Daydreaming style moderates the relation between working memory and mind wandering: Integrating two hypotheses[1]

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Abstract

Mind wandering—mentation unrelated to one's current activity and surroundings—is a ubiquitous phenomenon, but seemingly competing ideas have been proposed regarding its relation to executive cognitive processes. The control-failure hypothesis postulates that executive processes prevent mind wandering, whereas the global availability hypothesis proposes that mind wandering requires executive resources and thus an excess of such resources enables mind wandering. Here we examined whether these hypotheses could be reconciled by considering the moderating influence of daydreaming style. We expected that executive resources would be positively related to mind wandering in those who typically experience positive mind wandering mentation, but negatively related in those who typically experience negative mentation. One-hundred-eleven participants reported mind wandering over 4 days using experience sampling and completed the Sustained Attention to Response Task (SART), the Symmetry Span task, and the Stroop task. There was a significant interaction between working memory and negative, but not positive, daydreaming style on mind wandering: working memory related positively to mind wandering in those with a low negative style, but negatively in those with a high negative style. In contrast, poor Stroop performance significantly predicted increased mind wandering, but only in those with a low positive style. SART responses did not predict mind wandering although the relation was suggestively enhanced as the difficulty of daily-life activities increased, indicating that the SART is more generalizable to high-demanding than low-demanding activities. These results suggest that the content and context of mind wandering episodes play important roles in the relation between executive processes and mind wandering.

Keywords: mind wandering, working memory, daydreaming styles, Stroop, experience-sampling

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Human beings spend up to half of their waking life thinking about matters unrelated to their current activity (Killingsworth & Gilbert, 2010). Engaging in thoughts or images unrelated to one's current activity is known as mind wandering and is closely related to the construct of daydreaming (Klinger, 2009; Smallwood & Schooler, 2006). Mind wandering may impair performance on ongoing tasks (Randall, Oswald, & Beier, 2014), but it also serves positive functions such as allowing the mind to engage in more stimulating experiences than those provided by the current surroundings and keeping personal goals fresh in the mind (Klinger, 1971, 1990, 2013). People may therefore be inclined to inhibit or initiate mind wandering depending on the content and context.

Mind Wandering and Executive Control Processes

Two seemingly competing hypotheses on how individual abilities in shifting, updating, and inhibiting thoughts and actions (executive processes) may underlie tendencies to mind wander have been proposed. According to the *control-failure* hypothesis, mind wandering is interpreted as a form of attentional lapse more likely to occur in individuals with low executive resources (McVay & Kane, 2010). In contrast, the *global availability* hypothesis proposes that mind wandering requires executive resources and that a surplus of such resources should be associated with more frequent mind wandering (Smallwood, 2010). Numerous studies have supported each of these accounts: In support of the control-failure hypothesis, a meta-analytic review showed a weak but significant negative correlation between mind wandering and performance on attentional control tasks such as the color-word Stroop test (Randall et al., 2014). On the other hand, in support of the global availability hypothesis, multiple studies have shown that mind wandering decreases when executive demands are high (Levinson, Smallwood, & Davidson, 2012; Teasdale et al., 1995) and that brain regions associated with executive networks are activated during mind wandering without awareness (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). It has been suggested that the two hypotheses can be reconciled by considering the *context* of the task at hand and the *content* of mind wandering mentation when evaluating the relation between executive processes and mind wandering (Smallwood & Andrews-Hanna, 2013), and that the two original hypotheses focus on two related but separate questions (Smallwood, 2013): the control-failure hypothesis addresses the occurrences of mind wandering episodes (*why* they occur), whereas the global availability hypothesis addresses the processes involved in mind wandering episodes (*how* they operate). We next consider these recent theoretical suggestions.

The *context-regulation* hypothesis proposes that individuals constrain the frequency of mind wandering so as to reduce the risk of impairing performance on the ongoing task (Smallwood & Andrews-Hanna, 2013). This may help explain why seemingly contradictory results have been found when assessing the relations between mind wandering and working memory—a set of cognitive systems that temporarily store and operate on information necessary for complex cognitive tasks and which are thought to be essential to executive functioning (Baddeley, 1992; Kane & Engle, 2003). Several studies have found negative correlations between working memory and mind wandering when the latter has been measured in seemingly high-demanding task contexts (McVay & Kane, 2009, 2012a, 2012b; Mrazek et al., 2012; Unsworth, Brewer, & Spillers, 2012; Unsworth & McMillan, 2014; Unsworth, McMillan, Brewer, & Spillers, 2012) whereas a positive relation has been found when mind wandering has been measured in seemingly low-demanding tasks (Levinson et al., 2012). Null correlations between working memory capacity and mind wandering have been observed in other studies, including one that measured mind wandering during a vigilance task (McVay & Kane, 2012a), one that used diary recordings of mind wandering during chores and other seemingly low-demanding activities (Unsworth, McMillan et al., 2012) and another, most relevant to our study, that measured mind wandering during daily life using experiential-sampling (Kane et al., 2007). Consistent with the context-regulation hypothesis, a recent study found that working memory capacity significantly predicted *changes* in mind wandering frequency from a less demanding to a more demanding working memory condition (Rummel & Boywitt, 2014). However, in their meta-analysis, Randall et al. (2014) did not find support for the proposal that task complexity moderates the relation between mind wandering and executive resources. This suggests to us that if executive resources play a crucial role in mind wandering the relation between these processes is probably moderated by variables other than task difficulty, such as the content of the mentation.

The *content-regulation* hypothesis proposes that individuals with an adaptive processing style maximize self-generated thoughts (including mind wandering) with content associated with productive outcomes for one's well-being (e.g., planning one's future) and minimize mentation content associated with unproductive outcomes (e.g., ruminating about one's unhappiness; Andrews-Hanna, Smallwood, & Spreng, 2014; Smallwood & Andrews-Hanna, 2013). Insofar as mind wandering about the future and the self helps individuals to prepare for goal-relevant future events or enhance subsequent mood (Ruby, Smallwood, Engen, & Singer, 2013; cf., Smallwood & O'Connor, 2011), individuals with superior executive resources may use those resources to maintain future-oriented mentation when task demands allow it (Baird, Smallwood, & Schooler, 2011; Bernhardt et al., 2014; Smallwood, Ruby, & Singer, 2013). In support of this hypothesis, Baird et al. found that mind wandering about the future correlated positively with working memory capacity. In contrast, a re-analysis of two independent studies with larger sample sizes failed to replicate this result, finding zero-to-weakly-negative correlations between mind wandering about the future and working memory capacity (McVay, Unsworth, McMillan, & Kane, 2013). However, the absence of a relation in these studies is still arguably consistent with the context-regulation hypothesis insofar as the tasks measuring mind wandering were high-demanding tasks in which mind wandering could plausibly impair task performance. In addition to the purported moderating role of future-oriented content, a yet unexplored possibility is that the relation between working memory and mind wandering may depend on an individual's tendency to engage in mind wandering episodes that are positive in content and avoid those that are negative.

Daydreaming Styles: Positive and Negative Content

The content of mind wandering can cover a broad spectrum of affective content and range from a vivid image of one's pleasant upcoming summer vacation to worrying about failing a loved one. Previous research suggests that variability in the content of mind wandering can be understood in terms of three distinct daydreaming styles (Huba, Singer, Aneshensel, & Antrobus, 1982): *positive-constructive*, *guilt/fear-of-failure*, and *poor attentional control*. Positive-constructive daydreaming typically consists of future-oriented and problem-solving thoughts that involve vivid visual and auditory imagery and which the daydreamer considers worthwhile and pleasant. The guilt/fear-of-failure style, on the other hand, consists of hostile and achievement-oriented daydreams, with guilt, fear-of-failure, and frightened reactions to the content of the episode. The poor attentional control style refers to reports of having difficulty maintaining concentration on the current activity and drifting away from it, or being easily bored or distracted by one's surroundings.

As individuals vary in their affective response towards their mind wandering episodes, from deeming them pleasant to disturbing, some people may be more inclined to engage in mind wandering than others. For instance, in a study in which participants were asked to suppress thoughts about a past romantic relationship, the frequency of probe-caught thoughts of that relationship was positively related to the desire to reconcile with the partner (Baird, Smallwood, Fishman, Mrazek, & Schooler, 2013). People may also differ in their efficiency at inhibiting mind wandering. For instance, the ability to deliberately suppress unwanted thoughts, assessed with the “white bear paradigm,” in which people are asked not to think of a white bear (Wegner, Schneider, Carter, & White, 1987), correlates with working memory capacity (Brewin & Beaton, 2002). In light of these different lines of research—and Smallwood’s (2013) suggestion to reconcile the control-failure and global availability hypotheses by distinguishing between occurrences and processes—we expected the following: Individuals who interpret their mind wandering episodes in a positive manner would tend to use executive resources to *allow* mind wandering to occur and to prolong the duration of the mind wandering process by shielding it from interfering stimuli in the external world (the global availability hypothesis), whereas those who deem their mind wandering episodes negative would tend to use their executive resources to *prevent* mind wandering from occurring (the control-failure hypothesis).

Measures of Executive Resources: Complex Span and Stroop

Executive resources are diverse and consist of highly related but distinct functions (Miyake et al., 2000). Studies on executive processes and mind wandering have mainly used complex span tasks to measure working memory, which primarily taps information updating and monitoring, or the Stroop task, which primarily measures inhibition of prepotent responses. A latent variable analysis indicated that complex span measures loaded on a latent working memory factor, whereas Stroop performance loaded on another latent variable termed attention control, but both were highly correlated and each predicted individual differences in mind wandering (McVay & Kane, 2012b).

When considering the relation between Stroop performance and mind wandering, it is important to consider the proportions of different trial types. The Stroop task in the McVay and Kane (2012b) study included 75% congruent and 25% incongruent stimuli. Several studies have shown that the proportion of congruent trials influences responses with slower RTs on incongruent trials presented in blocks with mostly congruent stimuli compared to blocks with mostly incongruent stimuli (e.g., Grandjean et al., 2012). According to the *dual mechanisms of control model* (De Pisapia & Braver, 2006), individuals may use two different control strategies depending on the relative frequency of conflict: a *reactive* control strategy in which control is transiently activated when infrequent conflict is detected, or a *proactive* strategy in which control is activated in a sustained and preparatory way to manage frequent conflict. They further proposed that reactive control operates by suppressing task-irrelevant information whereas proactive control operates by priming task-relevant information. Several studies have supported the proposition that proactive control is mainly used in Stroop blocks with mostly incongruent stimuli whereas reactive control is mainly used in Stroop blocks with mostly congruent stimuli (De Pisapia & Braver, 2006; Grandjean et al., 2012; West & Bailey, 2012, but see Kane & Engle, 2003). Thomson, Besner, and Smilek (2013) found that mind wandering was more frequent in 100% congruent than 100% incongruent blocks. However, such pure-block designs do not distinguish between effects at the trial- and block-level and thus it remains unknown how the Stroop congruency effect at the trial-level relates to mind wandering in daily life when the congruency proportion varies from low to high.

Mind Wandering in Daily Life and in the Laboratory

If the regulation of mind wandering is sensitive to the context of the ongoing task, the generalizability of mind wandering during particular laboratory tests to everyday life requires further scrutiny. For instance, mind wandering may be automatically activated by surrounding circumstances related to personal concerns (Klinger, 2009; McVay & Kane, 2010), such as a song prompting mentation about a certain relationship. It is difficult to capture these circumstances in the laboratory, but they can be studied using experience-sampling methodology (ESM, e.g., Kane et al., 2007; Song & Wang, 2012), in which participants are probed at random periods regarding their ongoing mentation. ESM research has replicated a number of findings from laboratory research to daily life, such as the association between mind wandering and poor task performance (McVay, Kane, & Kwapil, 2009). The most widely used measure of mind wandering in the laboratory is the *Sustained Attention to Response Task* (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997), a signal detection task in which participants are required to respond to frequent non-target digits but withhold responses to infrequent target ones. One study found that subjective reports of mind wandering during daily life, as measured by ESM, was predicted by subjective, but not behavioral, indices of mind wandering during the SART (McVay et al., 2009) even though both indices typically correlate with one another (McVay & Kane, 2009, 2012a, 2012b; McVay, Meier, Touron, & Kane, 2013; Hu, He, & Xu, 2012, but see also Marchetti, Koster, & de Raedt, 2012). Thus, there seems to be important, but poorly understood, discrepancies between mind wandering in daily life and during the SART.

Previous attempts to assess the relation between mind wandering in daily life and the laboratory may be limited because they focused on singular measures in the lab that might also measure constructs other than mind wandering. For instance, a frequent measure of mind wandering in the laboratory, failures to withhold response to SART targets (commissions), has been proposed to be confounded by impulsive responding or speed–accuracy tradeoffs (Helton, Kern, & Walker, 2009, but see also Seli, Jonker, Cheyne, & Smilek, 2013). However, multiple studies have found moderate to strong inter-correlations between four behavioral SART indices of mind wandering, including commissions, extremely fast responses to non-targets, omissions to non-targets, and RT variability to non-targets (Cheyne, Solman, Carriere, & Smilek, 2009; Hu et al., 2012; Marcusson-Clavertz, Terhune, & Cardeña, 2012). Because subjective reports of mind wandering generally correlate with these behavioral indices, one valuable way of incorporating these measures would be a composite SART index that could more reliably measure individual differences in sustained attention.

Despite the repetitive nature and relatively low complexity of the SART (Randall et al., 2014), it appears to be a moderately concentration-demanding task as it usually induces a substantial amount of errors (e.g., 32% commissions [Hu et al., 2012]). Mind wandering during the SART or other moderately challenging tasks may be accounted for by control-failure to restrict attention to the ongoing task (McVay & Kane, 2010), but it is less plausible that cognitive resources should be prioritized to maintain task-focus when the tasks are low-demanding and not engaging, such as doing the dishes or taking out the trash (Smallwood, 2010). Therefore, if individuals regulate mind wandering depending on the context of the ongoing activity so as to minimize errors on the ongoing task (Smallwood & Andrews-Hanna, 2013), mind wandering during the moderately demanding SART may only generalize to daily-life activities that are similarly demanding.

Aims and Hypotheses

Our study had two broad goals pertaining to the role of content and contextual factors in mind wandering: To examine whether daydreaming style moderates the relation between executive control capacities and mind wandering in daily life, and to investigate the ecological validity of mind wandering laboratory tasks. Based on the content-regulation hypothesis and the finding that working memory capacity relates to efficiency in suppression of unwanted thoughts (Brewin & Beaton, 2002), we expected that the content of daydreaming styles would moderate the relation between working memory and mind wandering. Specifically, for individuals whose daydreams typically pertain to *guilt/fear-of-failure* and/or rarely are *positive-constructive,* we expected that working memory capacity would relate negatively to mind wandering. In contrast, for individuals whose daydreams rarely concern guilt/fear-of-failure and/or typically contain positive-constructive content, we predicted that working memory capacity would be positively related to mind wandering. We also tested whether similar interactions with daydreaming styles could be found with inhibition (as measured by the Stroop) and sustained attention (as measured by the SART), given their relations to working memory capacity and involvement of executive components (e.g., Kane & Engle, 2003; McVay & Kane, 2012b).

Pertaining to the second goal, we expected that an index of sustained attention in the laboratory would predict mind wandering in daily life. The SART is frequently administered when researchers are interested in evaluating mind wandering in the laboratory (Randall et al., 2014) and it is therefore of importance to understand its generalizability to mind wandering in other contexts. Behavioral and subjective measures of sustained attention to the SART were aggregated to form a more reliable laboratory index. We expected that it would predict mind wandering, as assessed by ESM. Insofar as mind wandering regulation depends on the context of the task, specifically the demands of the activity, it is plausible that the SART index and probe-reports of task-unrelated thoughts may only generalize to certain levels of concentration-demanding activities. Because the SART demands at least moderate levels of concentration, we expected that the SART index would be positively related to mind wandering during daily-life activities that require higher levels concentration.

Method

Participants

One-hundred-eleven students from Lund University participated in this study (41 males and 70 females, age ranging from 18 to 41 years old, $M = 24.75$, $SD = 4.62$). Most participants were undergraduate students and the first author, a Swede doctoral student, interacted with them. The study was approved by the local ethics review board and every volunteer provided written informed consent and received two cinema tickets as compensation.

Materials

The **Sustained Attention to Response Task** (SART; Robertson et al., 1997) is a go/no-go task in which participants are asked to respond with button presses to each digit between 0 and 9 (non-targets) except for the digit 3 (target) for which they are asked to withhold responses. Each digit was presented for 500ms followed by an inter-stimulus interval (blank screen) for 2000ms. Responses were registered from the onset of each stimulus and 2000ms forward. Previous research suggests that a long inter-stimulus-interval is more conducive to mind wandering (Smallwood et al., 2004). We inserted intermittent thought probes which required participants to respond with a button press to two questions about their experience immediately prior to the probe with three response options given for each question: 1) Whether they were thinking about the task, their own performance, or other things; and 2) whether their focus was oriented towards the past, present, or future.

The task contained 20 targets, 20 probes and 440 non-targets divided in blocks. Participants were exposed to 20 blocks with 9 non-targets and 1 target or probe; 8 blocks with 19 non-targets and 1 target or probe; and 6 blocks with 18 non-targets and 1 target and 1 probe. We varied the frequencies of targets and probes across blocks to reduce predictability. Trials were randomly ordered within each block and there were no breaks between blocks. The randomization of blocks operated across two cycles so that the first and second halves of the task were composed of an equal distribution of block types. A practice block was administered before the task (2 targets, 2 probes, and 16 non-targets). Participants were told that the task measured sustained attention and had to respond through key presses on a Cedrus response box, RB-730 (Cedrus Corporation, San Pedro, CA). They were instructed to use the index finger of their preferred hand and give equal weight to accuracy and speed of response. They sat approximately 60cm from the monitor. Digits were shown in Arial font (72 point size, 640 × 480 resolution) on a 19" monitor. Stimulus presentation and data collection were administered with E-Prime v. 2 (Psychological Software Tools, Pittsburgh, PA).

The **automated Symmetry Span** (SSPAN; Redick et al., 2012; Unsworth, Heitz, Schrock, & Engle, 2005) measures working memory capacity. It requires participants to switch between a symmetry task and a spatial memory task. For each trial in this version, the SSPAN first presented a figure of black and white squares and participants were required to judge whether or not it was symmetric. Next, a 4 × 4 grid with 1 red square was shown for 650ms, and participants were instructed to remember the spatial location of the red square; at the end of each block (2, 3, 4, or 5 trials) they were required to recall the spatial sequence of the red squares within the block. There were three blocks with each trial number, amounting to 12 blocks in total. The experimental task was preceded by three practice sessions (symmetry only, spatial only, both) and RTs on the symmetry practice served as baseline for the experimental task. Trials in which the symmetry response exceeded $M + 2.5SDs$ of the practice RT were coded as errors. Participants were told that the task measured the ability to store memories while simultaneously performing a symmetry task. To minimize the risk that participants neglected the symmetry part of the task, the computer instructions stated that over 15% symmetry errors would render the data invalid. Feedback on accuracy of symmetry and spatial memory was presented after each block. Participants responded on a computer mouse with their preferred hand and sat approximately 60cm from the monitor. E-prime v. 2 was used to implement stimulus presentation and data collection. The outcome measure in this study was the total number of correctly recalled squares (partial scores). Redick et al. (2012) found that partial scores showed better reliability than absolute scores (which include hits from only completely recalled blocks). We estimated reliability by summing the scores up for each block size (2, 3, 4, and 5) and computing the internal reliability of these set of scores ($\alpha = .70$).

In the **Color-Word Stroop Test** (Stroop, 1935) participants are required to identify the color of printed words but avoid reading the word themselves. This version involved three color words, RÖD [RED], GRÖN [GREEN], and BLÅ [BLUE], which were presented in any of three colors (red, green, blue). Congruent trials contain a word whose semantic meaning matches the color it is written in (e.g., the word RED written in red color). Incongruent trials contain a word that does not match with the color it is written in (e.g., RED written in blue color). Participants identified the color each word was written in by pressing the response box button with the corresponding color. Each trial began with a black fixation cross at the center of the screen (1000ms). A word was then shown in 18" Arial font (5000ms or until a response was registered), followed by a blank screen (1000ms). Each participant completed two versions of the test in which the proportion of congruent trials was manipulated: In the high congruency-proportion each block contained 25% incongruent trials and 75% congruent trials whereas in the low congruency proportion each block contained 75% incongruent trials and 25% congruent trials. Each version of the task was divided in 8 blocks of 24 randomly ordered trials each. Participants were instructed to not squint their eyes or gaze away from the center of the screen as that would qualify as cheating and to give equal weight to accuracy and speed of response.

The **Short Imaginal Processes Inventory** (SIPI; Huba et al., 1982) is a self-report measure of daydreaming tendencies. It consists of three subscales: *Positive-constructive* daydreaming (e.g., vivid imagery, positive reactions, and future-orientation), *guilt/fear-of-failure* (e.g., frightened reactions, hostile, and achievement-oriented), and *poor attentional control* (distractibility, mind wandering, and susceptibility to boredom). The SIPI has shown good psychometric properties (Huba et al., 1982), including moderately high test-retest reliability over a month (Tanaka & Huba, 1985–1986). We used a Swedish version (backtranslated), which exhibited adequate reliability in this study (positive-constructive: α = .77; guilt/fear-of-failure: α = .73; poor attentional control: α = .86).

The **Experience Sampling Program** (Barrett & Barrett, 2005) was used to sample individual mentation in daily life through personal digital assistants (PDAs; Palm® Tungsten T). PDAs probed each participant randomly 10 times per day during self-selected intervals of 13 hours on each of 4 successive days. On each trial, participants had 60s to respond to the PDA by clicking on the screen upon which a mentation questionnaire was administered. This questionnaire addressed participants' most recent mentation prior to the probe signal and it consisted of 17 items about the context and content of the mentation and ongoing activity. Participants were given two binary questions regarding whether the mentation immediately prior to the probe was related to the current activity or something else and whether it was related to the current surroundings or not (see Table 1). There was also a question about how much concentration the activity prior to the probe required (*activity demand*, cf., "What I'm doing right now is challenging", Kane et al., 2007). This and all the following items were answered on a Likert scale from 1 (*none at all*) to 5 (*very much*). The experimenter provided explanations and examples to ensure that participants understood the questions and would be able to respond as accurately as possible. Particular attention was devoted to the two questions pertaining to mind wandering which might seem similar. Participants were encouraged to ask for clarifications if needed.

To distinguish between different types of mind wandering in daily life, we administered 13 ESM items that were aimed to measure the three SIPI subscales (see Table 1). Five items were derived from the *positive-constructive* daydreaming style (items 5, 6, 9, 10, and 17), five from *guilt/fear-of-failure* (7, 8, 11, 14, and 15), and three from *poor attentional control* (12, 13, and 16). Because of the focus of the study, these questions were only asked if the mentation was reported as unrelated to the ongoing activity. To increase the likelihood that participants would answer probes during busy periods, they were asked each time they reported activity-unrelated mentation whether they wanted to answer the follow-up questions (which they did 90% of the times they reported task-unrelated mentation).

TABLE 1 ABOUT HERE

Procedure

Volunteers participated in two individual sessions. The first session consisted of one of the two versions of the Stroop task, the SIPI, and the automated SSPAN, in that order. The experimenter then instructed the participant how to use the ESM software. Participants subsequently carried the PDA for four days and were probed 40 times. The second session proceeded with the second version of the Stroop task (counterbalanced across participants), followed by the Dissociative Experiences Scale (reported elsewhere) and the SART. The order of measurements was fixed because we wanted to decrease fatigue by having a questionnaire in between the computer tasks, and because we compared two different Stroop versions we wanted to administer them at the start of both sessions to equalize order effects.

SART and ESM Measures of Mind Wandering

To measure sustained attention in the SART, we calculated the four behavioral indices proposed by Cheyne et al. (2009): *RT Coefficient of Variability* (RT CV) refers to variability of RTs to non-targets and was calculated for RTs above 200ms (RT CV = *SD/M*); *Anticipations* refer to the number of extremely fast responses to non-targets (≤ 100ms); *Omissions* refer to the number of failures to respond to non-targets; *Commissions* refer to the number of failures to withhold responses to targets. Non-target RTs that ranged between 100 and 200ms were considered ambiguous and excluded from the analyses (1% of non-target RTs). We measured *task-unrelated thoughts* by calculating the number of probe reports in which participants stated that their attention was focused on something other than the task or their own performance, and this served as a subjective measure of mind wandering in the SART. These five indices were then standardized and aggregated to an overall SART index.

We coded each mentation of the ESM reports according to the 2 (task-related vs. task-unrelated) × 2 (stimulus-dependent vs. stimulus-independent) categorization scheme presented by Stawarczyk, Majerus, Maj, Van der Linden, and D'Argembeau (2011). Reports in which participants rated their prior mentation as unrelated to the ongoing activity and surroundings were coded as *ESM mind wandering* (e.g., being at a lecture but thinking about what to do in the weekend). Reports of mentation unrelated to the activity but related to the surroundings were coded as *external distractions* (e.g., hearing people talking in the nearby room). Reports of mentation related to both activity and surroundings were coded as *task-focus* (e.g., listening to a lecturer), whereas reports of mentation related to the activity but unrelated to the surroundings were coded as *task-related re-appraisals* (e.g., thinking about something a lecturer said previously instead of listening to what he or she currently says). For instance, in analyses of mind wandering, ESM reports of mind wandering were coded as 1 whereas ESM reports of the three remaining mentation categories were coded as 0. We distinguished mind wandering from external distractions because they may relate differently to executive control abilities (Stawarczyk, Majerus, Catale, & D'Argembeau, 2014).

Statistical Analyses

Univariate outliers ($z > 3$) were adjusted with nearest-neighbor corrections to reduce their impact. Significance was set at $\alpha = .05$, two-tailed. We computed 95% confidence intervals (CIs) for correlation coefficients using the percentile bootstrap method in which data were resampled (1,000 samples). CIs that did not overlap with 0 were interpreted as statistically significant.

To corroborate the factor structure of the content of mind wandering episodes in daily-life we performed a principal components analysis on the ESM items of task-unrelated mentation. All items were individual-centered and a direct oblimin rotation was applied ($\delta = 0$). To determine the number of components retained we used the Parallel Analysis Engine in which Eigenvalues (EVs) of sample data are compared with corresponding EVs from 100 randomly generated matrices of the same size (Patil, Singh, Mishra, & Donavan, 2007, 2008).

Hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002) was performed on ESM data because ESM signal responses (level-1 units) are nested within participants (level-2 units). As mind wandering was coded as 0 or 1 we fitted our data to a Bernoulli distribution. Intercepts and slopes were modelled as random effects and Laplace estimation was used for estimating parameters (Raudenbush, & Bryk, 2002). As we were interested in cross-level interactions between level-1 variables (e.g., signal-response to ESM activity demand) and level-2 variables (e.g., individual SART score), we group-centered level-1 predictors (i.e., each score is relative to the individual's own average) and grand-centered level-2 predictors (i.e., each score is relative to the average of the total sample, see Hofmann & Gavin, 1998). To examine two-way interactions between level-2 variables we computed uncentered products of standardized variables as level-2 interaction terms. HLM analyses were performed with HLM 7. The *t*-values reported for the HLM analyses represent *t*-ratios (*B* coefficients divided by their standard errors). IBM SPSS was used for the remaining analyses.

Results

Descriptive Summary

A summary of the SSPAN, Stroop, SART, and SIPI data is given in Table 2. Eight participants were excluded from the SSPAN analyses because they responded inaccurately to more than 15% of the symmetry trials (cf. Unsworth, Redick, Heitz, Broadway, & Engle, 2009). Two participants were excluded from the Stroop analyses—one participant misunderstood the instructions and the other could not complete the Stroop because of a computer-related error.

As can be seen in Table 2, the proportions of SART commissions and task-unrelated thoughts were similar to those reported in previous research (e.g., Hu et al., 2012; Smallwood et al., 2004). Participants responded to an average of 31.65 ESM probes (range: 19–40, *SD* = 5.25)—a response rate of 79% that compares favorably with previous research (Hektner, Schmidt, & Csikszentmihalyi, 2007). ESM mind wandering reports did not relate to age, sex, signal-response-rate or the starting hour of the experience sampling interval (*p*s > .4).

TABLE 2 ABOUT HERE

Mind Wandering in Daily Life across Different Levels of Activity Demand

Participants reported mind wandering on 21% (*SD* = 11), attending to external distractions on 10% (*SD* = 9), engaging in task-related reappraisals on 10% (*SD* = 13%), and experiencing task-focus on 58% (*SD* = 16) of ESM responses. They rated the level of concentration required by the activity preceding the ESM signal on a scale from 1 (*none at all*) to 5 (*very much*) with rates of 18%, 25%, 25%, 20%, and 12%, respectively. In order to determine whether mind wandering states differed as a function of activity demand, we computed four separate HLM analyses with activity demand as the level-1 predictor and mind wandering, task-focus experiences, task-related re-appraisals, and external distractions as the binary dependent measures.

We observed significant slope effects of activity demand on mind wandering, $B = -0.64$, $SE = 0.06$, $t(110) = -11.17$, $p < .001$, external distractions, $B = -0.25$, $SE = 0.05$, $t(110) = -4.98$, $p < .001$, and task-focus reports, $B = 0.49$, $SE = 0.05$, $t(110) = 10.21$, $p < .001$, but not task-related reappraisals, $B = -0.04$, $SE = 0.06$, $t(110) = -0.69$, $p = .494$. These results indicate that mind wandering and attentional lapses due to external distractions decline in frequency as the ongoing activity requires a higher level of concentration, whereas task-focus mentation increases with demand level, but task-related reappraisals are unrelated to it (see Figure 1).

Given the findings of Kane et al. (2007) we tested whether individual differences in working memory capacity moderated the relation between mind wandering and activity demand. However, we did not find support for such an effect: the negative slope we observed between activity demand and mind wandering did not vary as a function of SSPAN scores, $B = 0.05$, $SE = 0.06$, $t(101) = 0.86$, $p = .394$.

FIGURE 1 ABOUT HERE

Principal Components Analysis of Task-Unrelated Mentation in Daily Life

To examine whether the SIPI daydreaming scales predict relevant content of mind wandering episodes in daily life, we first analyzed the factor structure of ESM mind wandering by performing a principal components analysis of the 13 ESM mind wandering content items. The analysis included 994 cases. The Kaiser-Meyer-Olkin measure was .71, indicating good sampling adequacy, and the rotation converged after nine iterations. All items had moderate to high communalities (extraction values above .27) and three components were retained, accounting for 20% (EV = 2.6), 16% (EV = 2.0), and 10% (EV = 1.4) of the variance, respectively.

Item-to-component loadings from the pattern matrix are shown in Table 1. Items derived from the guilt/fear-of-failure SIPI scale loaded highly on component 1 (“ESM guilt/fear-of-failure”), items derived from the positive-constructive scale loaded highly on Component 2 (“ESM positive-constructive”), and items derived from the poor attentional control scale loaded highly on Component 3 (“ESM poor attentional control”). It is worth mentioning that two ESM items did not load on the expected component based on the original SIPI scales: *problem-solving* mentation loaded on the ESM guilt/fear-of-failure component, whereas *achievement-oriented* mentation loaded on the ESM positive-constructive component. This may reflect discrepancies in within- and between-subjects relations. At the moment of the mentation, daydreaming about solving a problem may be accompanied by negative affect whereas daydreaming about achievements is accompanied by positive affect but the long-term effects of these two mentations may be different from the short-term effects. Inter-component correlations were small (*r*s < .13).

We next sought to validate the SIPI daydreaming scales against the ESM data. First, we computed average ESM index scores for each individual by summing up the uncentered variables that exhibited primary loadings above .40 on the respective ESM component (ESM positive-constructive index, 5 items: α = .71; ESM guilt/fear-of-failure index, 5 items: α = 78; ESM poor attentional control, 3 items: α = .68, see the bolded items in Table 1). We then examined the associations between the ESM index scores and the SIPI scales by performing three HLM analyses with the three SIPI scales as level-2 predictors and each of the ESM index scores as a dependent level-1 variable, respectively.

ESM positive-constructive index was predicted by the SIPI positive-constructive scale, $B = 0.47$, $SE = 0.24$, $t(106) = 2.00$, $p = .049$, but not the other two SIPI scales (*p*s > .5). ESM guilt/fear-of-failure index was predicted by the SIPI guilt/fear-of-failure scale, $B = 0.70$, $SE = 0.19$, $t(106) = 3.73$, $p < .001$, suggestively by the SIPI poor attentional control scale, $B = 0.32$, $SE = 0.18$, $t(106) = 1.74$, $p = .084$, but not the SIPI positive-constructive style ($p = .427$). However, ESM poor attentional control index was not predicted by the corresponding SIPI poor attentional control scale, $B = 0.16$, $SE = 0.17$, $t(106) = 0.92$, $p = .362$, nor was it predicted by the SIPI guilt/fear-of-failure scale ($p = .111$), but it was negatively predicted by the SIPI positive-constructive scale, $B = -0.29$, $SE = 0.14$, $t(106) = -2.09$, $p = .039$. This finding indicates that those who report mind wandering episodes low in positive-constructive SIPI dimensions experience daily life mind wandering characterized by attending to distractions and difficulties in concentrating on their current activity. In sum, the two SIPI scales positive-constructive and guilt/fear-of-failure predicted the corresponding content in daily-life mentation.

SART

Sustained attention and working memory capacity. To examine the extent to which SART behavioral and probe measures tap a uniform construct, we computed the correlations between, and internal consistency among, the SART measures. The SART variables of interest were RT CVs, Anticipations, Omissions, Commissions, and probe reports of task-unrelated thoughts. The average inter-item correlation was r_{ij} = .34. The Cronbach's α estimate indicated good reliability for the five variables (α = .72). The behavioral variables showed large corrected item–scale correlations, *r*s > .5, whereas the subjective measure showed a smaller corrected item–scale correlation, *r* = .23, although it was positively correlated with each variable, *r*s > .1, and dropping it did not substantially change α. The discrepancy is not surprising given the methodological differences between measuring motor responses to visual stimuli and introspective reports of attention. We nonetheless decided to include all five variables in the index in the interest of capturing a broader construct of failure to sustain attention during the SART and therefore computed an index of SART responses by summing the *z*-scores of the five variables (*SART index*). The SART index was unrelated to probe reports of thoughts about own performance during the SART, *r*(109) = -.10, CI [-.32, .12], indicating that it does not measure evaluations of current SART performance. Performance on the SSPAN did not correlate with the SART index, *r*(101) = .03, CI [-.13, .20], nor did the former predict task-unrelated thoughts about the future, *r*(101) = -.04, CI [-.21, .13], present, *r*(101) = .03, CI [-.12, .19], or the past, *r*(101) = .06, CI [-.12, .24]. Thus, we found no evidence that working memory, as measured by the SSPAN, correlated with mind wandering during the SART. Table 3 shows the correlations between the SART index and the other variables. The index correlated significantly with SIPI poor attentional control scale but not the other two SIPI scales, indicating that the SART is more likely to tap failures to sustain attention due to distractions.

TABLE 3 ABOUT HERE

Can we predict mind wandering in daily-life from the SART? To assess the hypothesis that responses to the SART are related to mind wandering in daily life, we performed an HLM analysis with activity demand as a level-1 predictor, SART index as a level-2 predictor, and ESM mind wandering as the level-1 dependent variable.

The hypothesis was not supported: The SART index did not predict ESM mind wandering, B = -0.00, SE = 0.08, t(109) = -0.00, p = .999. However, the index suggestively predicted the slope between activity demand and ESM mind wandering, B = 0.11, SE = 0.06, t(109) = 1.94, p = .055. As SART index scores increased, the slope between activity demand and mind wandering increased. In other words, SART index scores were more positively related to mind wandering during daily-life activities that required high rather than low levels of concentration (see Figure 2). We ran an analogous analysis with SART task-unrelated thoughts, instead of the overall SART index, as the predictor, but it did not predict daily-life mind wandering, B = 0.06, SE = 0.08, t(109) = 0.81, p = .422, nor did it predict the slope of activity demand, although it was in the positive direction, B = 0.09, SE = 0.06, t(109) = 1.59, p = .115.

FIGURE 2 ABOUT HERE

Interactions between Executive Control Processes and Daydreaming Styles on Mind Wandering

To test the predictions that positive and negative daydreaming styles moderate the relation between mind wandering and executive control variables, we performed an HLM analysis including the variables measuring working memory capacity (SSPAN), inhibition (Stroop effects in high congruency-proportion and low congruency-proportion versions) and sustained attention (SART index) together with the positive and negative daydreaming styles (positive-constructive and guilt/fear-of-failure) as well as the product of each task variable and each daydreaming style. Table 4 shows all predictors in the HLM model.

TABLE 4 ABOUT HERE

The HLM model including all main effects and interactions as predictors of the level-1 intercept of ESM mind wandering provided a significantly better fit to the data than the null model, $X^2(14) = 25.94$, $p = .026$, and the model including only main effects, $X^2(8) = 19.56$, $p = .012$. Adding SSPAN, the two Stroop variables, and the SART as predictors of the level-1 slope of activity demand, however, did not improve the model, $X^2(4) = 4.75$, $p = .313$, so we therefore report the results for the intercept analysis as shown in Table 4.

There were no significant main effects but two suggestive ones (*p*s < .1, see Table 4): Guilt/fear-of-failure daydreaming style was suggestively related to frequency of mind wandering in daily life, indicating that those whose mind wandering are typically of negative character spend high amount of their waking time mind wandering. As shown in Table 4, Stroop interference in the high congruency-proportion version suggestively predicted increased mind wandering in daily life, indicating that poor ability to inhibit rarely occurring conflict stimuli is associated with elevated mind wandering in daily life.

In support of our prediction, SSPAN scores interacted significantly with guilt/fear-or-failure on mind wandering, but contrary to our prediction there was no interaction between SSPAN and positive-constructive style on mind wandering. The former result indicates that working memory capacity is more negatively related to mind wandering in those who have a high negative daydreaming style (see Figure 3). Specifically, the slope between SSPAN and mind wandering was suggestively positive in those with low guilt/fear-of-failure (-1 *SD*), $B = 0.20$, SE = 0.12, $t(87) = 1.70$, $p = .093$. The upper bound of significance is at -1.25 *SD,* meaning that working memory capacity and mind wandering are significantly related in those with lower scores than -1.25 *SD* on guilt/fear-of-failure. In contrast, the slope was significantly negative in those with high guilt/fear-of-failure (+1 *SD*), $B = -0.35$, SE = 0.13, $t(87) = -2.73$, $p = .008$. The lower bound of significance is at 0.40 *SD,* meaning that there is a significantly negative relation between working memory and mind wandering in those with higher scores than 0.40 *SD* on guilt/fear-of-failure. Thus, as can be seen in Figure 3, SSPAN was positively related to mind wandering in individuals with low levels of guilt/fear-of-failure daydreaming, but negatively related in individuals with high levels of guilt/fear-of-failure daydreaming.

FIGURE 3 ABOUT HERE

Although there was no support for a two-way interaction between Stroop and guilt/fear-of-failure daydreaming style, there was a marginally significant interaction between Stroop and positive-constructive daydreaming style: As endorsement of a positive-constructive style increased, the relation between Stroop interference and mind wandering decreased. Simple slope analyses indicated that the slope between Stroop interference and mind wandering was significantly positive in those with a low positive-constructive style (-1 *SD*), $B = 0.31$, SE = 0.11, $t(87) = 2.77$, $p = .007$. The upper bound of significance is at -.07 *SD,* meaning that the effect of Stroop interference on mind wandering is significantly positive in those with a lower value than -0.07 *SD* on positive-constructive daydreaming style. In contrast, the slope was close to zero and non-significant in those with high positive-constructive style (+1 *SD*), $B = -0.03$, SE = 0.12, $t(87) = -0.25$, $p = .805$, with no significance found in the region ranging from 0 to +3 *SDs* (see Figure 4). The SART index did not interact with any of the daydreaming styles on mind wandering (see Table 4). In summary, mind wandering in daily life related to failures in resolving Stroop conflict, but only in those individuals with below average positive-constructive daydreaming style.

FIGURE 4 ABOUT HERE

Discussion

This study examined whether positive and negative daydreaming styles moderated the relation between executive control capacities and mind wandering and whether laboratory and daily life measures of mind wandering were related. In support of a moderating influence of a negative daydreaming style, working memory capacity was negatively associated with mind wandering in individuals who consider their mind wandering episodes to be of a negative character, whereas these variables were positively associated in individuals who rarely have negative daydreams. In contrast, the positive daydreaming style did not moderate this relation. Stroop results, on the other hand, supported a moderating influence of the positive daydreaming style, indicating that mind wandering is related to poor inhibition, but only in those who consider their mind wandering episodes to seldom be of a positive character. This relation between inhibition and mind wandering was observed in the Stroop task with mostly congruent stimuli, but not in the version with mostly incongruent stimuli. These results generally support the idea that the more positive individuals' mind wandering episodes tend to be, the less their tendencies to drift away from the ongoing task relate to task-inappropriate attentional lapses. Furthermore, an aggregate index of SART responses failed to predict overall rate of mind wandering in daily life, although it suggestively predicted mind wandering during high-demanding activities more positively than mind wandering during low-demanding activities. These results support recent theoretical suggestions to integrate seemingly competing hypotheses regarding the relation between mind wandering and executive control by taking the affective content of mind wandering episodes into account (consistent with the content-regulation hypothesis) and suggest contextual constraints on the ecological generalizability of laboratory measures of mind wandering (consistent with the context-regulation hypothesis; cf. Smallwood, 2013).

Previously, two ostensibly opposing ideas were put forward to explain the cognitive mechanisms underlying mind wandering. The control-failure hypothesis proposes that executive control processes prevent mind wandering from occurring (McVay & Kane, 2010), whereas the global availability hypothesis proposes that executive processes allow mind wandering to occur (Smallwood, 2010). This study provides empirical support for Smallwood's (2013) integrative proposal by considering the content of mind wandering episodes as a moderating influence. In particular, the results suggest that working memory capacity negatively predicts mind wandering in individuals who consider their mind wandering to typically be negative, consistent with the control-failure hypothesis. In contrast, working memory capacity positively predicts mind wandering in individuals who consider their mind wandering to rarely be negative, consistent with the global availability hypothesis. Together with earlier findings (Levinson et al., 2012; Rummel & Boywitt, 2014; Smallwood et al., 2013), these results suggest that greater working memory capacity allows individuals to flexibly adjust the occurrence of mind wandering relative to the content and the context. Smallwood and Andrews-Hanna (2013) proposed that the content of mind wandering mentation moderates the relation between mind wandering and functional outcomes, and this study extends previous research by showing that individual differences in affective daydreaming styles moderates the relation between working memory capacity and mind wandering.

Surprisingly, we found no support for an interaction between working memory capacity and positive-constructive daydreaming style on mind wandering. We had expected that for individuals with rewarding and pleasant daydreams, higher working memory capacity resources would be associated with greater mind wandering tendencies. One reason for this null result might be that individuals who find their daydreams positive and constructive may also find their activities positive and constructive. That is, the results may be confounded by a general aptitude for a positive attitude. This would decrease positive-constructive daydreamers' inclination to mind wander because at many times the activities are themselves regarded as positive and constructive and thus mind wandering is not necessary. A caveat is that the present sample generally reported high levels of positive-constructive daydreams. It would be instructive to sample a broader range of individuals in regard to the positive-constructive dimension and to assess individual attitudes not only to mind wandering content but also to the activities at hand, as well as their propensity to experience positive and negative affect more generally. Another way of exploring the contextual influence of affective content on mind wandering would be to investigate this relation in depression. We would hypothesize that for individuals with depression, mind wandering often reflects non-deliberate attentional lapses, which should be associated with poor working memory.

Successful inhibition in the Stroop task was suggestively related to reduced mind wandering in daily life. This effect was observed in the Stroop version with mostly congruent stimuli—consistent with earlier research (McVay & Kane, 2012b)—but not in the version with mostly incongruent stimuli. Importantly, the relation between mind wandering and inhibition was moderated by the positive-constructive daydreaming style. It was only in those with low positive-constructive daydreaming style that Stroop interference effects related to mind wandering in daily life. The Stroop version with mostly congruent stimuli is believed to promote a reactive control strategy in which conflict is managed online rather than in a preparatory manner (De Pisapia & Braver, 2006). Accordingly, we interpret these results to suggest that mind wandering more often reflects failures in reactive control in those with a low rather than a high positive-constructive style. Relatedly, we found that the positive-constructive daydreaming style negatively predicted daily life mind wandering reflecting attentional lapses (boredom, difficulty in concentration, and distractibility). Taken together, these results suggest that some positive mind wandering episodes are initiated intentionally by the agent, whereas other positive episodes commence automatically but are intentionally sustained once detected. The amount of time spent on these episodes does not seem be related to Stroop performance. In contrast, non-positive mind wandering episodes may arise automatically but are inhibited once detected. The time spent on these episodes may be related to poor Stroop performance. The role of intentionality in mind wandering has been largely neglected, but our data suggest that it plays a central role in those with a positive-constructive daydreaming style. Distinguishing deliberate from spontaneous mind wandering (Carriere, Seli, & Smilek, 2013) and the onset from the duration of the mind wandering process (Smallwood, 2013) will help clarify the role of executive cognitive processes in mind wandering.

An important aim of this study was to assess the ecological validity of the SART. Notably, we found no support for an association between overall mind wandering during daily life and our index of SART responses (see also McVay et al., 2009), although the latter was more suggestively related to mind wandering during high-demanding than low-demanding daily life activities. This pattern suggests that generalizations from the SART may only be viable for moderately difficult, not low-demanding, tasks, consistent with proposals that mind wandering is regulated differently based on the context of the task (Smallwood & Andrews-Hanna, 2013). As mind wandering most frequently occurs during low activity demand, as shown in the present study and elsewhere (Levinson et al., 2012), these results suggest that the SART may only generalize to a smaller subset of mind wandering episodes that occur during challenging activities. Two limitations of this study should be considered when interpreting these results: First, Randall et al. (2014) found that performance in attentional control tasks shorter than 30 min correlates less strongly with mind wandering than longer tasks. The short duration of our version of the SART (< 30 min) may thus have been a limiting factor when relating it to daily life mind wandering. A second limitation was the relatively small number of ESM signals when stratified by activity demand. It is nevertheless promising that despite the diversity of our SART measures of sustained attention, the five measures showed good reliability and the suggestive relation with mind wandering during high-demanding activities deserves further inquiry. The SART index also predicted self-reports of poor attentional control suggesting that it may be particularly sensitive to interference from task-unrelated thoughts that are due to distractibility, boredom proneness, or difficulties in maintaining concentration. The SART index is thus more likely to target spontaneous, rather than deliberate, mind wandering.

This study was unable to conceptually replicate the finding of a positive correlation between working memory capacity and mind wandering about the future (Baird et al., 2011), but is arguably consistent with the zero-to-weakly-negative correlations observed by McVay, Unsworth, et al. (2013). These three studies probed mind wandering in different tests: the SART, Stroop and reading tasks, and the choice reaction time task. Based on the context-regulation hypothesis, one possibility is that mind wandering during the choice reaction time task runs a lower risk of impairing performance compared to the other tasks that require inhibition of prepotent responses and participants might therefore have been more motivated to engage in future-oriented mind wandering in the test administered by Baird et al. This *post hoc* explanation deserves experimental inquiry. A limitation of this study is that we assessed working memory capacity with a single measure, the SSPAN. The SSPAN includes a spatial component and although many participants told the experimenter that they used apparent verbal memory techniques, it is plausible that the spatial nature of the task had an impact on the relation between working memory capacity and the mind wandering variables. Nevertheless, the SSPAN showed good psychometric properties and previous research indicates that it relates strongly with other working memory capacity measures (Redick et al., 2012, but see also Redick & Lindsey, 2013). In further support of the use of SSPAN, the interaction with guilt/fear-of-failure on mind wandering is arguably consistent with the literature on working memory capacity and thought suppression (Brewin & Beaton, 2002;

Brewin & Smart, 2005) in which the Operation Span task was used to measure working memory.

Conclusion

This study found that the association between working memory capacity and mind wandering depends on a negative, rather than positive, daydreaming style. In contrast, the relation between cognitive inhibition and mind wandering depends on a positive, and not negative, daydreaming style. These results support recent integrations of two hypotheses postulating that working memory and mind wandering are positively and negatively related (Smallwood, 2013), respectively, by showing that the relation varies as a function of affective daydreaming style. Sustained attention abilities as measured by the most commonly used laboratory measure (the SART) did not predict overall mind wandering in daily life but were suggestively related to mind wandering during attentionally demanding activities, placing a constraint on the ecological generalizability of the SART. This study emphasizes the need to consider the content of mind wandering mentation and contextual factors into account when assessing the underlying role of executive processes in mind wandering.

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Table 1

Experience Sampling Questionnaire Items and Principal Components Loadings for Task-unrelated Mentation Items

Item	Question (Right before the probe…)
1	What type of activity were you involved with? [*Work or Study/ Chore/ Leisure/ Passing time/ Rest*]
2	Was your experience related to the surroundings? [*Yes/ No*]
3	What was your experience related to? [*Activity I was doing/ Something else*]
18	How much concentration is required by the activity you were doing?
4	Do you want to continue and answer some follow-up questions? [*Yes/ No*]

		Component		
Follow-up questions to task-unrelated thoughts:		1	2	3
6	Was your experience about anything you want to happen in the future?	**.77**	-.03	.02
5	Was your experience interesting or worthwhile?	**.71**	.00	-.01
10	Was your experience pleasant or positive?	**.63**	-.52	.05
11	Was your experience about receiving recognition (e.g., fantasizing about getting an award, be seen as an expert, or become accepted)?	**.55**	.14	.03
17	Did your experience consist of imagery, and if so, were the images clear and vivid?	**.43**	.00	-.25
8	Was your experience about worrying over failing something?	.11	**.72**	.04

7	Was your experience about anything depressing?	-.18	**.71**	-.09
15	Did you feel guilt?	.09	**.65**	.08
9	Was your experience about solving a problem?	.29	**.53**	.02
14	Did you feel anger against others?	-.21	**.48**	-.05
16	Did you feel that it was difficult to maintain concentration on the activity?	.12	.10	**.77**
13	Did you feel distracted by other things (e.g., TV or someone talking on the phone)?	.01	-.12	**.73**
12	Did you feel bored?	-.29	.03	**.47**

Notes. Items 5–18 were answered on a five-point Likert scale (1 = *none at all* and 5 = *very much*) and response options for the remaining items are shown in brackets. Primary pattern matrix loadings above .40 are bolded.

Table 2

Descriptive Statistics for the Research Measures

Material	Measure	*M*	*SD*	Skew	Kurtosis
SSPAN	Partial score	28.85	6.51	-0.31	-0.01
Stroop	Stroop effect in high congruency-proportion	135	92	0.94	0.85
	Stroop effect in low congruency-proportion	60	45	0.77	0.42
SART	RT	331	30	0.30	0.29
	RT CV	0.22	0.05	0.53	-0.23
	Anticipations	0.32	0.65	1.85	1.99
	Omissions	2.39	3.08	1.45	1.23
	Commissions	7.31	3.78	0.40	-0.27
	SART Index (*z*)	0.00	1.00	0.84	0.47
	On-task thoughts	6.68	3.98	0.58	0.09
	Own performance thoughts	4.55	2.60	0.37	-0.27
	Task-unrelated thoughts	8.73	4.54	-0.02	-0.53
	Task-unrelated thoughts about the past	2.23	2.32	1.03	0.42
	Task-unrelated thoughts about the present	2.31	2.10	1.10	0.79
	Task-unrelated thoughts about the future	4.05	2.91	0.86	0.29
SIPI	Positive-constructive	3.70	0.51	-0.29	-0.26
	Guilt/fear-of-Failure	2.35	0.56	0.18	-0.76
	Poor attentional control	3.44	0.65	-0.19	-0.44

Notes. SSPAN = Symmetry Span. SART = Sustained Attention to Response Task. SIPI = Short Imaginal Processes Inventory.

Table 3

Correlation matrix with SSPAN, Stroop, SART, SIPI, and ESM mind wandering data

Variable	1	2	3	4	5	6	7	8
1. SSPAN								
2. HCP Stroop	-.15							
3. LCP Stroop	-.15	.52**						
4. SART index	.03	.03	.04					
5. SART TUT	.02	.07	-.01	.49**				
6. SIPI PC	.01	.08	.17	.06	.13			
7. SIPI G/FF	-.06	-.08	-.01	.09	.08	.17		
8. SIPI PAC	-.03	-.16	-.04	.22*	.16	.13	.32**	
9. ESM MW	-.08	.14	.08	-.04	.05	.02	.15	.08

Notes. SSPAN = Symmetry Span. HCP = High Congruency Proportion. LCP = Low Congruency Proportion. SART = Sustained Attention to Response Task; TUT = Task-Unrelated Thoughts; SIPI = Short Imaginal Processes Inventory; PC = Positive-constructive; G/FF = Guilt/Fear-of-Failure; PAC = Poor Attentional Control; ESM MW = Experience Sampling Methodology Mind Wandering.

* $p < .05$, ** $p < .01$

Table 4

Results from an HLM analysis with daily-life mind wandering as the outcome variable

Predictor	*B*	(SE)	*t*-ratio	*p*
SSPAN	-0.07	(0.08)	-0.87	.385
High Congruency-Proportion Stroop	0.14	(0.08)	1.83	.071†
Low Congruency-Proportion Stroop	0.01	(0.10)	0.14	.887
SART index	-0.02	(0.07)	-0.27	.790
Positive-Constructive	0.03	(0.07)	0.40	.689
Guilt/fear-of-failure	0.13	(0.07)	1.95	.054†
SSPAN × Positive-Constructive	0.02	(0.12)	0.20	.841
SSPAN × Guilt/fear-of-failure	-0.27	(0.09)	-2.90	.005**
High Congruency-Proportion Stroop × Positive-Constructive	-0.17	(0.08)	-1.99	.050*
High Congruency-Proportion Stroop × Guilt/fear-of-failure	0.04	(0.09)	0.41	.685
Low Congruency-Proportion Stroop × Positive-Constructive	0.21	(0.13)	1.58	.119
Low Congruency-Proportion Stroop × Guilt/fear-of-failure	-0.09	(0.11)	-0.79	.432
SART index × Positive-Constructive	-0.02	(0.08)	-0.23	.820
SART index × Guilt/fear-of-failure	0.06	(0.10)	0.60	.550

Notes. SSPAN = Symmetry Span. SART = Sustained Attention to Response Task. Approximate df = 87, N = 102.

** $p < .01$, * $p < .05$, † $p < .1$

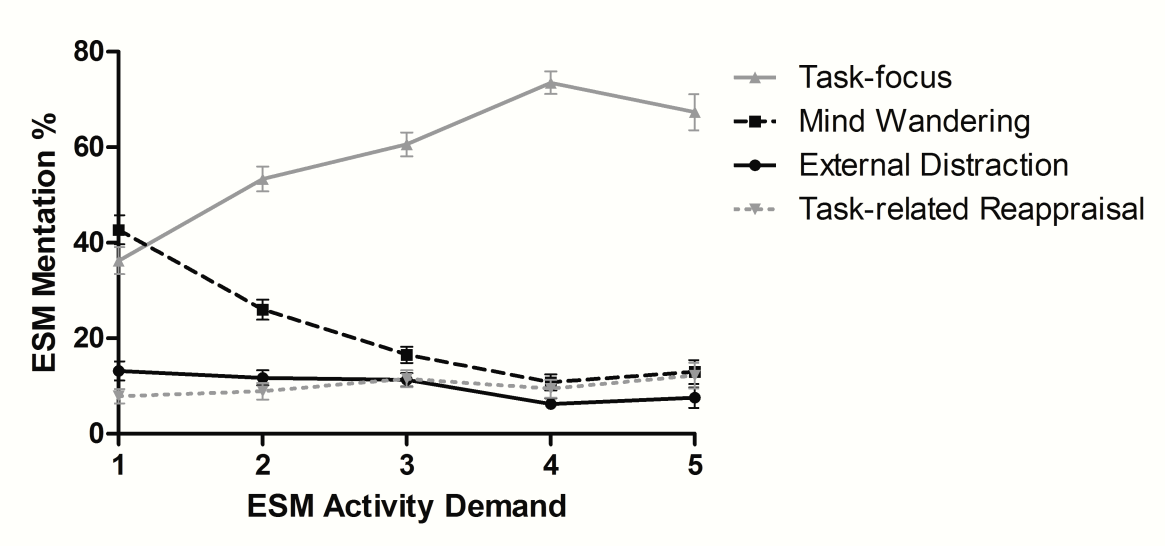

Figure 1. Rates of ESM mentation as a function of concentration required by activity. Error bars reflect standard errors of the means.

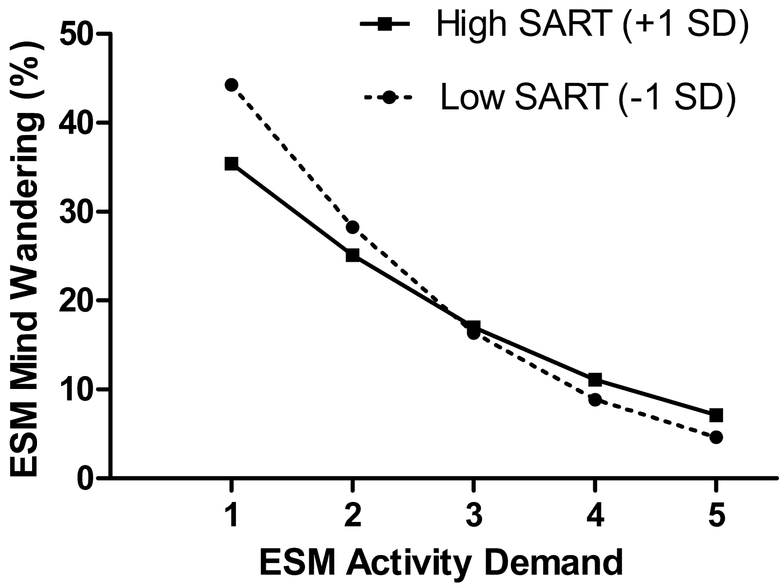

Figure 2. Rates of ESM Mind wandering (level-1) during daily life as a function of ESM Activity demand (level-1) and SART composite index (level-2). SART scores are continuous but were dichotomized here for the purpose of the figure.

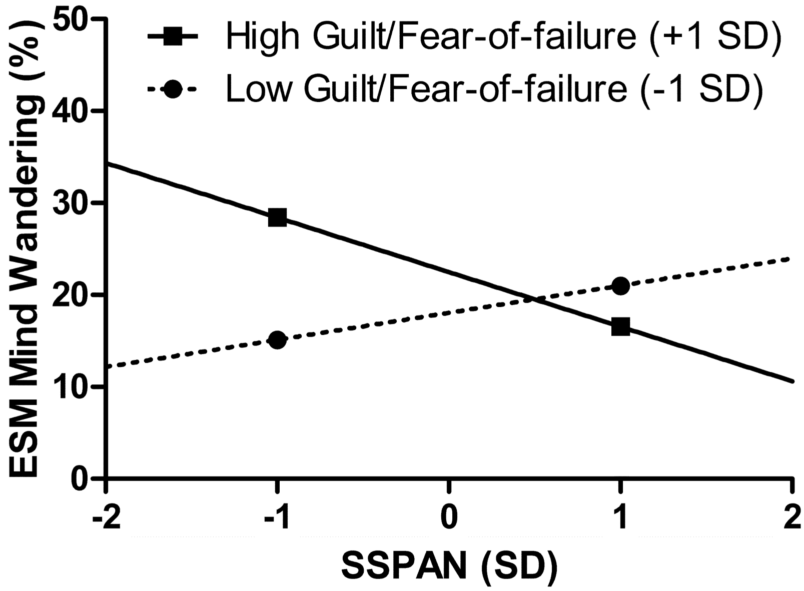

Figure 3. Regression slopes for ESM Mind wandering (level-1) as a function of Symmetry Span (SSPAN, level-2) and Guilt/fear-of-failure daydreaming style (level-2). Level-2 scores are continuous but were dichotomized here for the purpose of the figure.

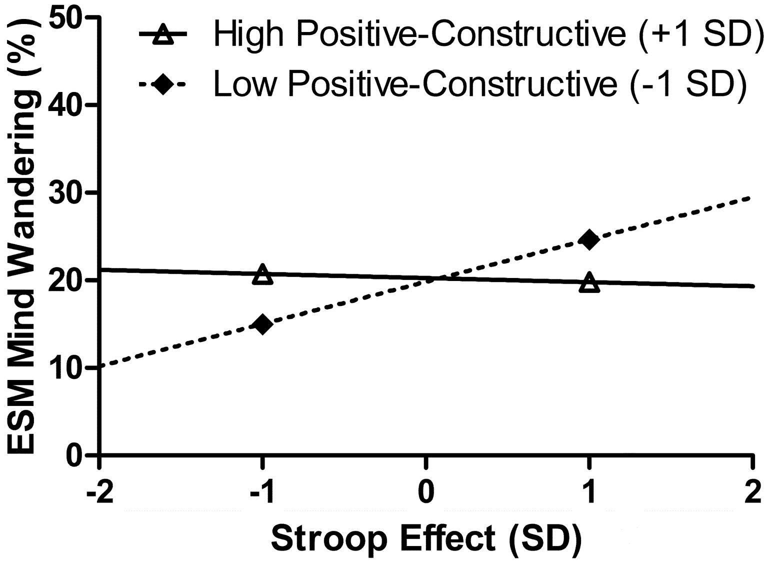

Figure 4. Regression slopes for ESM Mind wandering (level-1) as a function of Positive-constructive daydreaming style (level-2) and the Stroop effect in the high congruency-proportion version (level-2). Level-2 scores are continuous but were dichotomized here for the purpose of the figure.