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Where do our lonely minds wander?

Social mind-wandering in isolation

Psychology

Master's thesis

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Abstract

We experience ebbs and flows in our social environment, sometimes willingly and sometimes grudgingly. An interesting dimension of our social experience is our tendency to include other people in our spontaneous thoughts. Mind-wandering has been linked to well-being, but how changes in social environment affect social self-generated thoughts, and the role of individual well-being factors is still poorly understood. This study aimed to explore this. 136 MW reports from 18 participants were scored and analyzed in Study 1 during an isolation retreat before COVID-19 and another 177 from 43 self-isolated participants in Study 2 during COVID-19. Social content of the reports was scored by two independent raters. Need to belong, depression, and social loneliness were used as well-being predictors and the number of overall social interactions and the occurrence of familiar characters as independent variables in multiple regression models. Results from Study 1 suggested that participants reported accounting fewer familiar characters during isolation, but the overall social simulation rate wasn't affected by it. People feeling lonelier reported both fewer familiar characters and overall social simulations than less lonely participants. Interestingly, more depressed participants reported more familiar characters in reports. Regression models in Study 2 showed that higher depression scores predicted more social simulation and more familiar characters in mind-wandering during COVID-19 self-isolation. These results indicate that inner loneliness might predict social thoughts more than objective seclusion and that depression might have an interesting effect on our inner social experience.

Key words: Mind-wandering, Daydreaming, Isolation, Seclusion, COVID-19, Depression, Need to Belong, Loneliness.

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1 Introduction

1.1 Mind-wandering

You're working remotely from home and a song from one of your old playlists sparks a memory of that time you and your friend were at that party together and heard the song for the first time. Not having seen anyone for a few days, your mind effortlessly drifts to your other friends, and you wistfully wonder if they sometimes spontaneously think about you the same way. Then a message from your colleague popping on your screen makes you snap back into the present moment and realize your mind has wandered again. Our thoughts are often disconnected from the present moment. As much as half of the thoughts we have could be labeled as task-unrelated, and they occur during essentially everything we do (Killingsworth & Gilbert, 2010). Despite its universal nature, mind-wandering (MW) as a research topic hasn't achieved the same status as other universal phenomena of the psyche, such as sleep and dreaming. This could be due to the introspective quality and the challenges operationalizing of self-generated thought.

Definitive qualities of MW summarized by Smallwood and Schooler in their review (2015) are: 1) During MW, the external perceptual information is tuned out and attention shifts inwards; 2) the MW content comes from episodic and affective processes; and 3) executive control plays an important role in its regulation. "The average spontaneous thought is moderately visual, contains at least some sound, and is very likely (74% of reports) to contain some form of interior monolog or 'self-talk' (Fox et al., 2013, p. 4)." This study focuses on exploring why this monolog or self-talk involves other people.

While one's mind tends to wander on its own, there are situations, states and activities that can cultivate MW. According to research, these include hunger (Rummel & Nied, 2017), listening to sad music (Taruffi et al., 2017), poor sleep quality (Carciofo et al., 2014), reading difficult texts (Feng et al., 2013), reading aloud (Franklin et al., 2014), stickiness of thought (van Vugt et al., 2016), fear of failure during a task (Birnie et al., 2015) and low workload (Zhang & Kumada, 2017).

MW has attracted more interest in psychology and neurobiology since brain-imaging studies found that there is a neural network in the brain that seems to be active when we are not: The Default Mode Network (DMN) (Raichle et al., 2001). DMN could be described as a baseline state of the brain, and it has been closely linked to MW. A similar pattern is found in

dreaming, which has led to the comparison of these states and to the findings that they share many similar traits (e.g., Eeles et al., 2020). DMN shares neural basis with autobiographical memory, prospection, navigation, theory of mind and importantly: social cognition (Ruby et al., 2013; Yeshurun et al., 2021; Spreng et al., 2009; Schilbach et al., 2008). Yeshurun et al. (2021) proposed that DMN might be an active and dynamic sense-making system that integrates incoming external information with prior internal information, thus forming models of social situations depending on context. This would suggest that DMN makes establishing social networks possible, which is central to this study's primary question: how social environment and self-generated social cognition are connected.

There have been some suggestions for the purpose of MW based on different observed beneficial correlates. It has been suggested that MW may: attenuate boredom when engaging in a monotonous task by providing mental breaks (Smallwood & Schooler, 2014); facilitate creative problem solving (Smallwood et al., 2012; Preiss et al., 2016; Smith et al., 2022; Zedelius et al., 2021) – though not unanimously (Hao et al., 2015); strengthen goal striving via daydreams related to goal attainment (Langens, 2002); benefit behavioral change and achieving desired goals (Oettingen & Schwörer, 2013); benefit successful management of long-term goals (Smallwood et al., 2013); facilitate anticipation and planning of future events (Baird et al., 2011; Stawarczyk et al., 2011; Berntsen & Jacobsen, 2008); or connecting to this study, be a method of social problem solving and navigation (Ruby et al., 2013; Mildner & Tamir, 2021; Poerio et al., 2016b). The wide variety of these findings and theories suggest that MW may serve multiple purposes. Recently, it has also been suggested that differences in MW content and its relation to meta-cognition are critical in determining the functional outcome of the process (e.g., Smallwood & Schooler, 2014; Ruby et al., 2013; Mar et al., 2012; Zedelius et al., 2021). The connection between social and psychological correlates and MW content stands at the epicenter of interest in the current study, as we explore the effects that changing the social environment have on MW content.

1.1.1 Terminology

There is a myriad of at least partially overlapping terms used sometimes interchangeably in research to describe mind-wandering. The definitions of different varieties of the same state include "mind-wandering" (MW), "daydreaming" (DD), "unintentional thoughts", "unguided thoughts", "task-unrelated thoughts" (TUT), "stimulus-independent thoughts" (SIT), "self-generated thought" (SGT), "stimulus-independent and task-unrelated thoughts" (SITUTs) and

"meandering, unguided thought". This heterogeneity causes challenges to a unified approach to research MW, since these terms are defined slightly differently across the literature. However, it has recently been proposed that these different definitions should be seen as complimentary instead of competing (Seli et al., 2018), since phenomenology of MW itself is not of homogenous nature.

MW definitions can be too limiting or not limiting enough. Therefore, it might be more informative to use these terms to describe differentiated varieties of MW instead of trying to cover them all under a universal term. In this thesis, MW is used as the primary term describing the phenomenon and the context in which it's used is explicitly clarified. The term "social simulation" is used in accordance with the applied theoretical framework of Social Simulation Theory (Revonsuo et al., 2016) and stands for the cognitive modelling of social interactions during MW.

1.1.2 Voluntary vs. involuntary vs. instructed mind-wandering

MW was long studied as a homogeneous one-dimensional state of cognition, and the focus of interest was its disruptive effect on task performance. More recently it has been argued that involuntary and voluntary MW are distinguishable from each other. It seems, these two subtypes of MW are differentially connected to certain psychological traits and disorder symptomology (Vannucci & Chiorri, 2018; Seli et al., 2016; Seli et al., 2019; Mahmood et al., 2018), along with underlying mechanisms and neural correlates (Kane et al., 2012; Golchert et al., 2017).

In everyday life, the term "mind wandering" usually refers to inability to concentrate on the task at hand. Spontaneous, involuntary MW occurs when there is no current task that requires our attention or our ability to maintain our focus is enfeebled. Attention shifts from the external primary task to internal task-unrelated thoughts (Feng et al., 2013; Smallwood & Schooler, 2006). The negative outcomes of this involuntary type of MW have been well established: poorer working memory and sustained attention when negatively valenced (Banks et al., 2016); poorer performance in the response inhibition and working memory tasks (Kam & Handy, 2014); lower fluency and originality scores in creativity (Hao et al., 2015); reduced sensitivity to the physical discomfort of others (Kam et al., 2014); higher risk of crash when driving (Yanko & Spalek, 2014); and poorer comprehension of difficult texts (Feng et al., 2013). Spontaneous MW has also been associated with higher levels of ADHD (Seli et al.,

2015) and OCD (Mahmood et al., 2018) symptoms, which are known to be connected to executive cognitive control.

Intentionality of self-generated thoughts depends at least partially on cognitive control capability. In their study, Golchert et al. (2016) found that higher rates of deliberate MW correlated with a higher integration between the DMN and parts of the fronto-parietal network – a key area in control of cognition. The assumed role of cognitive control on MW is supported by the notions that alcohol consumption increases MW while decreasing the likelihood of noticing it (Sayette et al., 2009), and MW has a significant connection to working memory capacity (Kane & McVay, 2012; Kam & Handy, 2014). Compared to disruptive spontaneous MW, deliberate MW is less likely to have negative outcomes since its occurrence is dependent on executive function and can be voluntarily regulated. For example, disengaging from external perception probably has no significant negative effects for a bus passenger, but the risks are different for the driver.

Aging also seems to affect how the mind wanders. Most studies suggest that older individuals report less involuntary MW episodes (Jackson et al., 2013; McVay et al., 2013; Giambra, 2000; Moran et al., 2021), but some have stated, that the amount of involuntary MW doesn't differ amongst younger and older people, but the content and neural correlates do (Maillet et al., 2019). Relating to these differences, the relationship between voluntary and involuntary MW could be modulated by lifetime meditation experience (Hasenkamp et al., 2012).

Individual variance in spontaneous and deliberate MW might also be predicted by differential motivational dispositions of self-consciousness. Vannucci & Chiorri (2018) found that a subtype of self-focused attention "self-reflection" significantly predicted deliberate MW while "self-rumination" predicted spontaneous MW. Rumination can be defined as negatively evaluative and judgmental in nature with a passive dwelling on personal concern (Trapnell & Campbell, 1999), and it is strongly linked to depression. Seli et al. (2019) distinguished, that whereas unintentional MW is more likely to predict symptoms of depression, anxiety, and stress, intentional MW may protect against them. It is also noteworthy that people's reports on the intentionality of their MW in the laboratory correspond to their reports of the intentionality of MW in everyday life. (Seli et al., 2016).

1.1.3 Dreaming vs. daydreaming and the theoretical framework

When we spontaneously think of loved ones and their feelings or thoughts, do we do this to avoid loneliness, or do we perhaps prepare ourselves to face these people in the future? It is challenging to presume hypotheses on the relationship between social environment and MW content based on previous MW research alone. However, it can be beneficial to investigate theories from a more thoroughly studied process that some researchers have argued to have much in common with MW: dreaming during sleep.

Dreaming during sleep has been linked to MW as a more intense form of the same state. In both MW and dreaming, meta-content is mostly audio-visual and emotional, and it follows loose narratives with fantasy elements, it is strongly related to current concerns, it draws on long-term memory – and importantly it simulates social interactions (Fox et al., 2013). Both MW and dreaming also show similar activation DMN patterns in the brain alongside deactivation of executive regions in the prefrontal cortex, marked by reduced meta-awareness during these states (Fox et al., 2013). The key differences are found in the intensity of the processes: "dreams tend to be longer, more visual and immersive, and to more strongly recruit numerous key hubs of the DMN" (Fox et al., 2013, p. 1). Also, MW tends to have higher metacognitive content (Perogamvros et al., 2017). Cognitive effort has even been found to be higher in REM dreaming than in wakefulness, though thinking in general is more frequent in wakefulness than REM (Perogamvros et al., 2017).

When these states share much in common, it could be theorized that they might serve a somewhat comparable purpose. For example, *Continuity theory* (CT, Schredl & Hofmann, 2003) states, that rather than simulating the waking life, dreams reflect it, which is similar to the notion that MW content usually refers to current concerns. *Threat Simulation Theory* (TST, Revonsuo, 2000), on the other hand, suggests that simulating different threats in dreams has had an advantage in evolutionary context, resulting as a fundamental quality of human dreaming. This framework does not seem to fit completely with the findings on MW content, since a large proportion of the social interactions experienced during MW episodes are non-threatening. Analogous with TST is *The Social Simulation Theory* (SST, Revonsuo et al., 2016), that takes this inter-personal dimension of dreaming as the center focus of dreams. Based on recent findings and previous theoretical arguments, it considers dreaming to simulate social perception, interaction, and behavior during sleep (Revonsuo et al., 2016).

In the vein of TST, SST considers this type of simulation a benefit in the evolutionary context: During evolution, those who were more prepared to face different social situations in real life had stronger bonds with their community and therefore were more likely to survive and reproduce. Similarly, MW has been theorized to serve as means of social problem-solving and navigation (Ruby et al., 2013; Mildner & Tamir, 2021; Poerio et al., 2016b). SST provides three main hypotheses, that can be partially adapted to MW context: the Sociality Bias, the Strengthening Hypothesis (Revonsuo et al., 2016) and the Compensation Hypothesis (Tuominen et al., 2019). First, the Sociality Bias assumes that dreams should contain a biased amount of social content compared to waking life to serve a pro-social purpose. Second, the Strengthening Hypothesis predicts dreams to support existing social bonds by specifically simulating non-negative interactions with familiar characters. Third, these two are supplemented by the Compensation Hypothesis, which predicts that when social interactions in waking life decrease, dreams help to maintain social belonging.

Given their shared similarities, dreams and daydreams might share a mutual social function, in which simulation of human interactions could play an important role. In Study 1, the first and foremost point of interest was to explore the social functionality of MW by altering the social environment and consequently analysing MW content. Study 2 explored the relationship between mental well-being and the social contents of MW in a drastically changed social environment. Therefore, the SST with a modified version of the Social Content Scale (SCS, Tuominen et al., 2019) is the most suitable framework for the current study. This was supported by the literature on the MW function as described further.

1.2 Mind-wandering content and its functional correlates

The way we feel can affect what we think, but does this relationship work the other way around? In this study, change in the MW content is assumed to be a result of a drastic change in the social environment. However, the importance of this presumed effect is determined by the impact it has on people's lives. Previous studies have already shown significant support for the proposal that not only the quantity of MW predicts its effects, but crucially the quality as well. Therefore, studying the content more intricately (an approach called Content Regulation Hypothesis, Smallwood & Schooler, 2014) may be essential in determining how MW affects our lives, hence hinting the importance of the information this study has to offer. The study of MW has focused on three crucial dimensions of its content: affective, temporal, and social (Oettingen & Schwörer, 2013).

1.2.1 Affective content

A study conducted (N = 2250) via a smart phone application (Killingsworth & Gilbert, 2010) concluded that people's minds tended to wander more likely towards pleasant topics (42,5% of samples) than to unpleasant (26,5% of samples) or neutral topics (31%). Interestingly, this tendency did not correlate with consequent mood: participants were less happy when their minds wandered, regardless of the pleasantness of their MW content, than when they were focusing on the activity at hand, regardless of the pleasantness of the activity. This led the researchers to surmise that MW automatically leads to unhappiness (Killingsworth & Gilbert, 2010). Contradicting this conclusion, Welz et al. (2017) found that higher levels of MW in daily life predicted lower future negative affect, and the negative affect was lowest when MW content was most pleasant. Results of a study by Poerio et al. (2013) comparably suggest that MW per se is not associated with later mood and only predicts feeling worse if its content is negative.

Furthermore, Andrews-Hanna et al. (2013) found, that thoughts characterized as more negative and more personally significant were connected to higher depression and trait negative affect constructs, whereas thoughts characterized as more positive, less personally significant, and more specific were connected to constructs of improved well-being. Besides mood, negative emotional content was found to affect subsequent task performance by Banks et al. (2016). They found that negatively valenced MW but not positively valenced MW was related to poorer working memory and sustained attention.

It should also be noted that levels of clinical depression have been shown to affect MW and its contents, as rumination and sadness are key features of the disorder. For example, in a study by Hoffman et al. (2016) participants suffering from major depressive disorder engaged in more MW compared to healthy controls, and their MW content was primarily negative, more self-related and past-oriented. To avoid this factor influencing the results, levels of clinical depression were controlled in this study.

1.2.2 Temporal content

Humans have an exceptional capability to draw mental content from their memory and form possible future scenarios that have not yet taken place. This mental time travel is a key component of MW (e.g., Corballis, 2013) and it has even been proposed to be one of its potential purposes (e.g., Baird et al., 2011). When our mind wanders away from the environment to our

inner world, are some of our spontaneous thoughts “timeless” and what proportion time travels to the past or the future?

Many of the accounts on the temporal MW content seem to indicate, that it tends to be prospective in nature, and the future-oriented focus seems to be prominent between cultures (Smallwood & Schooler, 2014; Ruby et al., 2013). In laboratory setting, this bias has been shown to be moderated by the difficulty of the task (Smallwood & Schooler, 2014, Smallwood et al., 2009), qualities in personality (Kanske et al., 2017), prior mood (Stawarczyk et al., 2013), working memory capacity (Baird et al., 2011), connectivity between hippocampus and the DMN (Karapanagiotidis et al., 2017) and mental well-being (Shrimpton et al., 2017).

Berntsen & Jacobsen (2008) found in their study that spontaneous future event representations were as common as spontaneous autobiographical memories, but future oriented MW involved more positive and idyllic representations than past MW. These results indicate that the benefit – and possible function of MW might be, at least in part, anticipation and planning of future events (Baird et al., 2011; Stawarczyk et al., 2011; Berntsen & Jacobsen, 2008). However, contradicting the findings of MW’s prospective bias, Jackson et al. (2013) in their study found that an atemporal response option was used at least as frequently at least as often as retrospective or prospective options across self-reported and probe-caught MW. They argued this indicated that spontaneous thoughts often cannot be easily categorized as either past- or future-oriented, rather they are atemporal.

Whether mind wanders towards the past or the future may also have different correlates with well-being. Though Killingsworth & Gilbert (2010) argued that MW itself correlates with unhappiness regardless of content, other researchers have argued that this association is stronger with past-related thought. MW episodes about the past have been linked to consequent decrease in mood, even if the content is positive (e.g., Ruby et al., 2013). Poerio et al. (2013) found that prior sadness predicted retrospective MW and prior negative mood predicted MW to current concerns. Smallwood & O’Connor (2011) similarly connected unhappy mood to past-related MW: they found that inducing an unhappy mood was followed by an increase in past-related MW and the magnitude of this change increased with scores on measured symptoms of depression.

In a study by Ruby et al. (2013a) past- and other-related thought content was associated with consequent negative mood, even if the thoughts were positive in nature – while future- and self-related thoughts were associated with consequent positive mood, even if the content was

negative. Hall & Berntsen (2008) found that the frequency of involuntary and voluntary memories and future thoughts were similarly related to general measures of emotional distress, thus arguing that involuntary MW does not uniquely involve negative emotional affect.

1.2.3 Social content

Social thoughts are a substantial part of the mind-wandering experience, covering up to over 70% of the content (Song & Wang, 2012). Also, the quality of the social content has been found to be connected to multiple intra- and interpersonal functional outcomes, such as feeling lonely (Mar et al., 2012) or adapting to a new environment (Poerio et al., 2016b). Because this seems to be a universally human quality (not to mention that it spends a lot of precious energy in our brain), it stands to reason, that this process is not a mere coincidence – rather social MW may serve some functional purpose.

According to research, MW episodes tend to involve social others. For example, in a study by Mar et al. (2012), 21,5% of participants reported that they always daydream about social peers while 51,7% said they frequently do so, and only 0,8% reported that their daydreams were never social. Moreover, it appears that in addition to temporal focus of our thoughts, it is also who we dream about, that affects how we feel and behave accordingly (Ruby et al., 2013; Mar et al., 2012). Ruby et al. (2013) found that spontaneous thoughts about the past and social others were linked to subsequent negative mood and higher scores in BDI-depression index, even if the thought content itself was positive. By contrast, they also found thoughts about the future and self to correlate with an increase in mood, even if the content was negative. In their research, Andrews-Hanna et al. (2013) interestingly discovered that in addition to being social, self-generated thoughts were experienced in greater perceptual detail.

In their study, Mar et al. (2012) found that not only does the content of daydreams usually involve social others, but also that daydreaming about people not close to us predicted more loneliness and less perceived social support. By comparison, they found that daydreams about close ones (friends, family) predicted greater life satisfaction – suggesting that the social objects of MW content may moderate the relationship between MW and happiness. Similar result was found in a study by Poerio et al. (2016a), where daydreaming about significant others was found to be associated with substantial increase in feelings of connection, love and belonging compared to daydreaming about a non-social scenario or a doing a control task. In the same study it was also found that those who daydreamed about their significant others

behaved more pro-socially and expressed less of a desire to interact with others after daydreaming.

In another study by Poerio et al. (2016b), they found that social daydreams made the participants feel more socially connected and less lonely during a life transition (transition to a university) over a four-week period. The same research group compared reports of daydreams with social and non-social content and self-reported feelings before and after daydreaming (Poerio et al. 2015). They found that social but not non-social daydreams were associated with increased happiness, love and connection, regardless of the affective content of the thoughts. They suggested that "imagining close others may serve the current emotional needs of daydreamers by increasing positive feelings towards themselves and others" (Poerio et al., 2015, p. 135)

1.3 Mind-wandering in social context

1.3.1 Social isolation in research literature

"Social species, from Drosophila melanogaster (the fruit fly) to Homo sapiens, fare poorly when isolated (Cacioppo & Hawkley, 2009, p. 447)." Indeed, isolation is connected to numerous negative outcomes, but humans are so far the only known species that can attribute mental states of social others (Frith & Frith, 2003). The brain network active during MW, the DMN, shares regions with the neural network active in the Theory of Mind, such as the medial prefrontal cortex (Andrews-Hanna, 2012; Frith & Frith, 2003). Accordingly, most MW reports involve simulated social interactions and "mentalizing" – thinking about the thoughts and minds of others (Klinger, 2008 as cited by Fox et al., 2013). While the common fruit fly's well-being might deteriorate due to isolation, it (likely) does not reflect on the reasons for its loneliness or ponder about the thoughts of its social peers. Mentalizing spontaneous thought seems to be a uniquely human quality.

Perceived isolation, or loneliness, has been found to be associated with weakened overall cognitive performance, faster cognitive decline, weaker executive functioning, a self-protective but ultimately self-defeating confirmatory bias in social cognition, depressive cognition, increased sensitivity to social threats and heightened anthropomorphism (Cacioppo & Hawkley, 2009). And as described above, Poerio et al. (2016a, 2016b) have suggested that social MW content could be beneficial during loneliness and during a life transition. Yousaf et al. (2015) found loneliness to be a significant positive predictor of MW, while perceived social

support was a significant negative predictor of loneliness. Accordingly, Mar et al. (2012) found that MW about people not close to us was associated with more loneliness and less perceived social support, while MW about close others was associated with greater life satisfaction.

As COVID-19 restrictions have increased the risk of loneliness, if its negative consequences could be alleviated by regulating social self-generated thoughts, social MW content should be viewed as a vital and current research topic.

1.3.2 Social isolation and mental health during COVID-19

Experimental studies on social isolation have previously been understandably few and far between, since they require intensive ethical and methodological scrutiny. The unexpected opportunity to inspect the effects of social isolation arose, when World Health Organization declared COVID-19 outbreak a global pandemic on March 11, 2020 (www.who.int). Study 2's data comprises of MW reports from isolated individuals during COVID-19.

The virus quickly became known a fast-spreading global health threat, that could be effectively reduced by restricting social contacts, or "social distancing". Vast restrictions were ordered to prevent and slow down the spread, including limiting social gatherings and closing public services. The focus of public discourse initially centered around the spread of the disease and its damage to the physical health, but soon psychological effects of the pandemic and social isolation were also recognized as relevant health concerns.

MW reporting in Study 2 took place in April and May of 2020. This time in Finland was marked by vast nationwide changes and restrictions due to the spread of COVID-19: Schools, museums, libraries, recreational premises and other public and private services were closed, traveling within and across borders was limited, social gatherings of over 10 people were forbidden, visiting nursing homes was forbidden, intensive care units were close to their maximum capacity, and significant layoffs took place especially in the private sector (Safety Investigation Authority, Finland, 2021).

Finnish adults had approximately 2,5 meetings with other people per day in April of 2020, which was 75% less than previously recorded, and the MIELI ry crisis call service received 46% more contacts than the previous year (Safety Investigation Authority, Finland, 2021). Even if the world's response to the pandemic itself concerned physical health, these exceptional times were (and to some extent, still are) inarguably socially and mentally overwhelming for the majority of world's population.

Indeed, recent studies have suggested that the pandemic along with its numerous side effects is likely the cause of the recent surge in people's mental health issues, such as depression, anxiety, loneliness, and life satisfaction (Gao et al., 2020; Guo et al., 2020; Chen et al., 2021; Saraswathi et al., 2020; Lee et al., 2021; Ellis et al., 2020; Clair et al., 2021). It seems however, that the effects the pandemic has on people's well-being could be moderated by aspects of their social life, such as the use of social media (Gao et al., 2020; Ellis et al., 2020) or spending face-to-face time with close ones (Ellis et al., 2020), thus linking it to the current research topic. These unique social conditions served as the backdrop for Study 2's points of interest and provided a novel possibility to study how they were reflected in our inner social experience.

1.4 Aim of the study

1.4.1 The points of interest

Pondering the relationship between our social surroundings, well-being and our spontaneous thoughts has never felt quite as current as amidst recent globally shared experiences of social isolation. Mind-wandering (MW) research is still scarce and offers no clear answers to questions concerning these matters. This study aimed to address some of these questions by exploring mental well-being's relationship with the social content of spontaneous thought under two different seclusion conditions.

COVID-19 and the governmental response to the pandemic offered an incomparable opportunity to investigate people's social minds under exceptional circumstances of social seclusion. Study 1 included financially compensated volunteers participating willingly to a brief experimental retreat on an idyllic island with no actual risk of social exclusion over two years before COVID-19. In turn, Study 2 included participants, who were not voluntarily secluded as an experiment, but self-isolated at the beginning of the pandemic marked by strict social restrictions and societal uncertainty. These two groups of people experienced a similarly narrowed social world in wildly different contexts. Examining the results of these two study samples could provide important insight on how the human mind behaves when separated from the community.

The goal was to establish what happens to simulated social interactions during social seclusion (the variable "isolation" in Study 1), and how mental well-being predicts this. We explored this by measuring both the quantity and quality of these interactions during two

separate isolation periods: one during a social isolation retreat before COVID-19 (Study 1) and another during COVID-19 self-isolation (Study 2). Due to the scarcity of research in this subject, setting assumptions for the quality of connection between the mental well-being predictors (PHQ, UCLA-LSs, and NTB) and the independent variables (SS and FC) would have been precarious. We know very little of spontaneous social thought's relationship to loneliness, for example.

1.4.2 Hypotheses

Literature gives no clear theoretical or practical instances whether social thoughts react reflectively or compensatory to one's subjective solitude. However, Social Simulation Theory (Revonsuo et al., 2016) provides three main hypotheses, that can be partially adapted to MW context: the Sociality Bias, the Strengthening Hypothesis (Revonsuo et al., 2016) and the Compensation Hypothesis (Tuominen et al., 2019).

The assumptions of SST serve as a guideline in this study, though they are not all directly tested with the current data. In line with the Compensation Hypothesis and to some extent the Strengthening Hypothesis (data does not include information about the emotional valence of the MW content), Study 1 assumes that 1) seclusion period (Isolation) is reflected as an increase in the Social Simulation level (SS), and 2) seclusion period (Isolation) is reflected as an increase in the rate of familiar characters within MW reports (FC). Additionally, three secondary hypotheses concerning mental well-being's impact on the MW's social content are tested in Study 1: 3A) depression (PHQ), 3B) need to belong (NTB) and 3C) loneliness (UCLA-LSs) scores predict both SS and FC levels.

To see if during different isolation circumstances depression, need to belong or loneliness have a connection to self-generated social thought content, three hypotheses were tested in Study 2: 1A) depression (PHQ), 1B) need to belong (NTB) and 1C) loneliness (UCLA-LSs) scores predict both SS and FC levels.

2 Methods

2.1 Participants

2.1.1 Study 1

Data for Study 1 was gathered as a part of this study of a larger study conducted by (Tuominen et al., 2021) in the University of Turku, Finland. The purpose of the larger study as to explore the changes in dream content caused by changes in social environment. Recruiting was done through university mailing lists, that included students, staff, and alumni. The participation criteria included 18 years of age, no history of psychiatric or neurological illnesses, no sleep disorders, and no medication affecting the central nervous system. 20 Finnish nationals were selected to participate, but two of them cancelled. The final sample size was therefore 18, 13 of which were female and 5 male. Ages ranged from 20 to 54 (M = 30.28, SD = 8.40). The number of MW reports gathered from this sample was 136.

2.1.2 Study 2

Similar to Study 1, sample for Study 2 was gathered from another project Covid in Mind which explored the effects of COVID-19-related seclusion (Dream in Cosmos, 2021). Participants for this study were contacted via social media, e-mail lists and traditional media. Out of the 293 participants of the larger project (Dream in Cosmos, 2021), the selected sample for Study 2 consisted of 43 Finnish nationals based on their level of social interactions during a pandemic-related lockdown. Those not having social contacts (meeting people in person) the day preceding or on the day of the reporting were selected for this sample. Same criteria of no history of psychiatric or neurological illnesses, no sleep disorders, and no medication affecting the central nervous system were applied. Reporting MW and dream reports was done anonymously. The sample consisted of 39 cisgender female, two cisgender male, and 1 non-binary. Additionally, 1 participant did not report their gender. Ages ranged from 20 to 70 (M = 37.07, SD = 15.71). The number of MW reports for this sample gathered from the original 1281 raw data reports was 177.

2.2 Materials

2.2.1 Mind-wandering reporting

The chosen participants in both studies were asked to carry out their MW reports at a suitable time in the evening. They were asked to choose a peaceful non-social environment to execute the exercise and let their mind roam freely for 10 minutes (timer was recommended). After the exercise, participants were asked to write down everything they could remember from the MW episode as detailed as possible. Additionally, they were asked to specify in the text how the reported matters and characters were connected to their lives (e.g., "I thought about Jonathan [my brother], who asked me last week to drive him to Vantaa [where we grew up]"). The participants were also asked to transcribe hand-written reports into designated files online via safe connections. Participants had no access to each other's reports. All reports in both studies were in Finnish.

2.2.2 Content analysis

The social content of the MW reports was analyzed using a modified version of the Social Content Scale (SCS) (Tuominen et al., 2019) by two independent raters. SCS is designed to gather and analyze social content from written reports. From written social interactions, perceptions, or thoughts, SCS assorts initiating and recipient characters based on their relationship with the reporter, and the type, quality (valence), and tense of the simulated social event. Testing the applicability of the SCS on MW reports suggested certain modifications were required to effectively collect the crucial information for this study.

To examine more efficiently the quality of the social interaction or perception, subcategories of non-specific/vague positive and negative social interaction were also added to the scale. Other additions to the scale were the quality-related subcategories of mentalizing, the awareness and processing of thoughts and minds of others. Furthermore, mentions relating to the research setup were scored using an added category. Finally, a category of hypothetical/contrafactual quality of the social interaction was added to the SCS. All additions were not feasible to utilize in the final analyses because of the low frequencies due to limited sample sizes.

After the raters had independently combed the MW reports for social content and analyzed it using the modified version of SCS, the resulted scores were discussed and processed

between the raters to find an agreed interpretation of the social content. The final data used for analyses was processed and agreed upon by the raters.

2.2.3 Inter-rater agreement

The inter-rater agreement was assessed using free-marginal kappa. The kappa was calculated separately for the two specific points of interest in both studies: the rate of familiar characters (FC) in the reports and the overall number of social simulations (SS) in the reports. Kappa for the FC was calculated by assessing whether in the social events found by both raters involved familiar characters.

2.2.4 Well-being measures

2.2.4.1 Public Health Questionnaire 9

In both studies, level of depression symptoms was assessed using Public Health Questionnaire (PHQ-9, Kroenke & Spitzer, 2002). PHQ-9 is widely used for depression screening and consists of nine depression symptom related questions. Participants answer on a 4-point scale (not at all – every day) whether they've been bothered by the suggested experiences in the past two weeks, such as "Little interest or pleasure in doing things". The sum score between 0 and 27 points indicates five different levels of depressive symptoms: no symptoms (0 – 4), mild (5 – 9), moderate (10 – 14), moderately severe (15 – 19), and severe symptoms (20-27). For Study 1, the internal reliability (Cronbach's Alpha) was $\alpha = .726$, 95% CI [0.485, 0.881]. For Study 2, $\alpha = .852$, 95% CI [0.775, 0.910].

2.2.4.2 Need to Belong

In both studies the need to form and maintain interpersonal relationships was assessed using a Finnish version of the Need to belong -scale (NTB, Baumeister & Leary, 1995). The scale consists of 10 statements, such as "If other people don't seem to accept me, I don't let it bother me", that participants answer using a 1 – 5 Likert scale (not at all – extremely). Higher score on the 10 – 50 -point scale suggests higher need to belong. For Study 1, the internal reliability (Cronbach's Alpha) was $\alpha = .863$, 95% CI [0.745, 0.941]. For Study 2, $\alpha = .827$, 95% CI [0.739, 0.895].

2.2.4.3 UCLA Loneliness Scale (Social)

In both studies, the level of experienced social loneliness was measured using the revised UCLA (University of California Los Angeles) Loneliness Scale's Social subscale (Russell et al., 1980). The translated Finnish version UCLA Loneliness Scale consists of 12 statements concerning social experience, such as "no one really knows me well". The first six items measure social loneliness, and the latter six emotional loneliness. Participants rate each item from one of four choices: "Never", "Rarely", "Sometimes" or "Often" that are scored from 1 to 4 points. The maximum total sum score for the 12-item scale is 48, and 24 for the Social subscale. The scores for positive items (e.g. "I have a lot in common with the people around me") are reversed, so that the answer "Never" would score as 4. Higher scores on the Social subscale indicate higher levels of experienced social loneliness. For Study 1, the internal reliability (Cronbach's Alpha) was $\alpha = .689$, 95% CI [0.397, 0.867]. For Study 2, $\alpha = .863$, 95% CI [0.788, 0.918].

2.3 Procedure

2.3.1 Study 1

The MW reporting took place between April and October 2017. The duration of MW reporting in total was two weeks for each participant, including three days in home environment, five retreat days on the almost uninhabited island of Seili in the Archipelago of Turku, Finland, and seven days after the retreat. Participants were divided into two groups that went on the retreat separately. First retreat took place from September 18th to 22nd, 2017, and the second from October 16th to 20th, 2017. The five-day island retreat included a three-day social seclusion period (the variable "Isolation") during which the participants were to avoid social contacts. They were deprived of cellphones and other devices enabling social contact for these three days. On the day of arriving and the day of departing they were allowed to socialize freely. On the island, two researchers were present to carry out the study for the whole five-day period. Participants were accommodated in single rooms and served food three times a day without a contact. All necessary communication between the participants and the researchers was done via a hand-written notebook during the seclusion period. After the end of the seclusion period, all participants completed a questionnaire concerning their seclusion and the experience was debriefed. A 150 € compensation was given to all participants for taking part in the study.

2.3.2 Study 2

From the larger study sample (Dream in Cosmos, 2021), participants for Study 2 were matched with the demographic qualities of Study 1's sample. 43 participants were selected as a socially secluded sample. They completed the same well-being questionnaires as the participants in Study 1 and were similarly instructed to report their MW exercises. Each MW exercise was reported on separate days and required not having social contacts (meeting people in person) the day preceding or on the day of the reporting. However, they were not restricted from using their phones, other devices or social media. The number of returned reports varied from 1 to 12 per participant. Reporting took place in April and May of 2020.

2.3.3 Data diagnostics and analytic strategies

To explore the connection between seclusion, mental health, and social MW according to hypotheses, multiple linear regression analyses were conducted. The target independent variables were the frequency of social simulation (SS) during MW and the prevalence ratio of familiar characters within social simulation (FC). SS is simply the number of separate mentally simulated social interactions concerning others, such as "I thought about people from work" or "I wonder how many children live in my building". Self-mentalizing and nature-focused scores were subtracted from overall scores per report as non-social. FC ratio was calculated by subtracting the number of unknown characters and characters known only by role from the number of familiar characters. Thus, a positive FC statistic stands for individual report containing more familiar vs. unfamiliar characters and vice versa. Zero stands for an equal number of both types.

The predictor variables in Study 1 were the individual participant identification code (ID), the three-day seclusion period (Isolation, 0=baseline and 1=seclusion), loneliness (UCLA-LSs), the need to belong (NTB) and depression (PHQ-9). The predictor variables in Study 2 were the individual participant identification code (ID), loneliness (UCLA-LSs), the need to belong (NTB) and depression (PHQ-9). Participant ID variable was included in the analyses to monitor whether individual differences outside the well-being measures or isolation circumstance affected the target variables SS and FC. Hierarchical regression was used to determine which predictors to include in the final regression models: All predictor variables were systematically entered to the regression model to see how they predicted the variance of

the target variables FC and SS. Variables that had no significant predicting power were removed from the final linear regression models and those that did were included.

In Study 1, three MW reports were removed from the data as significant FC outliers, and a logarithmic transformation was used for social simulation level variable. In Study 2's data, one report was removed as a significant FC outlier and a square root transformation was performed for both SS and FC.

2.3.4 Ethical aspects

Study 1 had the approval of Turku University Ethical Review Board prior to the data collection. All participants were informed of the complete research procedure, the chance to discontinue their participation at any given time and were instructed to name an emergency contact for the seclusion period of the study in case of an urgent need or situation. Two researchers were present and available on the island in case of emergencies, canceling participation, or for other crucial issues. Briefings and debriefings were conducted at the beginning and at the end of the seclusion in small groups, and a licensed psychologist performed an interview to all participants. No participant reported any negative consequences caused by the study nor discontinued their participation during or after the seclusion.

Study II contained no personal information on the respondents and was conducted according to the TENK research ethical principles. Participants were informed on the research procedure and contributed to the study voluntarily. Participants were screened for pre-existing psychiatric or medical conditions that might affect their participation.

MW reports were scored by individual raters who had no personal connection to the participants. All electronic data was kept classified behind multiple passwords and was not accessible to participants or other individuals. Though the reports contained some names mentioned by the respondents, raters scored the data without access to personal information of the participants in Study 1. Study 2 contained no personal information on the respondents.

Both studies use the term "cisgender" for those participants who reported their gender as either male or female, and "non-binary" for those who identified themselves as other than male or female. An option of not reporting one's gender was also provided.

3 Results

3.1 Descriptive statistics and correlations

Descriptive statistics of both study samples' age and predictor variables depression (PHQ), Need to Belong (NTB) and loneliness (UCLA-LSs) are presented in Table 1. In both studies, these questionnaires were administered at the beginning of the study, and therefore are not reported separately for Study 1's two measuring points.

Table 1

Descriptive statistics of the participants' age and predictor variables in studies 1 & 2

	Study 1 (N = 18)			Study 2 (N = 43)		
	M	SD	Range	M	SD	Range
Age	30.28	8.40	20 – 54	37.07	15.53	20 – 70
PHQ	4.09	2.85	0 – 10	7.68	5.25	0 – 22
NTB	28.30	6.99	11 – 37	31.00	6.87	18 – 46
UCLA-LSs	11.81	2.55	7 – 18	13.45	4.21	6 – 22

Note. PHQ = Public Health Questionnaire depression score, NTB = Need to Belong score, UCLA-LSs = UCLA Loneliness Scale Social Score

Table 2 presents descriptive statistics of the target variables SS and FC at Study 1's both measuring points and in Study 2.

Table 2

Descriptive statistics of the participants' target variables SS and FC in Studies 1 & 2

	Study 1: Baseline (N = 18)			Study 1: Isolation (N = 18)			Study 2 (N = 43)		
	M	SD	Range	M	SD	Range	M	SD	Range
SS	4.11	3.17	0 – 14	3.75	3.11	0 – 17	5.47	4.38	0 – 22
FC	0.37	2.41	-8 – 7	-0.45	2.07	-7 – 6	-.24	4.41	-14 – 10

Note. Baseline = reporting in home environment before the island retreat period, Isolation = the three-day seclusion period during the island retreat, SS = The number of simulated social interactions in MW reports, FC = Familiar character ratio in MW reports

Pearson correlations in Studies 1 and 2 are presented in Tables 3 and 4.

Table 3

Pearson correlations for predictor and target variables in Study 1, N = 132

	PHQ	UCLA-LSs	NTB	SS	FC
PHQ	1				
UCLA-LSs	.455**	1			
NTB	.344**	.090	1		
SS	-.147	-.214*	.046	1	
FC	.133	-.105	.050	.112	1

Note. PHQ = Public Health Questionnaire depression score, NTB = Need to Belong score, UCLA-LSs = UCLA Loneliness Scale Social Score, SS = The number of simulated social interactions in MW reports, FC = Familiar character ratio in MW reports. * Correlation is significant at the .05 level (2-tailed), ** Correlation is significant at the .01 level (2-tailed).

PHQ had significant correlation with UCLA-LSs and NTB, and UCLA-LSs also correlated with SS.

Table 4

Pearson correlations for predictor and target variables in Study 2, N = 174

	PHQ	UCLA-LSs	NTB	SS	FC
PHQ	1				
UCLA-LSs	.271**	1			
NTB	.185*	.015	1		
SS	.185*	-.019	-.025	1	
FC	-.262**	.050	.012	-.181*	1

Note. PHQ = Public Health Questionnaire depression score, NTB = Need to Belong score, UCLA-LSs = UCLA Loneliness Scale Social Score, SS = The number of simulated social interactions in MW reports, FC = Familiar character ratio in MW reports. * Correlation is significant at the .05 level (2-tailed), ** Correlation is significant at the .01 level (2-tailed).

As indicated in Table 4, PHQ had significant correlation with UCLA-LSs, NTB, SS and FC. FC and SS also correlated negatively

Multicollinearity wasn't an issue for most of the regression models since they did not include the correlating predictors. However, as depression understandably correlates with

loneliness, it is more difficult to differentiate their individual impact in Study 1's second regression model with FC as the independent variable.

3.2 Inter-rater agreement

The free-marginal kappa indicated that the agreement on familiar characters rate (FC) was excellent (Fleiss et al., 2013) in both studies. In Study 1, the free-marginal kappa was 0.94, 95% CI [0.91, 0.97], while percent overall agreement was 96.98%. For Study 2, the free-marginal kappa was 0.92, 95% CI [0.90, 0.95], while percent overall agreement was 96.19%. For the overall number of social simulations (SS) in the reports, the kappa was intermediate: In Study 1, free-marginal kappa was 0.52, 95% CI [0.45, 0.60], while percent overall agreement was 76.20%. In Study 2, kappa was 0.54, 95% CI [0.49, 0.59], while percent overall agreement was 77.09%. Agreement statistics are presented in Table 5.

Table 1

The inter-rater agreement in studies 1 and 2

	Study 1		Study 2	
	FC	SS	FC	SS
Free-marginal kappa	0.94	0.52	0.92	0.54
Explanation	Excellent	Intermediate	Excellent	Intermediate
95% CI	[0.91, 0.97]	[0.45, 0.60]	[0.90, 0.95]	[0.49, 0.59]
Overall agreement	96.98%	76.20%	96.19%	77.09%.

Note. SS = The number of simulated social interactions in MW reports, FC = Familiar character ratio in MW reports.

3.3 Statistical results

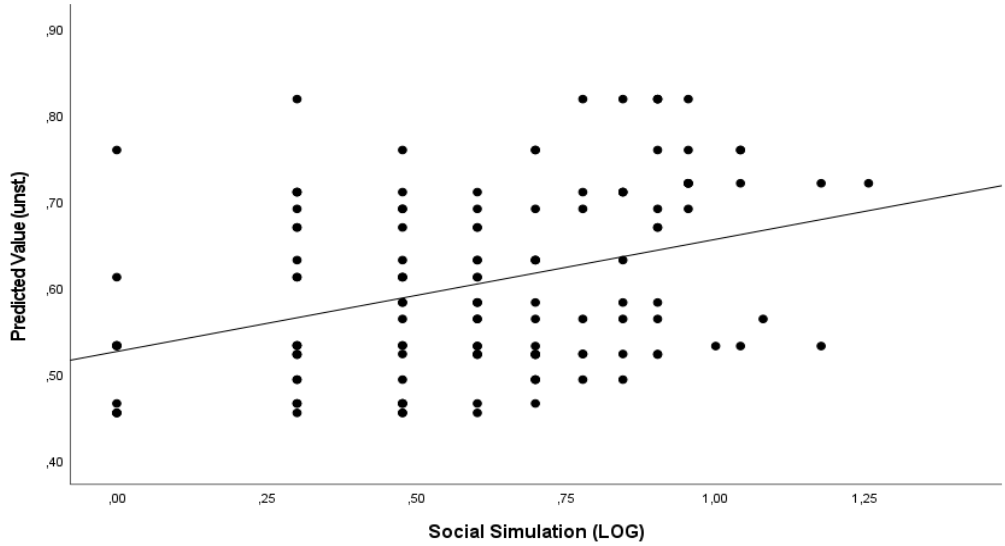
In Study 1, hierarchical regression revealed, that of all predictor variables (ID, Isolation, PHQ, UCLA-LSs and NTB), ID (B = .010) and UCLA-LSs scores (B = -.039) emerged as significant ($p < .001$) predictors of social simulation level (SS). The final model with ID and UCLA-LSs as predictors for SS did not support the first hypothesis derived from Social Simulation Theory's Compensation hypothesis, that isolation would result in an increase of social simulation.

However, in line with the secondary (3C) hypothesis, that loneliness would affect the social simulation level, ID and UCLA social loneliness scores predicted SS, B = .894, 95% CI

[.673, 1.116], p < .001. The model's adjusted R^2 was .116, and F (2, 129) = 9.621, p < .001. Kolmogorov-Smirnov test indicates that the model's residuals were normally distributed, D (132) = .072, p = 0.086. The model is represented in Figure 1.

Figure 1

Study 1's multiple linear regression model with Social Simulation as the dependent variable

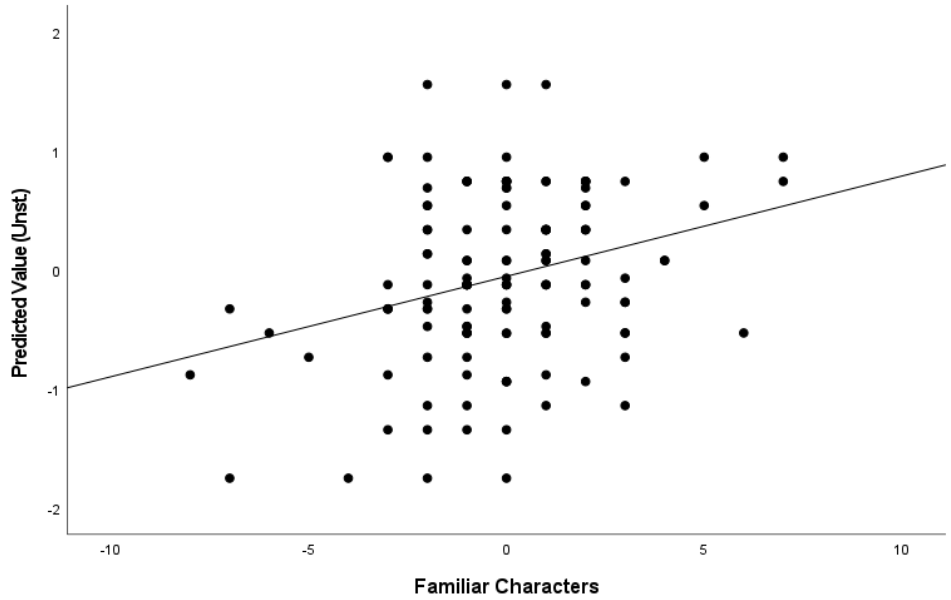


Note. Y-axis: unstandardized predicted values by the model with ID and UCLA social loneliness score as predictors; X-axis: dependent variable, logarithm transformed social simulation score.

For Study 1's final model with the ratio of familiar vs. unknown characters (FC) as the dependent variable, Isolation (B = -.868), UCLA (B = -.203), and PHQ (B = .203) emerged as significant (p < .05) predictors after all predictor variables were entered in hierarchical regression. This model predicted FC, B = 1.963, 95% CI [-.035, 3.960], p = .054. Adjusted R^2 for this model was .063, and F (3, 128) = 3.924, p < .05. Kolmogorov-Smirnov test indicates that the model's residuals were normally distributed, D (132) = .069, p = 0.200. This model did not support the first primary hypothesis (1) of isolation increasing the number of self-generated thoughts of familiar characters, since the relationship was interestingly negative. However, supporting the second primary (2) and secondary (3A & 3C) hypotheses, depression and loneliness predicted the ratio of familiar characters in the MW reports. This model is represented in Figure 2.

Figure 2

Study 1's multiple linear regression model with Familiar Characters as the dependent variable

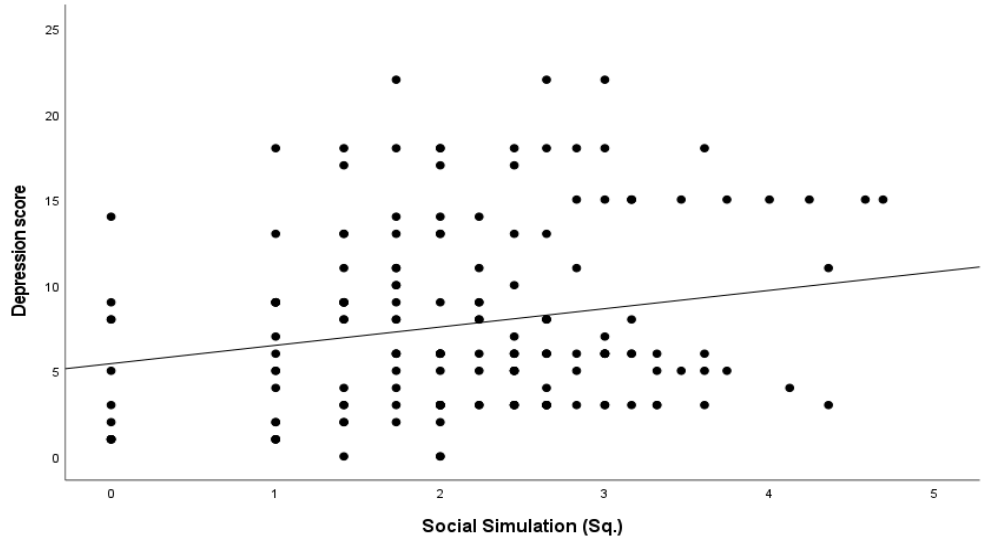


Note. Y-axis: unstandardized predicted values by the model with Isolation, UCLA social loneliness scores and PHQ depression scores as predictors; X-axis: dependent variable, familiar characters ratio.

All predictor variables were entered in the hierarchical regression models with SS as the dependent variable, and only PHQ scores (B = .040) emerged as a significant ($p < .01$) predictor. PHQ scores predicted SS, B = 1.821, 95% CI [1 .560, 2.081], $p < .001$. The model's adjusted R^2 was .036, and F (1, 172) = 7.414, p = .007. Kolmogorov-Smirnov test indicates that the model's residuals were normally distributed, D (174) = .048, p = 0.200. This model supported the first primary (1A) hypothesis of Study 2, that depression level affects the level of social simulation during self-isolation. This model is represented in Figure 3.

Figure 3

Study 2's multiple linear regression model with Social Simulation score as the dependent variable

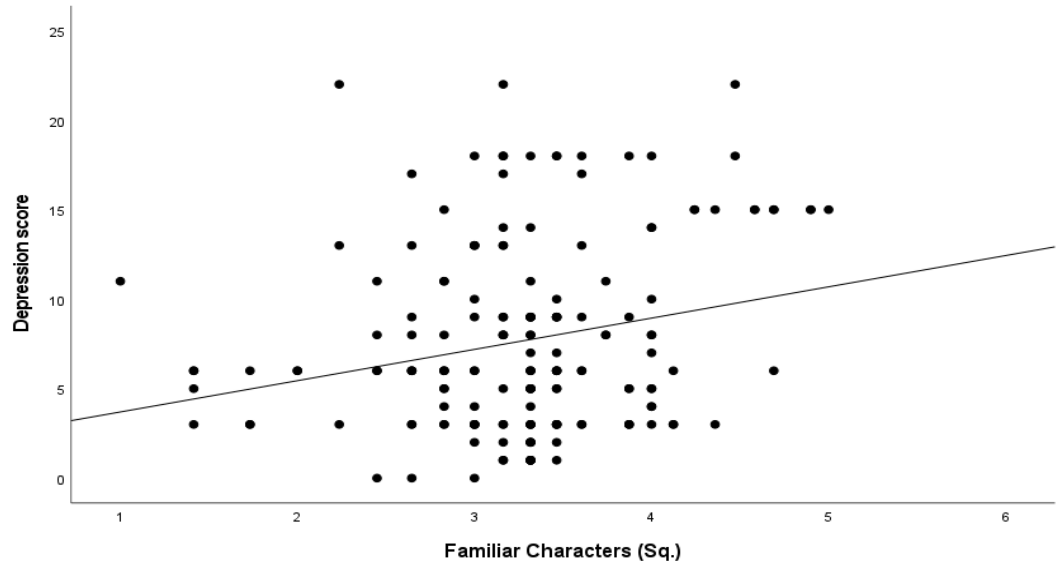


Note. Y-axis: PHQ depression score; X-axis: dependent variable, square root transformed Social Simulation score.

Similarly supporting the primary hypothesis (1A) that depression predicts the number of familiar characters, in Study 2's final model with FC as the dependent variable, PHQ (B = .030) emerged as a significant (p = .002) predictor. The model predicted FC, B = 3.050, 95% CI [2.872, 3.229], p < .001. The model's adjusted R^2 was .047, and $F(1, 172) = 9.534$, p = .002. Kolmogorov-Smirnov test indicates that the model's residuals were normally distributed, D(174) = .067, p = 0.053. This model is represented in Figure 4.

Figure 4

Study 2's multiple linear regression model with Familiar Characters as the dependent variable



Note. Y-axis: PHQ depression score; X-axis: dependent variable, familiar characters ratio.

4 Discussion

This study aimed to explore mental well-being's relationship on the social content of mind-wandering (MW) in two different seclusion conditions: one before COVID-19 at an island retreat with a three-day seclusion period (Study 1) and one during COVID-19 social restrictions and self-isolation (Study 2). Social Simulation Theory for dreams (SST, Revonsuo et al., 2016) served as a theoretical guideline. The primary points of interest were "what happens to simulated social interactions during social seclusion, and how mental well-being predicts this?" Two primary hypotheses were adapted from the assumptions of SST in Study 1: "Three-day social seclusion period increases both 1) the level of social mind-wandering and 2) the number of familiar characters within these thoughts". Three additional secondary hypotheses concerned individual well-being predictors: 3A) depression, 3B) need to belong and 3C) loneliness predict both target variables. These three hypotheses were also tested under different circumstances in Study 2.

4.1 Interpretations and implications

In Study 1, results of the first regression model indicated that lower levels of social loneliness predicted more social mind-wandering (MW), supporting a secondary hypothesis (3C) of loneliness affecting the number of social self-generated thoughts. Since isolation did not predict changes in the level of social simulation, the primary hypothesis (1) of social MW's "compensating" effect was not supported. In this setting, one's inner experience of seclusion seemed to represent itself in spontaneous thoughts more than objective solitude. Yousaf et al. (2015) found that perceived social support is a significant negative predictor of loneliness, which reversely relates to results presented above. UCLA Social Loneliness Scale's items, such as "there are people who really understand me" or "there are people I can turn to" measure this type of perceived support. According to these results, they are reflected as fewer social representations in one's spontaneous thoughts. The result of the variable ID predicting SS suggests that there were individual differences outside used measures affecting the target variable. For example, one person might have been able to remember the contents of their MW episode in more detail than the next, and therefore consistently reported more social interactions.

The results of the second regression model indicated that in isolation, participants reported fewer familiar characters during isolation than during baseline reporting. This finding

did not support the second primary hypothesis (2), that assumed an opposite effect. However, those who reported lower UCLA-LSs scores reported accounting more familiar characters, supporting a secondary hypothesis (3C) of loneliness level predicting the number of familiar characters within MW. One possible explanation could be that when isolated, people with an experience of a strong social network also mentally maintain their social life without conscious effort. This could alleviate the negative effects of objective loneliness, which is in line with previous research that has found people both lonely *and* isolated to be most vulnerable to psychological distress (Menec et al., 2020). This possible explanation would also be in line with the Compensation Hypothesis of SST (Tuominen et al., 2019) which assumes that when social interactions in waking life decrease, dreams – or in this case, daydreams – help to maintain social belonging. Interestingly by comparison, fewer social simulations have been found to occur in dreams during seclusion (Tuominen et al., 2022).

It may also be that social environment simply reflects into the inner experience, thus not having contact with close ones represents as less familiar social thought content. This could suggest that social daydreaming is a continuation of one's waking experiences, similar to the Continuity Theory in dreams (Schredl & Hofmann, 2003). It may also be that an unfamiliar environment and an exceptional situation shifted participants' mental focal point detaching them from their daily social lives. Since we do not know what resulting effect maintaining familiar characters within MW had on well-being during seclusion, these explanations are hypothetical. Researching the actual causality of these relationships remains a curiosity for future research.

Interestingly, the second regression model in Study 1 also revealed that participants with higher depression scores accounted more familiar characters in their MW reports (3A). There are a few possible explanations for depression's somewhat surprising relationship with familiar characters in these findings. Benefits of including familiar people in mind-wandering have been suggested by Poerio et al. (2016b). They found that participants asked to daydream about their significant others after induced loneliness reported heightened feelings of connection, love and belonging compared to those with non-social daydreams or control participants. Depression is often connected with experienced distance between oneself and others (e. g. Achterbergh et al., 2020), which makes current findings raise the question: could those with higher levels of depression subconsciously or knowingly utilize a socially compensating mental strategy when isolated or was this finding a mere coincidence caused by the limitations of the study?

There is another possible explanation for this finding. Although each social interaction within the MW reports was scored as either neutral, positive or negative based on the description's wording or an interpretation by the raters, these scores provided frequencies too weak to reliably utilize in analyses. In other words, based on this small sample, we cannot realistically assume that keeping loved ones in mind would be positive in affect or have positive effects on one's secluded experience. Rumination is a key element in depression, so depressed individuals might have the unfortunate tendency to brood on the social distance between them and their close ones. It should be noted also that participants were screened before taking part in the study and no clinical levels of depression were present. These are hypothetical explanations, and the question why (or if) depression symptoms truly affect the number of familiar characters in isolated people's spontaneous thoughts could be truly answered only by different research setting and a larger study sample. A suggestion is provided further.

In Study 2's both regression models, only depression predicted the level of both social simulation and familiar characters. This supported the hypotheses (1A) assuming that depression affects both the overall social simulation level and the number of familiar characters. Hypotheses of loneliness or need to belong affecting these target variables were not supported by the evidence. Depression's effect was in line with Study 1's second model's results, and as described above, it seems intuitively contradictory to known effects, such as proneness to withdraw from social connections and therefore worsening depression's negative effects (Achterbergh et al., 2020). One possible explanation might relate to Study 2's setting: It might be that during COVID-19 related self-isolation, more depressed people are in an exceptionally similar situation with non-depressed people and therefore the effects on mental social simulation are smaller. It could also be that imagining social interactions with familiar and non-familiar characters is used as a compensating strategy that aims to alleviate the negative effects of seclusion, as considered above. These conclusions cannot, however, be drawn without a more robust data.

In Study 2, the lack of predicting power of social loneliness on SS or FC is thought-provoking. It could be that this effect in real world is simply exceedingly small or non-existing despite the findings of Study 1. A more declamatory explanation could be that by forcing more people to face the same lonely circumstances, pandemic-related self-isolation reduces this effect. A third possible explanation is that utilizing other, non-controlled means of social communication, such as social media or phones had a significant impact on the relationship between loneliness and social thought content.

Any of the models in Studies 1 and 2 did not support the hypothesis of Need to Belong (NTB) affecting the level of social simulation or familiar characters. Though it has been argued that "human beings are fundamentally and pervasively motivated […] by a strong desire to form and maintain enduring interpersonal attachments" (Baumeister & Leary, 1995, p. 522), those with a stronger NTB showed no significant difference in social thought contents to those with a lower NTB in current results. Whether this reflects reality, meaning that people experience social simulation in a similar manner regardless of their need to belong, or that there is a connection beyond the reach of the current research design remains to be explored by future research.

Due to the scarcity of strong theories concerning the relationship between the environment and contents of self-generated thought, the Social Simulation Theory (SST, Revonsuo et al., 2016) was applied from dream research as the study's theoretical framework. This was based on the findings of dreams and daydreams sharing numerous similar features (Fox et al., 2013), and the assumption that they might therefore also share a similar function. Directly testing all three main hypotheses of SST – the Sociality Bias, the Strengthening Hypothesis and the Compensation Hypothesis – was not feasible due to the limitations of the MW data. The results presented and discussed above either do not clearly show effects assumed by the SST or partially contradict the theory's hypotheses. Therefore, this study does not strongly support the dream theory translating well to daydream context. It may be, that dreams and daydreams react differently to seclusion, or this study did not have tools sharp enough to measure the similarities. It's likely dreams and daydreams share many parallels that are beyond the scope of this research setting. It's also possible that a study designed particularly to test all three hypotheses of SST with a stronger sample size might yield different results.

4.2 Limitations and suggestions for future research

Results presented and discussed above should be interpreted acknowledging the constraints of this study, the first and foremost being small sample sizes. Though the final number of scored MW reports was closer to a strong sample, the number of participants (Study 1: N = 18, Study 2: N = 43) meant that individual differences between participants were challenging to control entirely. Replicating the study conditions and analyses with larger samples might produce new or different interesting connections between well-being and social MW content. It should also be noted that even though regression behavioral studies seldom yield powerful effect sizes, R^2 in these analyses was fairly low.

Scoring the reports is a challenging task prone to human error. Although the SCS and the version modified for the current study were tested and found to be sufficiently objective, subjectivity cannot be entirely removed from the equation. The challenge in the operationalizing of freely written reports of people's thoughts was presented in the process of inter-rater agreement. There are as many ways to write a MW report as there are those writing them. Reports reflect not only their writers' objective thoughts but also linguistic skills, motivational aspects and socially desirability bias even if the instructions were specifically aimed at reducing these differences. The challenge is to convey instructions neither too vaguely or too explicitly, so the responses are honest and specific, but also the effect of individual writing styles is reduced. When people are urged to practice MW, it's also important to reflect whether the resulting state is of voluntary or involuntary type.

In the current study, while engaging in a MW episode was instructed, the moment of engaging was voluntary. On one hand, participants could choose when they started the MW episode, but on the other hand, the instructional nature of the task reduced the individual agency and possibly shaped the thought narrative. But because participants were not in any way instructed on what to think about during MW task or when to do it, we might argue that the MW episodes were more deliberate or task-related than spontaneous or task-unrelated.

It should also be noted that the lower level of agreement between the raters in the number of social simulations is somewhat misleading. It can be attributed to the challenge to recognize the situations that the raters *did not* interpret as social. Were it feasible to quantify this information and add to the calculation, the kappa would likely be higher. There was no disagreement on the final data between the two raters when addressing the scores, and that consensus was reached in both studies.

The effects well-being had on the social thought content was most consistent with depression scores that predicted higher levels of both SS and FC in three out of four models across both studies. Depression levels seemed to have a curious effect on social simulation. Depression's decreasing effects on one's social life did not seem to necessarily carry into one's inner experience. It would have been curious to compare the two datasets more, but the lack of comparable baselines made this unrealistic. There is no certain approach to rule out some pandemic-related effect this setting has on the results. Were these preliminary findings to be replicated with larger study samples, they could give a new insight into how the human mind automatically or deliberately navigates through mood and social life. Since this study excluded

higher levels of depression and other well-being variables, further research into clinical samples could broaden these findings.

To achieve a deeper understanding of mental well-being's connection to people's social minds, a three-phase study could be conducted in participants' home environment. If the research were to concentrate solely on mind-wandering, limitations of sleep and dream measures such as the limited number of the brain imaging equipment used in Study 1 would not apply, and therefore gathering a larger sample could be more straightforward. Participants should be financially compensated at least for the isolation phase, but without an expensive island retreat and research personnel's costs during the isolation, budget could still stay at a moderate level.

Participants would live out their normal daily lives the first phase (a week for example) to set a baseline, socially self-isolate (including means of electronic communication) the second phase and return to their daily lives in the third phase. For the isolation period, participants would receive some communication tools, such as simple phones, that they could use in case of emergencies or other urgent issues, but the use of these devices would be monitored remotely. The other possibility is to let the participants keep their smart devices, but have their activity monitored. The apparent challenge would be to monitor the actual isolation safely and ethically, but a simple easily breakable tape seal on the door or a movement sensor could indicate the person has left their apartment during the seclusion period. MW reporting would take place twice a day for the whole duration increasing the number of reports and lowering the impact of individual sessions on report content, such as not remembering the MW content or feeling more tired in the evening.

In this scenario, trait-level depression, anxiety, and other mental disorder symptoms should mostly represent the larger population, though people with clinical symptom levels should not be included, for isolation might dangerously worsen their well-being. The depression and other mental health screenings should take place during each of the three phases to see whether state-level symptoms are affected by the isolation. With this more robust data, it could be analyzed if more severe depression symptoms or other mental health factors result in differences in social mind-wandering and if mentally maintaining social relationships could protect against the negative effects of objective loneliness. To mitigate the subjectivity of the raters scoring the data, three raters could score the reports. Scores that at least two of the raters agree upon, would be included in the final data. The study setting should be designed with the

co-operation of the ethical board of the university to ensure the safety and well-being of participants.

5 Conclusions

Research presented here has dived into a previously uninhabited territory of isolation, well-being, and one's inner social experience. The two conducted studies aimed to explore the connection social environment and its changes have on spontaneous social thoughts, and how this relationship is shaped by mental health. The results from Study 1 indicate that objective and subjective loneliness can make inner spontaneous social experience less active. Interestingly, depression seems to have an inverse effect. This effect was also present in Study 2 indicating that during COVID-19 related self-isolation, people suffering from depression symptoms seem to instinctively maintain their inner social experience. These results suggest that depression symptoms might have an unintuitive effect on one's inner sense of community. The findings are preliminary, but they could offer a sense of direction for future mind-wandering and seclusion studies. Results presented here could be enforced or further elaborated by sharpening the thought content analysis tools, enlarging sample sizes, and utilizing ethical experimental settings. Inarguably, the relationship between our outer and inner social worlds remains a fascinating research frontier, occupied by questions and possibilities for clinical and academic implications.

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