigilance around possible future threats (e.g., causing an embarrassing scene at a party, see del Palacio Gonzales & Berntsen, 2020 for a study of low and

high socially anxious individuals). In short, high-anxiety individuals tend to envisage possible negative situations in the future, rather than a focus or rumination on past scenarios[3].

It is important to note that cognitive theories of psychopathology have demonstrated how depression and anxiety can be distinguished along two non-correlated dimensions (positive and negative affect) (Clark & Watson, 1991, Watson, Clarke & Carey, 1988): Depression is associated with a lack of positive affect (e.g., reduction in arousal, lack of interest, apathy), whereas anxiety is associated with an increase in negative affect (e.g., increased tension, hyper-arousal, irritability). In terms of temporality of thought, depression has been conceptualized as a change in perceptions of the self, the world and the future (Beck, 1976) – where future perspective is affected by a reduction in the ability to generate *positive future* events (MacLeod & Byrne, 1996; Williams et al., 1996). The link between depression/low mood and MW has now been established in several studies, both dispositionally (Deng, Li & Tang, 2014) and at state level (Killingsworth & Gilbert, 2010; Ruby, Smallwood, Engen & Singer, 2013). In short, MW is associated with a significant reduction in mood. Research has also shown that in addition to the occurrence of MW, the temporal content of MW may play an important role. Specifically, it has been found that a retrospective bias of MW (more past- than future- oriented MW) is associated with low mood (Ruby et al., 2013; Poerio, Totterdell & Miles, 2013), in line with research linking depression and ruminative past-thinking (Watkins & Teasedale, 2001).

Currently, there exist only a few studies examining the link between MW and anxiety (e.g., Arch, Wilcox, Ives, Sroloff, & Andrews-Hanna, 2020; Seli, Beaty, Marty-Dugas, &

[3] Although the majority of research has investigated the link between depression/anxiety and future thinking, it is acknowledged that anxiety disorders (such as PTSD and social anxiety disorder) are also associated with changes in the content of autobiographical memories (e.g., Krans, Peeters, Näring, Brown, de Bree, 2017)

Smilek, 2019) – and these are often studies of anxiety traits in the general population. As such, our understanding of this relationship is growing, yet still in a formative stage. However, it is possible to generate some hypotheses based on current cognitive accounts of anxiety. For instance, 'intrusive thought', especially 'intrusive mental imagery' (see Holmes & Matthews, 2010; Raune, MacLeod & Homes, 2005), that is, thoughts that arise with no intention (as in spontaneous MW, Seli et al., 2013) has recently been posited as an important characteristic of anxiety disorders, such as post-traumatic stress disorder (Ehlers & Steil, 1991), and of relevance here, OCD. The relevance of intrusive mental imagery is supported by prominent clinical accounts of OCD (Rachman, 1997; Salkovskis, 1985). Indeed, such intrusive thoughts or images may have a role in the *onset* and *maintenance* of psychological disorders (e.g., Ehlers & Clarke, 2000), such as OCD, and thus may be a suitable target for therapeutic interventions (Blackwell, 2019).

A hypothesis follows from these approaches suggesting that more anxiety will be associated with an increase in *spontaneous* MW, but not deliberate MW. This hypothesis has found support in three types of anxiety[4]. First, in a non-clinical group of university students, Seli and colleagues (Seli, Beaty, Marty-Dugas, & Smilek, 2019) found that spontaneous, but not deliberate MW, was positively associated with general anxiety and stress as measured by the Depression, Anxiety, Stress Scale (Antony, Bieling, Cox, Enns, & Swinson, 1998). Secondly, those with a diagnosis of social anxiety disorder had more spontaneous MW experiences than

[4] MW has also been examined in relation to Attention Deficit Hyperactivity Disorder (ADHD), a disorder that often coexists with anxiety (Schatz, & Rostain, 2006).). In ADHD, several recent studies have found an elevated frequency of MW in ADHD compared to control groups (Biederman, Lanier, DiSalvo, Noyes, Fried et al., 2019; Helfer, Cooper, Bozhilova, Maltezos, Kuntsi, 2019) and higher levels of *spontaneous* MW (Moukhtarian, Reinhard, Morillas Romero, Ryckaert, Mowlem et al., 2020; Seli, Risko, Purdon, & Smilek, 2017)

those without social anxiety (Arch, Wilcox, Ives, Sroloff, & Andrews-Hanna, 2020). Finally, in a recent study, Seli and colleagues (Seli, Risko, Purdon & Smilek, 2017) found that spontaneous MW, but not deliberate MW, predicted variance in trait-level obsessive and compulsive symptoms in a non-clinical cohort of 2636 students. This finding was in line with the prediction of Seli and colleagues, who explained the results in terms of alterations to executive control mechanisms that may result in both spontaneous MW and OCD symptomology (Seli et al., 2017).

An untested hypothesis leading from previous theoretical and empirical research on anxiety concerns whether temporality of MW explain further why MW is related to OCD symptomology. Specifically, although the results of Seli et al (2017) support a positive association between spontaneous MW and anxiety conditions, it was not able to identify whether past or future-oriented spontaneous MW predicts OCD symptoms. OCD is an anxiety disorder that involves hypervigilance around circumscribed concerns (Rachman, 1997) – concerns which often feature looming disasters (e.g., death of a friend).

The relation between future-oriented spontaneous MW and OCD is clearly seen when we consider a hypothetical event involving an obsession and subsequent compulsion to act. Assume John - an OCD sufferer - has a fear of causing harm to others. His body becomes tense when he notices a traffic cone which has fallen over into the road. John has several vivid spontaneous thoughts involving a possible future car crash, which causes anxiety and is (mis)interpreted as a genuine threat must be neutralized (see Rachman, 1997). As well as increasing anxiety, the spontaneous negative imagery can also increase the perceived likelihood this negative event will

happen[5] (Raune, MacLeod & Holmes, 2005). As a preventative measure, he walks back several hundred metres to replace the cone to its original position, leading to a feeling of relief (but causing him to be late for an important meeting), and resulting in a cycle of obsessions and behaviours which increasingly interfere with his daily life. The role of intrusive thought in OCD is consistent with well-known cognitive accounts of OCD (Rachman, 1997; Salkovskis, 1985) and anxiety (Raune, MacLeod & Holmes, 2005).

How might this example highlight the role of temporality of MW in OCD and OC cognitions? For John, it is the intrusive thought of the negative future, rather than past-oriented spontaneous thoughts, that can be seen to drive the looming obsessional worry ('I have created a negative situation which will *lead to* others coming to harm') and a subsequent compulsion to act ('If I don't act, the negative event *will occur!*'). Additionally, compared with healthy controls, people with OCD report heightened vividness and contextual richness when imagining events (Gehrt, Frostholm, Pallesen, Obermann, & Berntsen, 2020; Zermatten, Van der Linden, D'Argembeau, & Ceschi, 2008). The fact that highly vivid imagined scenarios can lead to increased feelings of probability (Raune, MacLeod & Holmes, 2005), especially when they are repeated (Szpunar & Schacter, 2013) leads to an explanation of how future-oriented thoughts may trigger the obsessions and compulsions of OCD. As noted above, cognitive theories of anxiety converge on the idea that anxiety disorders are associated with an increase in negative affect (Clark & Watson, 1991, Watson, Clarke & Carey, 1988) – especially concerning negative future scenarios (MacLeod & Byrne, 1996). In OCD, this negative affect often manifests as

[5] For a related explanation of how mental imagery can increase subjective probabilities of negative future scenarios (in anxiety in general), see Raune, MacLeod & Holmes (2005) in which they propose 'the simulation heuristic' – an explanation for the role of mental imagery in anxiety disorders.

intrusive thoughts about possible tragic, worst-case scenarios (as in John, above) in relation to one of the four dimensions of OCD symptomology (Abramowitz et al., 2010). This contrasts with negative past-oriented thoughts which, as we have seen, are strongly associated with depression (Watkins & Teasedale, 2001)[6].

Although future-oriented spontaneous thought could explain the salience of 'intrusions' in the clinical presentation of OCD, the importance of future-oriented thoughts in OCD has been especially highlighted in theories from evolutionary psychology (Abed & DePauw, 1998; Miloyan, Bulley & Suddendorf, 2016). Nevertheless, to our knowledge, this project is one of the few attempts to directly measure prospection in relation to patterns of OCD symptomology (see also Gehrt, et al., 2020; Zermatten et al., 2008).

Aims and Hypotheses of the Current Study

In the present study, in addition to spontaneous and deliberate MW, we examined the temporality of spontaneous thought in relation to OCD symptomology in a non-clinical sample. Our reasoning was thus: If spontaneous future-oriented thoughts offer additional insights into the link between MW and OCD symptomology (because future-oriented spontaneous thoughts can maintain the obsessions and compulsions in OCD), frequency of future-oriented spontaneous thoughts should add significant variance in OCD symptomology, over and above MW, as measured by the spontaneous MW scale (Carriere, Seli & Smilek, 2013). We predicted that future spontaneous MW, but not past-oriented MW, would be able to explain additional variance, over and above variance explained by spontaneous MW (in general). If this is found to be true, it

[6] From the start of this investigation, we were agnostic as to whether past-oriented MW would predict additional variance in OCD symptomology, due to a lack of previous evidence or theory linking OCD with past-oriented thought. This contrasts other disorders such as PTSD or depression, where a link with past-oriented thoughts has been well-documented.

will not only support established theories of OCD (Rachman, 1997) concerning the role of intrusive imagery in general, but will importantly lend support to recent theories of OCD (Gehrt, et al., 2020; Zermatten et al., 2008) highlighting how spontaneous thoughts *about the future* are able to drive and maintain anxiety-related disorders.

As Seli and colleagues' study (2017) was the first of its kind, it is important to contribute to this emerging literature, and indeed a key component of scientific investigation, to generate replications (Zwaan, Etz, Lucas, & Donnellan, 2018). The hypotheses for this study were:

Hypothesis 1: We attempted to replicate the finding that the tendency to mind wander spontaneously, but not deliberately, would predict obsessive-compulsive thought (Seli et al., 2017).

Hypothesis 2: We tested whether the frequency of future-, but not past- oriented spontaneous MW experiences added explanatory value to a regression model where spontaneous MW predicts OCD symptomology - whereby an increase in future-oriented spontaneous MW is associated with an increase in OCD symptomology. If future-oriented spontaneous MW adds variance to this regression model, it would strongly indicate that future-oriented spontaneous MW is an important part of the obsession-compulsion cycle that drives and maintains OCD.

Method

We adopted a cross-sectional design using an online questionnaire format (Qualtrics, Provo, UT) to program the presentations and order of all scales. In all, we measured three constructs; OCD symptomology, MW frequency and spontaneous past and future thoughts. Data was collected throughout May, 2020. The project was approved by a York St John University Ethics Committee.

Participants

In line with Seli, Risko, Purdon and Smilek's (2017) study, we targeted healthy adults over the age of 18. A power analysis using G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) found that a minimum of 89 participants would be needed for a medium-sized effect, hence we aimed to recruit at least 100 participants to account for data exclusions. In total, we included 102 UK-residing participants, after removing 38 incomplete entries. Participants were aged 19 to 80 (31% male, 68% female, 1% self-categorised as 'other'), with an average age of 33 (*SD* = 12.42). No explicit restrictions (e.g., diagnosis of a clinical disorder) were placed on exclusion criteria when recruiting. We recruited participants via York St John University's student population, snowball sampling through social networks and convenience sampling from local groups. As an incentive for participation, all participants were entered into a prize draw for an £50 Amazon voucher.

Materials

Three questionnaires were presented in the online study hosted by Qualtrics (Provo, UT); The Mind-wandering: Deliberate and Spontaneous Scale (MS-D, MS-S, Carriere, Seli & Smilek, 2013) to establish the presence of voluntary and involuntary mind-wandering, the Dimensional Obsessive-Compulsive Scale (DOCS, Abramowitz, Deacon, Olatunji, Wheaton, Berman et al., 2010) to establish symptoms of Obsessive Compulsive Disorder and the Involuntary Autobiographical Memory Inventory which measures the temporality of spontaneous thought (Berntsen, Rubin & Salgado, 2015). More detail on these three scales is provided separately below. The order of these three scales was randomised to reduce order effects (e.g., fatigue).

Mind wandering: Spontaneous (MW-S) and Deliberate (MW-D) (Carriere, Seli & Smilek, 2013)

This scale is designed to measure two separate phenomena; spontaneous and deliberate mind-wandering. It is therefore split into two separate scales (MW-S and MW-D); each with four items (Carriere, Seli & Smilek, 2013). The deliberate mind-wandering scale gives statements such as '*I allow my thoughts to wander on purpose*', with which the participants rate how much they agree. The spontaneous mind-wandering scale includes statements such as '*I find my thoughts wandering spontaneously'*. The minimum score for each scale is 4 and the maximum is 28 (each scale is rated 1-7). A higher total reflects a greater tendency to spontaneously or deliberately mind-wander in everyday life. Both scales have been shown to have good internal consistency ($\alpha > .80$, Carriere et al., 2013).

Dimensional Obsessive-Compulsive Scale (DOCS) (Abramowitz, Deacon, Olatunji, Wheaton, Berman et al., 2010)

This scale is designed to measure four separate subscales of OCD symptomology; Contamination, Responsibility, Unacceptable thoughts and Symmetry/completeness. Each subscale has five items. The questions for each subscale are specific to the component of OCD they are measuring, so, for example, a contamination question includes '*About how much time have you spent each day thinking about contamination and engaging in washing or cleaning behaviours because of contamination?*'. All questions are answered on a 5-point scale that ranges from 0 to 4, with labels that reflect the frequency of cognitions and behaviours associated with that component. The minimum score for each subscale is 0 and the maximum is 20. A higher total reflects a greater tendency to engage in those specific OCD-like symptoms. However, the DOCS does not provide a diagnosis of the disorder, only indicating related symptomology which

may exist in non-clinical populations (Abramowitz et al., 2010). As described in Abramowitz and colleagues (2010), the DOCS has good internal reliability ($\alpha > .90$) and convergent validity with other well-known measures of OCD symptoms (*r*s = .54 -.71).

Involuntary Autobiographical Memory Inventory (Berntsen, Rubin & Salgado, 2015)

This scale is designed to measure the temporal focus of spontaneous cognition[7]. It is split into two separate scales; past and future, that have 10 questions each. The past scale focuses on spontaneous memories and includes statements such as '*Memories of personal events pop into my mind by themselves – without my consciously trying to remember them'*. The participant then answers how frequently this statement applies to them on a 5-point Likert scale that ranges from 0 (Never) to 4 (Once an hour or more). Hence the scale measures the frequency of past and future spontaneous thought. The items for the future uses the same scale and anchor points but with future-oriented statements such as '*Imaginary future events pop into my mind by themselves – without me consciously trying to evoke them'*. We use the mean score, in line with Berntsen, Rubin & Salgado (2015), which can range from 0 to 4 (Never (0) - Once an hour or more (4)). A higher mean score reflects a greater tendency to experience either past- or future-related spontaneous thoughts. Internal consistency for both scales was at least $\alpha = 90$ (Berntsen, Rubin & Salgado, 2015).

[7] This measure was selected due to its relevance to measuring involuntary thoughts about the past and future. We were not aware of any scale that specifically measured MW about the past and future, and although Berntsen (2019) has argued for differences between autobiographical involuntary memory and future thinking and MW on conceptual grounds, based on a recent review of empirical research from MW, future thinking and prospective memory (Cole & Kvavilashvili, 2019), we believe there is enough convergence in findings between these studies, to consider past and future involuntary thoughts to past and future oriented thoughts measured in the MW literature (see Baird et al., 2012) . We therefore selected the scale by Berntsen, Rubin & Salgado (2015) for both pragmatic and conceptual reasons.

Procedure

Each participant accessed the study from their own computer or smartphone via an active link (provided within the advert). Participants were informed of the three constructs under investigation, but none of the hypotheses of this study. Descriptions of all constructs were provided on the first page of the survey (before consent), including an explanation of obsessive and compulsive thoughts and behaviours that are common in the population. Participants were also informed that mind-wandering refers to the process where you are "not present in the moment, and instead are following your thoughts, either voluntarily or without realizing…such as conducting a task and being distracted by thoughts about a holiday". Spontaneous thoughts were described as "the type of thoughts that are involuntary, whether related to the present moment or not. They are not brought to mind with intention, and instead are experienced without will and can be positive, negative or neutral.". After a description of the concepts, they were provided with the opportunity to give informed consent by selecting a series of radio buttons. They then provided demographics (gender, current age) before completing the three questionnaires.

Participants took a median of 13 minutes to complete the study (Mean= 44 mins, inter-quartile range, 7.5 [Q1] - 16.5 mins [Q3]), with a small minority who took long durations (3 participants took > 1 hour). Nevertheless all participants completed all sections.

After participants completed these scales they were provided with a debrief detailing further information about the study and sources of support for OCD and contact details, should they want to ask further questions or withdraw their data.

Data Analysis Plan

All fully completed surveys were included (total $N = 102$) in data analysis, and there was no evidence of erroneously completed surveys (i.e., no 'straight-lining' even in those participants with the shortest completion times). Hierarchical regression models (enter method) were conducted in SPSS for each dependent variable using two blocks (Block 1: MW-S; Block 2: Temporal Focus of MW). In the first block of each analysis, a regression analysis was used to investigate if spontaneous and deliberate MW can predict OCD symptomology. The outcome variable for this was OCD symptomology in four forms; Contamination, Responsibility, Unacceptable thoughts and Symmetry/completeness. To test our second hypothesis, we added the temporality of spontaneous MW as a predictor (with the prediction that future spontaneous cognition would add significant variance to the model).

Results

Below we summarise the descriptive statistics before providing a correlation matrix of the variables, then planned regression models.

Descriptive Statistics

For the scores on all scales (and sub-scales), central tendency, variation and range were calculated (see Table 1). To allow direct comparisons with Seli et al. (2017), and to account for missing answers, scores on the MW scale were averaged (rather than summed), as were scored on the IAMS. The DOCS sub-scales, however, were totalled, in line with Seli and colleagues (2017). The minimum and maximum total scores (and SDs) for all scales demonstrate that a good range of individual differences were present. Mean scores were consistent with Seli et al., for MW but somewhat elevated for OCD symptomology[8]. In line with Kline (1998), the Skewness and Kurtosis values were all within the acceptable range; Skewness <2 and Kurtosis <4. Mean scores for temporality of past and future involuntary thought ranged from 1.6 and 2.1 on a 0-4 scale, consistent with all studies reported in Berntsen et al (2015). Finally, high cronbach's alpha for all scales/sub-scales (all α s > .85) indicated good internal reliability, consistent with previous research (see Abramowitz et al., 2010; Berntsen et al., 2015; Seli et al., 2017).

Correlational Analyses

Before conducting regression models we conducted Pearson product-moment correlations to examine the relationship between all variables. These zero-order correlation coefficients are

[8] In Seli et al. (2017), MW was 4.50 (deliberate) and 4.27 (spontaneous), whereas DOCS was M = 3.53 (contamination), M = 3.28 (responsibility), M = 3.90 (unacceptable thoughts) and M = 2.96 (symmetry/completeness). This may have been due to data collection taking place in the covid-19 pandemic and UK lockdown in May 2020. This point will be elaborated in the discussion section.

presented in Table 2. It can be noted here that there are stronger positive (significant) correlations between MW-S and DOCS subscales, and an absence of significant correlations between MW-D and OCD symptoms. It is also evident that past- and future- oriented spontaneous thought are strongly correlated, despite internal reliability (see Table 1), consistent with previous work (r > .68, del Palacio-Gonzalez & Berntsen, 2019; Berntsen, Rubin & Salgado, 2015)

Our first hypothesis was that spontaneous, not deliberate MW would predict OCD symptomology (Seli et al., 2017). First, we must observe that there were only small correlations between deliberate MW and the four sub-scales of the DOCS (r = -.02 - .18), neither of which reached statistical significance. As linear regression models (themselves based on the same linear relationships) would not result in this measure significantly predicting OCD symptomology, we decided to omit deliberate MW from subsequent regression models. Nevertheless, an exploratory analysis using four linear regression models (using t test to assess difference of b from zero) confirmed that none of the DOCS sub-scales significantly predicted by deliberate MW, ps = .84, .13, .11, .07).

The lack of a relation between deliberate MW and OCD symptomology is consistent with Seli et al. (2017) (rs = .05 - .12), but a full test of hypothesis 1 is provided below when spontaneous MW is incorporated in the regression models. Nevertheless, it was therefore statistically justified to continue the calculations without the inclusion of the deliberate MW variable as they would not add variance to our subsequent regression models.

Regression Models: Examining Hypothesis 1 and 2:

Below we describe three hierarchical multiple regression models to assess whether spontaneous MW predicted variance in OCD symptomology within each of the dimensions

identified by Abramowitz et al. (2010)[9], thus further replicating the findings by Seli et al (2017). However, only three (out of a potential four) sub-scales were examined, as the contamination subscale of OCD symptomology was not found to be significantly correlated with any of the scales outside of OCD symptomology sub-scales and so was omitted from these analyses (see Table 2). To examine our second hypothesis, for each three sub-scales of the DOCS, in addition to our first block (MW-S), we added a second block (temporality of spontaneous thought), resulting in three hierarchical regression models. This added step was included to assess whether past or future spontaneous thoughts increased the variance explained (assessed by R^2 change) after the first step in which spontaneous MW was entered as a predictor. We predicted that future, but not past spontaneous thought would add significant variance to the second step of each model (and that the variance explained by past spontaneous thought would not differ, statistically, from zero).

Predictors of Responsibility OCD symptomology

In the first block, spontaneous MW predicted significant variance in OCD symptoms [$F(1, 100) = 22.63$, $p < .001$], with an R^2 of .185, this explaining 18.5% of the variance in responsibility OCD symptomology scores. The coefficients for the model in Table 3 indicate that for every increase of 1 on the spontaneous mind-wandering scale there was a 1.15 increase on the responsibility OCD subscale.

When entering spontaneous mind-wandering and temporal focus in the second block, a significant model was also found [$F(3, 98) = 8.392$, $p < .001$], with an R^2 of .20. This suggests that, collectively, spontaneous mind-wandering and temporal focus explain 20% of the variance

[9] This separation of regression models based on the four sub-scales of the DOCS (Abramowitz et al. 2010) is consistent with Seli and colleagues (2017).

in responsibility OCD symptomology scores. The R^2 change for this second model (.020) was not significant [*F* change = 1.223, *p* = .30]. This is also reflected in Table 3, where it can be observed that, as individual variables, neither future- or past- oriented thought significantly contribute to the second regression model.

Predictors of Unacceptable Thoughts OCD symptomology

When entered in the first step, spontaneous mind-wandering significantly predicted variance in unacceptable thoughts OCD symptomology scores [$F(1, 100) = 33.349$, $p < .001$], with an R^2 of .25, explaining 25% of the variance. The coefficients for the model (Table 3) suggest that for every increase of 1 on the spontaneous mind-wandering scale there was a 1.64 increase on the unacceptable thoughts OCD subscale.

When entering spontaneous mind-wandering and temporal focus in a second step, a significant model was also found [$F(3, 98) = 14.588$, $p < .001$], with an R^2 of .31. This demonstrates that spontaneous mind-wandering and temporal focus together explain 30.9% of the variance in unacceptable thoughts OCD symptomology scores. The R^2 change for this model was .06, which was significant (F change = 4.155, *p* = .019). This indicates that including temporal focus into the model increases the variance explained significantly by 5.9%. However, as Table 3 shows, the coefficients of both future and past temporal focus were non-significant. Although their presence appears to increase predictability of the model, their individual contributions are not strong enough to reach statistical significance.

Predictors of Symmetry/Completeness OCD symptomology

When entered in the first step, spontaneous mind-wandering was a significant predictor of symmetry/completeness OCD symptomology [$F(1,100) = 14.885$, $p < .001$], with an R^2 of .13, therefore explaining 13% of the variance in symmetry/completeness OCD symptomology

scores. Coefficients for the model are included in Table 3 and suggest that for every increase of 1 on the spontaneous mind-wandering scale there was a 1.04 increase on the symmetry/completeness OCD subscale.

When entering spontaneous mind-wandering and temporal focus in the second step, a significant overall model was also found [$F(3, 98) = 11.259$, $p < .001$], with an R^2 of .256, indicating that spontaneous mind-wandering and temporal focus explain 25.6% of the variance in symmetry/completeness OCD symptomology scores. This suggests that including temporal focus into the model almost doubles the variance explained (R^2 from .13 to .26) and explains an additional 12.7% of variance. The R^2 change for this model was .13, and was significant (F change = 8.352, $p < .001$). Supporting our second hypothesis, future-oriented spontaneous MW was a significant contributor to the second model but past-oriented MW was not (see Table 3). In short, it was primarily responsible for the increase in variance explained. Interestingly, and only for symmetry/completeness OCD, when temporal focus is added to this second regression model, the coefficients for spontaneous mind-wandering and past-oriented MW do not differ from zero (the 95% confidence intervals of both β values overlap with zero, see Table 3), leaving future-oriented spontaneous MW as the only significant and the strongest predictor (standardised β = .52 versus .13 and -.13) (see Table 3), when other variables are held constant[10].

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[10] We acknowledge that examining the contribution of variance explained by spontaneous temporal focus of thought *over and above* variance explained by spontaneous MW, may be an overly conservative test of Hypothesis 2. We therefore conducted a separate regression model only including past-future temporal focus as predictors. In terms of responsibility (13.6%

variance, significant model, $F(2,99)=7.76$, $p < .001$), unacceptable thoughts (23.9% variance explained, significant model, $F(2,99)=15.56$, $p < .001$), and symmetry/completeness (24.5% variance explained, significant model, $F(2,99)=16.04$, $p < .001$), temporal focus explained a significant amount of variance in each model. Additionally, in line with the main analysis, the variance explained by temporal focus for symmetry/completeness was driven by future-oriented spontaneous thought. Consistent with the analysis above – temporal focus did not significantly predict contamination symptomology (3.6% variance explained, significant model, $F(2,99) = 1.87$, $p = 0.16$). Therefore removing spontaneous MW from the models underlined which dimension of OCD symptomology were strongly or weakly predicted by the temporal focus of thought.

Discussion

In this study we had two aims: (1) To confirm the initial finding by Seli and colleagues (2017) regarding the association between spontaneous MW and OCD symptomology and (2) to elucidate the contribution of temporality of MW in explaining frequency of OCD symptoms. In relation to our first aim, we found that spontaneous, but not deliberate MW predicted OCD symptomology in three out of the four sub-types of OCD symptoms. It can be concluded therefore that, except for one sub-scale, we successfully replicated findings from a separate study using similar methods and scales (Seli et al., 2017). A possible explanation of this unexpected anomaly is provided below.

Secondly, based on cognitive and evolutionary theories of anxiety (Abed & DePauw, 1998; Miloyan, Bulley & Suddendorf, 2016; Raune, MacLeod & Holmes, 2005), it was predicted that, of the two directions of temporality of thought (past, future; Berntsen, Rubin & Salgado, 2015), future-oriented MW, but not past-oriented MW, would predict significant variance in OCD symptomology. Of three hierarchical multiple regression models conducted, future-oriented spontaneous MW was only found to be a strong significant predictor of the symmetry/completeness dimension of OCD symptomology scores. Of the other two dimensions, temporality of spontaneous thought only increased the model for unacceptable thought OCD symptoms. Yet, this change could not be attributable to scores on either the past or future orientation of the IAMS (but was likely a combination of both). Therefore, we only found support for hypothesis two in one dimension of OCD symptoms, and support for the role of temporality in general in one other.

The Effect of Lockdown on OCD symptoms

Pandemics (such as covid-19 and SARS) are known to increase worry and 'over-reactivity' in the populations in which they occur (Hazma Shuja et al., 2020). In fact, the World Health Organisation identified the potential for the covid-19 pandemic to cause negative psychological effects and recommended that people minimise intake of pandemic-related content on TV, radio and the internet (WHO, 2020). At the time of data collection (7-28th May, 2020), just after a national lockdown (with a 'stay at home' order) lasting around seven weeks, the UK was experiencing the 'first wave' of the covid-19 (with > 20,000 total cases and > 3,000 deaths caused by covid-19). Travel and work restrictions associated with the national lockdown were eased on 10th May (for data, Desvars-Larrive, Dervic, Haug, Niederkrotenthaler, Chen, et al. 2020).

Within this context of high stress and hyper-vigilance, and with a message to wash hands regularly, it is not surprising that obsessive-compulsive symptoms, compared to general anxiety and depression, were found to selectively increase (and persist) in the UK (Loosen, Kvortsova and Hauser, 2000). Indeed, it has been suggested that UK government advice and the covid-19 pandemic have provided apt conditions for OCD symptoms to rise in the general population (Loosen, Kvortsova and Hauser, 2000; Shafran, Coughtrey, & Whittal, 2020). Thus, it is unsurprising that participants had a higher frequency of contamination-related thoughts (e.g., "About how much time have you spent each day thinking about contamination and engaging in washing or cleaning behaviours because of contamination?) than thoughts related to other OC symptoms (see Table 1). Direct comparisons with non-clinical groups in Seli and colleagues (2017) and Abramovic et al. (2010), demonstrated significantly higher scores for contamination symptoms in our study (one-sample *t*-tests were significant [*p*s < .001] using the means found in these studies, $M = 3.53$ and M = 2.50 for comparison against $M = 6.24$ in the current study).

In sum, we reason that the elevated values for the contamination sub-scale reflects a covid-19-related increase, affecting sensitivity of the DOCS when analysing the correlation between contamination OC and spontaneous MW, leading to the (unexpected) exception of spontaneous MW *not* predicting OCD symptoms. As found in Seli et al., (2017), we would expect spontaneous MW to predict variance in contamination OC symptoms, in this and future studies, in the absence of such a stressful ongoing situation.

The Role of Spontaneous MW in OCD symptomology

The common nature of spontaneous MW and obsessive-compulsive cognitions - both involving an inward turning of attention (i.e., to feelings, thoughts, images), and with the potential to arise without intent (Abramowitz et al., 2020; Seli, Risko, Purdon and Smilek, 2017) – was the rationale for expecting spontaneous, but not deliberate, MW to predict variance in trait OCD symptomology. Although greater precision was achieved by Seli and colleagues (2017) (with $N = 2636$, smaller confidence intervals), our results were highly convergent: three models including spontaneous MW (alone) as a predictor significantly predicted variance in OC symptoms. In contrast, zero-order bivariate correlations showed that deliberate MW invariably did not correlate with OC symptoms measured via the DOCS (Abramowitz, Deacon, Olatunji, Wheaton, Berman et al., 2010). Specifically, whereas an increase in spontaneous MW was associated with an increase in OC symptomology in a non-selected student and community sample, variation in levels of deliberate MW did not covary with OC symptomology in the current study (all *r*s considered low-small, -.02 - .18, Cohen, 1988).

The confirmation of this finding has both general and specific implications. Broadly, it strengthens the conceptual distinction between spontaneous and deliberate MW (Seli, Cheyne, Xu, Purdon, & Smilek, 2015; Seli, Risko & Smilek, 2016), which can be aligned with the well-

known distinction between system 1 and system 2 mental processes, respectively (Kahneman, 2011). Also, providing a direct and independent replication of Seli et al's (2017) finding, using the same measures, is important to a new area of investigation, and replications are considered a 'fundamental feature' of scientific endeavour, despite their supposed limitations (Zwaan et al., 2018)[11].

More precisely, our findings are potentially important in increasing theoretical understanding of the cognitive mechanisms in OC symptomology in subclinical and clinical OCD, especially considering that the DOCS has convergent validity with standard clinical measures of OCD (Abramovitch et al., 2010). It has been suggested that the reduced executive control associated with increases of MW underlies the increase in obsessional thoughts in OCD (Seli et al., 2017). In other words, the lack of cognitive control that allows high amounts of MW experiences to enter consciousness could similarly explain why people with OCD experience high frequency of (unwanted) obsessional thoughts. This explanation implies that people with OCD would have a general executive function deficit, but the literature is complex and inconsistent, with some studies showing no deficit in people with OCD (see Abramovitch, & Cooperman, 2015 for a review). The executive-deficit view of OCD is inconsistent with the prevailing neurobiological model of OCD (the 'frontostriatal' model, see Pauls, Abramovitch, Rauch, & Geller, 2014) which explains OCD as a hypervigilance toward potential threat, which over-activates, rather than under-activates, prefrontal circuits.

Alternative explanations of this data may propose a common third variable. For example, the tendency to experience mental imagery could explain the frequency with which MW and OC

[11] To facilitate future research in this area, such as meta-analyses, we provide details of our methods on the open science framework (link: DOI 10.17605/OSF.IO/E2KXP).

symptoms occur. Mental imagery is an important component of anxiety disorders such as OCD (Holmes & Matthews, 2010) and MW in healthy adults (Stawarczyk, Majerus, Maj, Van Der Linden, and D'Argembeau, 2011), and evidence suggests imagery-based versus verbal-based content has a specific role in emotional disruptions such as dysphoria (Ji, Holmes, MacLeod, & Murphy, 2019). Could spontaneous mental imagery have a key role in the development or maintenance of OC symptoms? One way to examine this hypothesis causally, however, would be to assess MW and OCD symptoms in patients with damage to areas of the brain associated with vivid imagery (e.g., Moro, Berlucchi, Lerch, Tomaiuolo, & Aglioti, 2008) or in those with aphantasia (a lack of mental imagery, Zeman et al., 2017). However, at present, this hypothesis requires development and is only tentatively suggested here to initiate further theoretical and empirical work. Nevertheless, the current data do not indicate a causal factor for OCD but instead implies a possible risk factor - a common third variable of vivid mental imagery[12].

The Role of Temporality of Thought in Spontaneous MW in OCD symptomology

The present data regarding temporality of spontaneous thought indicated that spontaneous future MW had a more limited, circumscribed relationship with OCD symptoms than would be expected by recent theories (Abed & DePauw, 1998; Miloyan, Bulley & Suddendorf, 2016; Raune, MacLeod & Holmes, 2005) and by our prediction that spontaneous future MW may explain the maintenance and cycle of OCD symptoms and behaviours. In particular, for symmetry/order OC symptoms, beta values clearly indicated the temporality effect was driven by a positive association between future spontaneous MW and the OC dimension. This is largely

[12] A further hypothesis is that both spontaneous MW and OCD symptomology share a common, third variable, such as dissociative absorption, which may indicate another risk factor in the emergence of full OCD (Soffer-Dudek, 2019). However, again, this hypotheses is mainly preliminary and future studies would be needed to support it.

consistent with Berntsen and colleagues' study (Study 4, Berntsen et al., 2015) whereby bivariate correlations with a well-used anxiety measure (GAD-7, Spitzer, Kroenke, Williams, & Löwe, 2006) showed that spontaneous future thinking correlated more strongly with anxiety than past spontaneous thought (*r*s = .30 versus .19).

As the relation between spontaneous future MW and OC symptoms was dependent on OC dimension, a more nuanced approach is required to explain the present findings. For instance, OC-related thoughts about the future can involve 'catastrophising' (Rachman, 1997), such as the aforementioned story of John (see *Introduction*) who experienced distressing mental images of a potential car crash. Based on current findings, the extent to which such spontaneous future MW experiences have a role in the four dimensions of OCD symptomology is unclear. It is possible, for example, that intrusive mental images of the future could be linked with incomplete behaviours in the symmetry/completeness component (e.g., not checking the door four times), thereafter leading to future catastrophizing (e.g., the house being robbed). Ultimately, due to the methodology herein, it is difficult to examine how the *content* of spontaneous thought relates to dimensions OCD symptomology. Qualitative studies and open-ended thought probes will likely uncover the nuanced relation between future-oriented MW and OCD.

Is Mind Wandering Inherently Bad?

In addition to providing the first evidence linking the temporality of MW with OCD symptoms, the present study adds further evidence indicating a 'dark side' to MW (see Killingsworth & Gilbert, 2010). Although there are clearly benefits of MW (see Smallwood & Schooler, 2015), this study shows how high frequencies of MW are associated can be associated with high levels of specific psychopathological symptoms (where intentional MW is not, see

Seli, Beaty, Marty-Dugas & Smilek, 2019). In short, by demonstrating a link between trait level MW and OCD symptoms, our study can be interpreted with a variety of recent studies showing links between spontaneous MW and other disorders such as ADHD, Post-traumatic stress disorder and depression (Seli et al., 2019), at least when tested in non-clinical populations. However, caution is needed before settling with the statement "a wandering mind is an unhappy mind" (Killingsworth & Gilbert, 2010, p. 932). Rather, we would advocate a functional approach to MW, whereby MW, especially in spontaneous forms, *generally* facilitates activation of current goals, which then activates goal-oriented behaviour (Klinger, 1971, Klinger, Marchetti, & Koster, 2018), but *in certain conditions* (e.g., when experiencing high negative affect), can elicit negative-self cognitions and reduce overall mood (Marchetti, Koster, Klinger, & Alloy, 2016; Klinger, Marchetti, & Koster, 2018).

Limitations

As a cross-sectional study, the data herein is limited by not offering a causal statement about the link between spontaneous thought and OC symptomology. In addition to approaches mentioned above, future work would benefit from using other designs to study this link, such as an AB/BA crossover design. As such, one could determine if decreases in spontaneous thought predict remission of OC symptoms, following an intervention which targets MW via mindfulness (Hawley, Rector, DaSilva, Laposa, & Richter, 2020).

There are also potential issues around the scales used in this study. First, it is possible that future-oriented spontaneous MW was positively correlated with spontaneous MW because it overlaps conceptually with MW construct in general. Indeed, we agree that there is overlap between these two constructs, as has been argued in Cole & Kvavilashvili (2019a) and based on *r* values in this study, *r*s = .14 - .50). However, *despite* this covariance, there is additional

explanatory variance added by future temporality in the symmetry subscale of the DOCS. These variables also displayed independence, as there was no evidence of multicollinearity (all VIF values < 5, with VIF >10 diagnostic of multicollinearity). By assessing the role of future-oriented spontaneous MW in additional variance explained (in a two-step regression model), and by recognising the covariance between independent variables, it can be concluded that we used a conservative test of hypothesis two. We therefore reason that the predictive validity of future-oriented spontaneous MW in symmetry OC symptoms represents a sufficiently robust finding.

The IAMI scale also warrants discussion. Specifically, whether involuntary past and future thinking can be classified as MW. Indeed, it has been stated that despite overlap between these phenomena, past and future involuntary thinking on the one hand and mind wandering on the other, should remain conceptually distinct (Berntsen, Rubin & Salgado, 2015, Berntsen, 2021). However, it is important to recognize some recent conceptual developments and differences in approach regarding MW and spontaneous thought. Recently, authors have considered MW an ‘umbrella term’ to incorporate, for example, unintentional and intentional thought (Smallwood & Schooler, 2015; Seli, Kane, Smallwood, Schacter, Maillet et al., 2018). Further, models of spontaneous thought contain different types of content, such as past and future oriented thought (Christoff, Irving, Fox, Spreng, Andrews-Hanna, 2016). For these reasons, we believe it is possible to conceptualise spontaneous past and future thought as within a partonomic hierarchy, with MW at the most general level, spontaneous MW/thought at the intermediate level and spontaneous MW about the future/past at the most specific level (see also Cole & Kavavilashvili, 2019a for similar arguments). Thus, we believe conceptualizing involuntary past and future thoughts under the broader category of spontaneous MW as a

reasonable method to examine the content of MW experiences, and their relation with OC symptoms.

Extending the discussion of measurement, within the scales used herein and design implemented (cross-sectional questionnaire-based study), it was impossible to elucidate the degree to which spontaneous past and future thoughts were about obsessional concerns. In future research it will be important to measure the temporal direction of the OC thoughts themselves, in subclinical and clinical groups.

Future Directions

Regardless of the precise mechanism underlying the existence of OC cognitions, due to the similarity between MW and OC thoughts, MW research may provide more precise and adaptable methodological techniques to understand the emergence and maintenance of OC symptoms (for an example using a self-caught method, see Kollárik, van den Hout, Heinzel, Hofer, Lieb et al., 2020). Indeed, research on MW has identified reliable ways of measuring spontaneous thoughts in the laboratory using cognitive tasks (Plimpton, Patel & Kvavilashvili, 2015), everyday experience sampling (Warden, Plimpton & Kvavilashvili, 2019), in addition to questionnaires (e.g., Mrazek, Phillips, Franklin, Broadway & Schooler, 2013). More specifically, recent work indicates that, similar to OC thoughts (see Rachman, 1997), MW experiences can be triggered by either external environment or internal thoughts/emotions (Plimpton, Patel & Kvavilashvili, 2015). A fruitful direction for research may therefore be to use methods from MW to disentangle externally- and internally- triggered obsessional thoughts.

Summary

In this study, we provided a direct, independent replication of a recent finding (Seli et al., 2017) that spontaneous, not deliberate, MW predicts OCD symptoms in a nonclinical sample.

Furthermore, in light of recent cognitive and evolutionary theory, and based on cognitive models of OCD, we posited that spontaneous MW experiences that were future-oriented would predict frequencies of OC symptoms, in addition to spontaneous MW, in general. Although only moderate support was found for this hypothesis, results highlight how the construct of temporality can add to our understanding of OC symptoms. Thus, in addition to increasing theoretical understanding of MW (e.g., conceptual distinctions between spontaneous and deliberate MW), the current study highlights for the first time the role or spontaneous future-oriented mind wandering in obsessive-compulsive tendencies thus opening new avenues for clinical research.

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Tables

Table 1

Descriptive statistics for the measures and subscales for Mind-Wandering, OCD symptomology and Past and Future-oriented Spontaneous Mind-wandering sub-scales.

Measure	Min	Max	Mean	SD	Skewness	Kurtosis	Cronbach's alpha
Mind-Wandering							
Mind-Wandering: Deliberate	4	28	3.89	1.51	-.028	-.642	.86
Mind-Wandering: Spontaneous	4	28	4.25	1.39	.045	-.359	.85
DOCS							
Contamination	0	17	6.24	3.63	.479	-.189	.81
Responsibility	0	17	4.78	3.71	.848	.739	.87
Unacceptable thoughts	0	15	5.12	4.55	.667	-.673	.93
Symmetry/Completeness	0	17	3.94	4.00	1.183	1.02	.92
IAMI							
Past	3	34	1.99	0.74	-.086	-.796	.92
Future	0	37	1.78	0.82	.042	-.502	.92

Note: Min and Max values all based on totals of items; Mind-Wandering measured using the Mind wandering scale; spontaneous and deliberate (Carriere, Seli & Smilek, 2013); DOCS (Dimensional Obsessive-Compulsive Scale, Abramowitz et al. (2010); Spontaneous past and future thoughts measured using the Involuntary Autobiographical Memory Inventory (Berntsen, Rubin & Salgado, 2015)

Table 2

Correlation Matrix: Pearson product-moment correlations between Mind-Wandering, OCD symptomology and Past and Future-oriented Spontaneous Mind-wandering sub-scales.

	2	**3**	**4**	**5**	**6**	**7**	**8**
1. Mind-Wandering: Deliberate	.39*	-.02	.15	.16	.18	.45*	.33**
2. Mind-Wandering: Spontaneous		.14	.43*	.50*	.36*	.57*	.55*
3. DOCS: Contamination			.45*	.30**	.40*	.17	.19
4. DOCS: Responsibility				.57*	.63*	.36*	.34*
5. DOCS: Unacceptable thoughts					.58*	.45*	.47*
6. DOCS: Symmetry/Completeness						.49*	.36*
7. Future-oriented IAMI							.80*
8. Past-oriented IAMI							-

* $p < .001$, ** $p < .05$

Table 3

Hierarchical multiple regression models examining the contribution of spontaneous mind-wandering and past and future-oriented spontaneous mind-wandering in OCD symptomology.

		Unstandardised coefficients		Standardised coefficients		Confidence intervals	
Step	Predictor	B	SE	β	t	Lower	Upper
	Dependent Variable: responsibility						
1	Spontaneous mind-wandering	1.15	.24	.43	4.76***	0.67	1.63
Model Statistics: [F(1, 100) = 22.63, p < .001], R^2 of .19							
2	Spontaneous mind-wandering	.87	.30	.33	2.91**	0.28	1.47
	Future-oriented IAMI	.05	.07	.10	0.64	-0.10	0.19
	Past-oriented IAMI	.04	.08	.08	0.55	-0.11	0.20
Model Statistics: [F(3, 98) = 8.39, p < .001], R^2 of .20							
	Dependent Variable: unacceptable thoughts						
1	Spontaneous mind-wandering	1.64	.28	.50	5.78***	1.08	2.20
Model Statistics: [F(1, 100) = 33.35, p < .001], R^2 of .25							
2	Spontaneous mind-wandering	1.07	.34	.33	3.14**	0.40	1.75
	Future-oriented IAMI	.05	.08	.09	0.60	-0.11	0.21
	Past-oriented IAMI	.14	.09	.22	1.55	-0.39	0.31
Model Statistics: [F(3, 98) = 14.59, p < .001], R^2 of .31							
	Dependent Variable: symmetry/completeness						
1	Spontaneous mind-wandering	1.04	.27	.36	3.86***	0.50	1.57
Model Statistics: [F(1,100) = 14.89, p < .001], R^2 of .13							
2	Spontaneous mind-wandering	.39	.31	.13	1.24	-0.23	1.00
	Future-oriented IAMI	.25	.07	.52	3.42**	0.12	0.40
	Past-oriented IAMI	-.07	.08	-.13	-0.88	-0.23	0.09
Model Statistics: [F(3, 98) = 11.26, P < .001], R^2 of .26							

*Note: * < .05, ** < .005, *** < .001*