The study of mind wandering provides a novel means to explore fundamental issues of consciousness. For example, the commonplace experience of moving one’s eyes across a page without comprehending a thing suggests the startling conclusion that we are sometimes unaware of our own conscious experience; if we “knew” our thoughts were elsewhere, we would return to reading or drop the charade (Schooler, Reichle, & Halpern, 2004). Moreover, despite controversy about the causal functions of consciousness (e.g., Morsella, 2005; Rosenthal, 2008; Wegner, 2002), field and laboratory studies of human performance (e.g., Reason, 1990; Smallwood et al., 2004) indicate that errors increase when people report experiencing task-unrelated thoughts (TUTs). Mind wandering thus co-occurs with events of scientific and practical interest. It is also beginning to figure into general theories of executive control, metacognition, and the “default mode” brain network (e.g., Bar, 2007; Buckner & Carroll, 2007; Burgess, Duhamel, & Gilbert, 2007; Mason et al., 2007; Schooler, 2002; Smallwood & Schooler, 2006); we have argued, for example, that unwanted mind-wandering experiences represent momentary failures of goal maintenance that reflect, in part, enduring individual differences in executive control (Kane et al., 2007; McVay & Kane, 2009).

Like most areas of cognitive investigation, mind-wandering research is dominated by laboratory and neuroimaging methods; here, subjects engage in an ongoing task that is periodically interrupted for them to report or categorize their current thoughts (e.g., as on or off task; Giai- bra, 1995; Mason et al., 2007; Smallwood, McSpadden, & Schooler, 2007). Such thought-probe responses appear to be valid: TUT reports vary systematically with experimental manipulations, such as memory load, stimulus pacing, and task practice (e.g., Antrobus, Singer, & Greenberg, 1966; Teasdale, Proctor, Lloyd, & Baddeley, 1993); TUTs show a reliable neural signature (e.g., Mason et al., 2007); and task errors can increase by 25% during TUTs as opposed to on-task thoughts (McVay & Kane, 2009; Schooler et al., 2004). As well, individual differences in TUT rates are reliable across different primary tasks and across substantial test–retest lags (Giai- bra, 1995; Grodsky & Giambra, 1990/1991) and they are predicted by objective cognitive ability assessments (McVay & Kane, 2009).

Unlike some heavily investigated cognitive phenomena, however, mind wandering seems ubiquitous in everyday life. Perhaps for this reason, researchers have also investigated TUTs in ecologically valid contexts, by inserting thought probes into normal classroom activities (e.g., Cameron & Giuntoli, 1972; Geerligs, 1995) or by electronically paging (“beeping”) subjects to answer questions about their thoughts, emotions, and environmental context during unconstrained daily activities (e.g., Hurlburt, 1979). As in laboratory studies, daily-life mind wandering occurs frequently and it varies reliably with context: Subjects report TUTs on 30%–40% of probes, overall (e.g., Klinger & Cox, 1987/1988), but they occur more often...
during classroom lectures than during discussions (e.g., Schoen, 1970), and less often during enjoyable activities and happy moods (e.g., Kane et al., 2007).

The goal of the present work was to bridge the controlled and ecological approaches to mind-wandering research by asking whether people who experience more (or fewer) TUTs during a challenging laboratory task also experience more (or fewer) TUTs in daily life. If mind wandering reflects, in part, executive-control failure (Kane et al., 2007; McVay & Kane, 2009) and if executive-control capabilities are domain general (e.g., Engle & Kane, 2004), then subjects’ TUT rates in the lab should predict those outside the lab. To test this prediction, we administered a daily-life experience-sampling protocol to subjects who had previously completed a laboratory assessment of mind wandering during an executive-control, go/no-go task, the sustained attention to response task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997; Smallwood et al., 2004). McVay and Kane reported that these subjects experienced frequent mind wandering, high error rates, quite variable response times to “go” trials, and significant associations among the three.

Our secondary goal was to examine the relation between mind wandering and performance in daily life, a relation that is well established in the laboratory (e.g., McVay & Kane, 2009; Schooler et al., 2004; Smallwood, McSpadden, & Schooler, 2007). We therefore asked subjects to evaluate their performance of ongoing activities on the same occasions on which we probed their thoughts. We expected that in life, as in the lab, subjects would report performing less well when mind wandering than during on-task thinking.

METHOD

Laboratory SART
The SART presented 1,810 words for go/no-go responses based on a perceptual (letter case) or semantic (animals vs. foods) discrimination. Subjects pressed a key for nontarget “go” stimuli (e.g., lowercase words) and withheld responses to infrequent (11%) target “no-go” stimuli (e.g., uppercase words; for details, see McVay & Kane, 2009). Thought-probe screens followed 60% of the no-go targets and presented the question, “What were you just thinking about?” with the following response options: (1) the task; (2) own task performance; (3) everyday stuff; (4) current state of being; (5) personal worries; (6) daydreams; and (7) other. We instructed subjects to report what they had been thinking immediately before the probe, and the experimenter initially elaborated on the response option meanings. For all analyses, Options 3–7 were considered TUTs.

Table 1
Mean Ratings (1–7) for Perceived Thought Control and Content When Subjects Reported Daily-Life Mind Wandering

<table>
<thead>
<tr>
<th>Questionnaire Prompt</th>
<th>M ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I was aware my mind was wandering in the moments before the beep.</td>
<td>4.40 ± 0.95</td>
</tr>
<tr>
<td>I allowed my thoughts to wander on purpose.</td>
<td>4.06 ± 0.96</td>
</tr>
<tr>
<td>I was thinking about personal concerns or things I need to do.</td>
<td>4.29 ± 1.00</td>
</tr>
<tr>
<td>I was daydreaming or fantasizing about something.</td>
<td>3.81 ± 1.25</td>
</tr>
<tr>
<td>I was worrying about something.</td>
<td>3.37 ± 1.05</td>
</tr>
</tbody>
</table>

Table 2
Contextual Predictors of Daily-Life Mind-Wandering Episodes

<table>
<thead>
<tr>
<th>Questionnaire Prompt</th>
<th>b ± SE</th>
<th>t(71)</th>
<th>p</th>
<th>prep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was doing this activity successfully.</td>
<td>-.541 ± .049</td>
<td>-10.949</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>I was trying to concentrate on what I was doing.</td>
<td>-.577 ± .057</td>
<td>-10.135</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>I like what I’m doing right now.</td>
<td>-.177 ± .024</td>
<td>-7.421</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>I am trying hard at what I’m doing right now.</td>
<td>-.155 ± .029</td>
<td>-5.366</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>I feel happy right now.</td>
<td>-.145 ± .033</td>
<td>-4.358</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>I’m good at what I’m doing right now.</td>
<td>-.124 ± .030</td>
<td>-4.132</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>What I’m doing right now is important.</td>
<td>-.083 ± .021</td>
<td>-3.163</td>
<td>.003</td>
<td>.98</td>
</tr>
<tr>
<td>It takes a lot of mental effort to do this activity.</td>
<td>-.077 ± .027</td>
<td>-2.912</td>
<td>.005</td>
<td>.98</td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would prefer to do something else right now.</td>
<td>.168 ± .022</td>
<td>7.507</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>What I’m doing right now is boring.</td>
<td>.173 ± .026</td>
<td>6.555</td>
<td>.000</td>
<td>.99</td>
</tr>
<tr>
<td>There is a lot going on around me right now.</td>
<td>.063 ± .026</td>
<td>2.451</td>
<td>.017</td>
<td>.95</td>
</tr>
<tr>
<td>I feel anxious right now.</td>
<td>.064 ± .032</td>
<td>2.259</td>
<td>.027</td>
<td>.94</td>
</tr>
<tr>
<td>I feel tired right now.</td>
<td>.073 ± .032</td>
<td>2.259</td>
<td>.027</td>
<td>.94</td>
</tr>
<tr>
<td>What I’m doing right now is stressful.</td>
<td>.050 ± .024</td>
<td>2.092</td>
<td>.040</td>
<td>.93</td>
</tr>
</tbody>
</table>

Note—Parallel analyses from Kane et al. (2007) considered the contextual predictors of on-task thinking, and so the signs of the b and t values here are reversed in comparison with that study.
mind wandering and subjective evaluation of activity performance. All Level 1, within-subjects variables (e.g., self-reported happiness) were standardized within subjects (group centered). The mind-wandering variable was dichotomous (on task vs. TUT), which violates the normality assumption of HLM; we therefore used an HLM model for binary outcomes (using a log transformation and Bernoulli sampling distribution, a special case of the binomial distribution where the values are 0 and 1; see Raudenbush & Bryk, 2002) to evaluate Level 1 and Level 2 effects on TUTs. We analyzed three Level 2 between-subject predictors of thought and performance (grand-mean centered): SART session TUT rate, $d_L$, and $RT_{SD}$.

RESULTS

We report nondirectional NHSTs ($\alpha = .05$) with $p_{rep}$ values. On average, subjects completed 45.6 ($SD = 10.8$, range = 20–65) usable questionnaires, which were uncorrelated with daily-life $[r(72) = −.04]$ and laboratory $[r(72) = −.13]$ TUT rates.

Mind Wandering in Daily Life

Our initial analyses examined the frequency and nature of daily-life mind wandering. Consistent with previous findings, subjects reported TUTs at 30% of the beeps, on average, with considerable variation among subjects (SD, 15%; range, 6%–75%). Table 1 presents mean ratings of thought content and awareness when subjects reported mind wandering; replicating Kane et al. (2007), subjects generally reported more personal-concern content than fantasy, and more fantasy than worry (but these categories were not mutually exclusive, because concern-related content might intrude into worries or daydreams; see Klinger,

Subjects

Of 244 undergraduates (aged 18–35) who completed the laboratory SART, 72 subsequently completed the experience-sampling study (ESM). Subjects began the 7-day ESM collection period between 1 and 63 days ($M = 16; SD = 13$) after the laboratory session, on the basis of their availability. This subsample had laboratory TUT rates similar to the full sample’s (both $M$s = .55) and similar levels of SART performance ($M$ signal detection accuracy ($d_L$) = 3.73 vs. 3.33, respectively; mean go-trial response time (RT) variability ($RT_{SD}$) = 151 msec vs. 158 msec, respectively); for analyses of the full sample, see McVay and Kane (2009).1

Experience-Sampling Protocol

Palm Pilot PDAs using iESP software (Barrett & Barrett, 2004; Intel Corp., 2004) presented questionnaires and collected data during subjects’ daily-life activities. A “beep” signaled subjects to complete eight daily questionnaires, between noon and midnight, for 7 full days. The signals occurred once randomly during each 90-min block. During a 60-min training session, the experimenter instructed subjects to take immediate stock of their thoughts upon the beep and to report on only these thoughts; the experimenter also familiarized subjects with the PDAs, questionnaires, and mind-wandering examples. PDA signal blocks began immediately after subjects left the session (yielding an additional, partial day of data collection). Subjects completing ≥70% of the questionnaires were entered into a lottery for a retailer gift card.

The PDA questionnaire first asked subjects whether their current thoughts had wandered from their activity ($1 = \text{yes}; 0 = \text{no}$). If so, they answered 5 questions about those thoughts; all subjects also answered 18 questions about their mental and environmental context (all on a 1–7 scale; see Tables 1 and 2).

Statistical Analyses

Experience-sampling data have a hierarchical structure in which responses (Level 1 data) are nested within subjects (Level 2 data) and are best analyzed with multilevel or hierarchical linear modeling (HLM; Raudenbush & Bryk, 2002). We used HLM to examine within- and between-subjects predictors of two daily-life outcomes:

- Laboratory TUT rate
- On-task thoughts
- Value on the y-axis is the grand-mean centered laboratory TUT rate.

Figure 1. The relation between daily-life mind wandering and the propensity to experience task-unrelated thoughts (TUTs) during a lab task. Values on the y-axis represent the mind-wandering dependent variable, scored on each questionnaire as either 1 (for mind wandering) or 0 (for on-task thoughts). Values on the x-axis represent the grand-mean centered laboratory TUT rate.

Figure 2. The relation between daily-life mind wandering and self-reported happiness as a function of the propensity to experience task-unrelated thoughts (TUTs) during a lab task. Lines depict the means of the within-person slopes for subjects in the top and bottom quartiles for laboratory TUT rate. Values on the y-axis represent group-centered ratings for happiness (“I feel happy right now”).
success at daily-life tasks, as shown in Table 3. Subjects reported performing better when engaged in important or enjoyable activities, when concentrating or expending effort, or when happy. They reported performing worse when engaged in stressful, unappealing, or boring activities, when in chaotic environments, or when anxious or tired.

Of central importance, and as predicted, subjects’ performance ratings were lower while mind wandering than while mentally on task \( (b = -1.15, SE = .10) \) \( t(71) = -11.69, p_{\text{rep}} > .99 \). We also found that mind-wandering awareness and content predicted perceived performance. When subjects were aware that they had been mind wandering, they believed they had been performing better than when they had been mind wandering without awareness \( (b = .094, SE = .040) \) \( t(71) = 2.34, p_{\text{rep}} = .95 \). This finding mirrors laboratory reports of increased task errors during mind-wandering episodes that lack “meta-consciousness” (Smallwood, McSpadden, & Schooler, 2007, 2008). Finally, with respect to mind-wandering content, when subjects experienced daily-life TUTs, their self-reported performance was worse with more worry- or fantasy-based content \( [\text{for worry}, b = - .072, SE = .027, t(71) = - 2.67, p_{\text{rep}} = .97; \text{for fantasy}, b = - .105, SE = .026, t(71) = - 4.02, p_{\text{rep}} > .99] \); neither purposeful mind wandering nor variation in personal-concern content predicted performance ratings \( (ts < 1.28, ps > .21) \).

**DISCUSSION**

We found that the propensity to mind wander is a stable cognitive characteristic, representing an individual difference that is reliable across time, activities, and conditions.
texts. Subjects with higher TUT rates during a laboratory executive-control task experienced more off-task thoughts during their unconstrained everyday activities. This relation held even though we measured daily-life TUTs several weeks after the initial lab assessment. Our TUT rate findings also differed in an important way from our previous results regarding laboratory measures of working memory capacity (WMC), which are correlated with, but not isomorphic to, laboratory TUT rates (McVay & Kane, 2009): Whereas WMC variation predicted daily-life mind-wandering differences only in cognitively demanding contexts (such as those perceived as requiring concentration; Kane et al., 2007), laboratory TUT rate variation predicted daily-life mind wandering across virtually all contexts. Thus, whatever variables, aside from WMC, contribute to high levels of mind wandering during laboratory tasks (e.g., personality, emotion, psychopathology, goals, recent life events), they assert their influence very broadly across people’s everyday lives and activities.

Unexpectedly, we found that mood moderated the laboratory TUT relationship, with happiness being an equalizer. When people reported being especially happy in the moment, their laboratory TUT rate no longer predicted well whether they were currently mind wandering. We will not make too much of this unanticipated result. However, given that unhappiness exacerbated mind-wandering differences between lab TUTers and lab non-TUTers, and that lab TUTers were especially likely to be worrying when they did mind wander in daily life, future mind-wandering research should draw upon allied work in the clinical and personality domains, on phenomena such as rumination and worry and their covariation with depression and anxiety (e.g., Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008; Sarason, Pierce, & Sarason, 1996; Smallwood, Fitzgerald, Miles, & Phillips, 2009; Smallwood, O’Connor, Sudbery, & Obonsawin, 2007; Watkins, 2008).

Our study conceptually replicated, in daily life, the common laboratory finding that task performance suffers on occasions when people report off-task versus on-task thought (e.g., McVay & Kane, 2009; Schooler et al., 2004; Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Smallwood et al., 2004; Smallwood, McSpadden, & Schooler, 2007, 2008; Smallwood, Riby, Heim, & Davies, 2006). That is, subjects rated their ongoing activity performance to be worse when they were mind wandering than when they were mentally focused. Were these subjective reports valid? We believe so, although we could not measure subjects’ performance objectively outside the laboratory. We see evidence for validity in that subjects’ performance ratings varied systematically with contextual variables, metaconsciousness, and thought content, despite it being unlikely that subjects shared folk beliefs about the effects of metaconsciousness on performance, or about the effects of fantasy versus personal-concern thought content on performance. If we are right that the thought–performance relation is real, then the consistency with which our study and others find that 30%–40% of daily-life thoughts are off task (Hurlburt, 1979; Kane et al., 2007; Klinger, 1978/1979; Klinger & Cox, 1987/1988) suggests a need to take mind wandering seriously as an impediment to learning, productivity, and public safety (e.g., Reason, 1990; Smallwood, McSpadden, & Schooler, 2007; Wiegmann et al., 2005).
mance outside the laboratory: Subjects performed their daily-life activities more poorly when they had been less aware, before the beep, of their TUTs. Our findings thus support the Smallwood and Schooler (2006; Smallwood, McSpadden, & Schooler, 2007) argument that mind wandering without meta-awareness of one’s mind wandering (or, “zoning out”) is particularly harmful to task performance. At the same time, our data, like theirs, suggest that mind wandering with awareness can have negative consequences. Figure 4 shows that, whereas increased awareness of mind wandering was associated with higher self-rated performance, even the highest levels of meta-awareness during mind wandering predicted considerably lower performance ratings than did on-task thoughts; thus, awareness of off-task thought does not necessarily trigger enough (or timely enough) conscious focus to prevent errors. Further laboratory and daily-life research should address the performance consequences of mind wandering with and without awareness (see also Smallwood, Fishman, & Schooler, 2007; Smallwood, McSpadden, & Schooler, 2008).

Indeed, we suggest that mind wandering, in general, should become a phenomenon of choice in studies of conscious awareness, metacognition, executive control, and individual differences therein (see Smallwood & Schooler, 2006). Unlike other theoretically diagnostic outcome variables, such as action slips, RT variability, and perseverative errors, mind wandering is readily observable (albeit indirectly) in a wide variety of laboratory tasks and ecological settings. Moreover, technological advances are increasingly allowing researchers to triangulate self-report, behavioral, and neuroimaging data as a means to better measure and understand mind wandering and other subjective experiences (e.g., Christoff, Gordon, Smallwood, Smith, & Schooler, 2009; Mason et al., 2007; Smallwood, Beach, Schooler, & Handy, 2008). We contend that ecological and individual-differences investigations of mind wandering, like the present one (see also Kane et al., 2007), should similarly contribute to building comprehensive theories of conscious awareness and control.

AUTHOR NOTE

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REFERENCES


NOTES

1. McVay and Kane (2009) also collected working memory capacity (WMC) data from these subjects, but the present sample was too small to detect WMC effects on daily-life mind wandering (it was only about half that of Kane et al., 2007).

2. The significant effects on mind wandering in the present study for the “effort” posed by current activities may have differed here from Kane et al. (2007) because we modified this prompt between studies. In the present study, the prompt asked whether one’s activity was mentally effortful, whereas Kane et al. did not use the “mentally” qualifier (thus conflating physical and mental effort).

3. We recognize the possibility that, although mind wandering is often detrimental to immediate task performance, it may serve the adaptive function of allowing people to keep their broader life goals mentally accessible (e.g., Klinger, 1971; Singer, 1968; Singer & Singer, 2006).

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