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Distracted by Your Mind? Individual Differences in Distractibility Predict Mind Wandering

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Attention may be distracted from its intended focus both by stimuli in the external environment and by internally generated task-unrelated thoughts during mind wandering. However, previous attention research has focused almost exclusively on distraction by external stimuli, and the extent to which mind wandering relates to external distraction is as yet unclear. In the present study, the authors examined the relationship between individual differences in mind wandering and in the magnitude of distraction by either response-competing distractors or salient response-unrelated and task-irrelevant distractors. Self-reported susceptibility to mind wandering was found to positively correlate with task-irrelevant distraction but not with response-competition interference. These results reveal mind wandering as a manifestation of susceptibility to task-irrelevant distraction and establish a laboratory measure of general susceptibility to irrelevant distraction, including both internal and external sources.

Keywords: mind wandering, task-unrelated thoughts, attention, response-competition, distractibility

Efficient task performance requires that attention be focused exclusively on information relevant to the task while task-irrelevant distracters are ignored. However, failures to ignore irrelevant distractors abound, and much attention research has been devoted to measuring distraction and delineating its critical determinants (e.g., Egeth & Yantis, 1997; Eriksen & Eriksen, 1974; Lavie, 1995; Lavie, Hirst, De Fockert, & Viding, 2004).

This research has almost exclusively focused on cases of distraction by extraneous external stimuli presented during the task performance (e.g., the presence of a response-competing distractor—e.g., see Lavie, 1995—or one that has a unique visual or auditory feature; Dalton & Lavie, 2004; Theeuwes, 1992). In daily life, however, people may often find their attention being distracted from its intended focus on their task by their own thoughts when their mind wanders off the task and onto some task-unrelated topic. For instance, readers of this article may find their thoughts drifting off at some points (perhaps during the Method section) into other directions (e.g., an interesting issue they have heard about in the morning news).

Such mind wandering can be a particularly potent internal source of distraction and produce frustrating impediments to task

performance. Nevertheless, despite an increasing interest in the study of mind wandering (e.g., see Kane & McVay, 2012; McVay & Kane, 2010; Smallwood, 2010; Smallwood & Schooler, 2006), this growing literature has remained largely separate from mainstream study of selective attention and distraction. Thus, previous research has not as yet established mind wandering as another manifestation of an individual's vulnerability to distraction. Our aim in the present study was therefore to examine and establish the relationship between mind wandering and external distraction. We reasoned that if mind wandering propensity is, at least in part, driven by an overall vulnerability to irrelevant distraction, then individual differences in mind wandering should be associated with individual differences in other measures of distraction (by external stimuli).

Because of its highly subjective nature, measures of mind wandering typically rely on subjective reports (see Smallwood & Schooler, 2006, for a review). Our second aim in this study was therefore to examine whether mind wandering propensity can be predicted from behavioral performance measures of distraction.

Existing measures of mind wandering typically use either intermittent thought probes during a task or questionnaires. These two types of mind wandering reporting have been consistently found to correlate with each other and to relate in the same manner to other variables (e.g., Smallwood, Baracaia, Lowe, & Obonsawin, 2003; Smallwood et al., 2004; Smallwood, Heim, Riby, & Davies, 2006). In the present study, the questionnaire approach was most appropriate for two reasons: We wished to assess the general tendency to mind wander rather than the specific tendency for mind wandering during the particular task used. Most important, we wished to avoid any confounding effect of the thought probes themselves on our behavioral index of external distraction and vice versa any effects of the distractors we have used on mind wandering.

To assess the propensity to mind wander, we therefore used the Daydreaming Frequency subscale (DFS) of the Imaginal Processes Inventory (Singer & Antrobus, 1970). This is the best established

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questionnaire measure of individual differences in propensity to mind wander. Moreover, it is exclusively focused on mind wandering rather than other types of attention failure, and thus any correlation between this measure and external distraction can be attributed specifically to mind wandering. The DFS has been shown to have good internal consistency, test–retest reliability, and concurrent validity (Tanaka & Huba, 1985–1986). Scores on this test were found to correlate with other self-report measures of mind wandering such as diary keeping (Gold, Teague, & Jarvinen, 1981) and thought probing (Hurlbert, 1980). Scores on the DFS have also recently been shown to correlate with the increased neural activity in regions of the default network, suggested to be associated with task-unrelated thought, when performing practiced tasks (during which participants had previously been shown to report more task-unrelated thought) compared with novel tasks (Mason et al., 2007).

To measure distractibility, we used the response-competition paradigm, a well-established and widely used index of distraction (Eriksen & Eriksen, 1974; Forster & Lavie, 2007; Lavie, 1995). Participants made speeded forced-choice responses to one of two target letters (*X* or *N*) while attempting to ignore a distractor letter that was either response-congruent (e.g., distractor *X* for target *X*) or response-incongruent (e.g., distractor *N* for the target *X*) presented in the periphery on 80% of trials. As is standard in this paradigm, distractor interference was calculated by subtracting the mean reaction time (RT) to trials with response-congruent distractors from the mean RT to trials with response-incongruent distractors.

The distractor interference measured in the response-competition paradigm might differ, however, from interference from task-unrelated thoughts in one potentially important respect. Far from being task unrelated, the distractors in the response-competition paradigm are closely task-related: having the same identity as the response targets. We therefore also included a recently established (Forster & Lavie, 2008a, 2008b) measure of vulnerability to task-irrelevant distractions, presenting a salient and meaningful distractor image (e.g., of Superman) in the periphery on a minority of the trials (10%). Within this paradigm, distractor interference from the task-irrelevant stimuli is calculated as the mean RT in the distractor present trials minus the mean RT in the no-distractor trials.

Experiment 1

Method

Participants. Ninety-four undergraduate psychology students (21 men), between 18 and 47 years of age ($M = 20$ years old), participated in Experiment 1. Two participants had very low accuracy in incongruent trials (<25%), which, coupled with their high accuracy on congruent trials (>85%), suggested misunderstanding of task instructions (i.e., they had responded to the distractor rather than the target). The data of these two participants were therefore excluded from all analyses.

Stimuli and procedure. All stimuli in all experiments were presented using E-Prime on a computer with a 15-in. monitor at a viewing distance of 57 cm. Participants were presented with an attention task followed by the 12-item DFS of the Imaginal Processes Inventory (Singer & Antrobus, 1970). In each trial of the attention task, participants were presented with a centrally pre-

sented fixation point (500 ms), followed immediately by a stimulus display (100 ms) consisting of a target letter (either *X* or *N*, subtending $0.6^\circ \times 0.4^\circ$) arranged with five small nontarget *O*s ($0.15^\circ \times 0.12^\circ$) in a circular formation (1.6° radius) around fixation. The targets and nontargets were presented in gray (with the RGB values 160, 160, 160) on a black background. Participants were instructed to search this display for the target letter, ignoring any stimuli that did not appear as part of the circular search array, and to press the *O* key for an *X* and the *2* key for an *N* as fast as possible while being accurate.

On the first three trials of every block (these three trials were intended as warm-up trials and were excluded from all analyses) and 10% of the remaining 60 trials in each block, this circular search array was presented alone. This was the no-distractor condition, and all combinations of target position and target identity were fully counterbalanced on these trials. On 80% of the trials (excluding the first three trials in each block), a light gray (with the RGB values 200, 200, 200) response-competition distractor (either an *X* or an *N*, $0.8^\circ \times 0.5^\circ$) was presented to either the left or the right of the circular search array, 1.4° from the nearest circle letter. All combinations of distractor–target compatibility, target identity, target location, and distractor location were fully counterbalanced for these trials.

On the remaining 10% of trials (excluding the first three trials of each block), a task-irrelevant cartoon character distractor (Superman, Spiderman, Pikachu, SpongeBob SquarePants, Mickey Mouse, or Donald Duck), subtending 2.8° to 4° vertically \times 2.8° to 3.2° horizontally, was presented above or below the circular search array (with its center 4.6° from fixation and between 6° and 10° edge to edge from the nearest circle letter). The task-irrelevant distractors remained onscreen until response. For these trials, all combinations of distractor position, target position, and target identity were fully counterbalanced, and each specific distractor was equally likely to appear with each combination of target identity and target position. A 90-ms beep was sounded on incorrect responses or if the participant failed to respond within the 2,000-ms time limit.

Participants who did not achieve 65% accuracy during the two practice blocks repeated the practice blocks. After the practice blocks, participants performed four blocks of 63 trials of the attention task before finally completing a computerized version of the DFS of the Imaginal Processes Inventory.

To test for the possibility that participants might vary in their level of familiarity with the cartoon distractor images we used or in their level of interest in each of these images (factors that could potentially influence the likelihood of distraction), the majority ($n = 45$) of the participants also completed a follow-up session approximately one year following the first session. In this session, they provided ratings of each image on 8-point scales for familiarity, interest, stimulation, and meaningfulness. Participants were also asked to fixate on each distractor image for 1 min and then indicate on a 7-point scale whether they had few or many thoughts about the cartoon picture or (on another 7-point scale) about things unrelated to the cartoon picture.

Results and Discussion

In all experiments, RT analyses were performed on correct responses only. Table 1 presents the results for the two behavioral measures of distraction. As can be seen in the table, the task

Table 1
Mean Reaction Times (in Milliseconds) and Error Rate Percentage as a Function of Distractor Condition in Experiments 1–3

| Variable | Distractor condition | | | | | |
|--------------|----------------------|------------|-------|----------|------------|---------|
| | I | C | I – C | ID | ND | ID – ND |
| Experiment 1 | | | | | | |
| RT (SE) | 623 (10) | 577 (8.43) | 46 | 615 (10) | 567 (9.28) | 48 |
| % error | 17 | 11 | | 13 | 11 | |
| Experiment 2 | | | | | | |
| RT (SE) | | | | 516 (20) | 481 (15) | 35 |
| % error | | | | 10 | 14 | |
| Experiment 3 | | | | | | |
| RT (SE) | 806 (24) | 708 (17) | 98 | 789 (18) | 685 (16) | 104 |
| % error | 16 | 7 | | 14 | 10 | |

Note. RT = reaction time; I = response-incongruent distractor; C = response-congruent distractor; ID = irrelevant distractor; ND = no distractor.

provided a sensitive measure of distraction. Robust interference effects on task RT were found from both the irrelevant distractors, $t(91) = 7.12$, standard error of the mean (SEM) = 6.69, $p < .001$, for the increase in mean RT on irrelevant distractor versus no-distractor trials and the response competing distractors, $t(91) = 11.42$, $SEM = 4.00$, $p < .001$, for the increase in RT on response-incongruent versus response-congruent distractor trials. There was no correlation between the two measures of distractor interference, Pearson $r(92) = .041$, $p = .701$ (two-tailed as in the rest of the statistical reports).

Mind wandering scores ranged between 19 and 58 ($M = 39$). Figure 1 plots mind wandering scores as a function of individual differences in the magnitude of the irrelevant distractor interference effects.¹ As shown in the figure, there was a positive correlation between the mind wandering scores and irrelevant distractor interference effects, Pearson $r(92) = .262$, $p = .012$; higher mind wandering scores were associated with greater interference from the irrelevant distractors. No relationship was found between mind wandering and irrelevant distractor effects on errors ($p > .8$).

Our follow-up session results indicated that mind wandering scores were not associated with the ratings of the stimulation, familiarity, interest, or meaningfulness of the cartoon images, nor were they associated with the extent to which participants reported thoughts about the cartoon images during the follow-up session (all r values $< .1$, all p values $> .5$, with the exception of familiarity, for which $r = -.13$, $p = .38$). The reduced sample size in the follow-up session necessitates particular caution in interpreting these null effects.² However, the lack of any statistical trends approaching significance makes it unlikely that a larger data set would have revealed evidence supporting an alternative account of the correlation between mind wandering and irrelevant distraction simply in terms of differences in individual response to the cartoon stimuli.

However, our follow-up data set did reveal positive correlations between cartoon-unrelated (i.e., task-unrelated) thoughts and both the magnitude of irrelevant distractor effects in the first session, $r(45) = .302$, $p = .044$, and mind wandering scores, $r(45) = .381$, $p = .010$. In other words, even when asked to fixate on the cartoon distractor images, participants with wandering minds were more likely to produce thoughts unrelated to these. These findings replicate and extend our finding of the relationship between mind

wandering and task-irrelevant external distraction using an online measure of mind wandering. Such replication further supports our proposal of a relationship between mind wandering and external distraction, while making alternative accounts in terms of questionnaire-related issues (e.g., reporting biases) appear unlikely.

In contrast to the pattern found in relation to the irrelevant distractors, response-competition effects were not positively related to mind wandering: In fact, the (nonsignificant) trend was for a negative correlation, $r(92) = -.133$, $p = .20$. A similar nonsignificant trend was found in relation to response-competition effects on errors, $r(92) = -.194$, $p = .063$. Thus, the relationship between mind wandering and external distraction does not appear to extend to response-competition interference. Indeed, we have previously found that although perceptual load, a well-established determinant of attention, can modulate both mind wandering and response-competition effects (and while individual differences in the magnitude of perceptual load effect on one measure correlate with those on the other measure; Forster & Lavie, 2009, Experiment 4), the two measures do not correlate with each other, $r(20) = .024$, $p > .90$.

Our present findings that the two external distraction measures did not correlate with each other and that only irrelevant distraction correlates with mind wandering suggest two distinct forms of distraction depending on whether the source is task relevant or irrelevant. However, although we suggest task relevance is the critical factor, we note that our two measures (response-competition and irrelevant distraction) also differed in terms of several other factors such as visual salience, frequency of presentation, and semantic meaning (see footnote 2). We return to the dissociation between these different forms of distraction further in Experiment 3, which directly addresses the role of task relevance while controlling for other differences. However, we first focus on

¹ Note that even after excluding the participant with the highest irrelevant distractor interference effect, our correlation remains significant at $r(91) = .198$, $p = .03$, one-tailed.

² Within this reduced sample, Experiment 1's correlation between irrelevant distractor interference and mind wandering is reduced to marginal significance, $r(45) = .227$, $p = .067$, one-tailed.

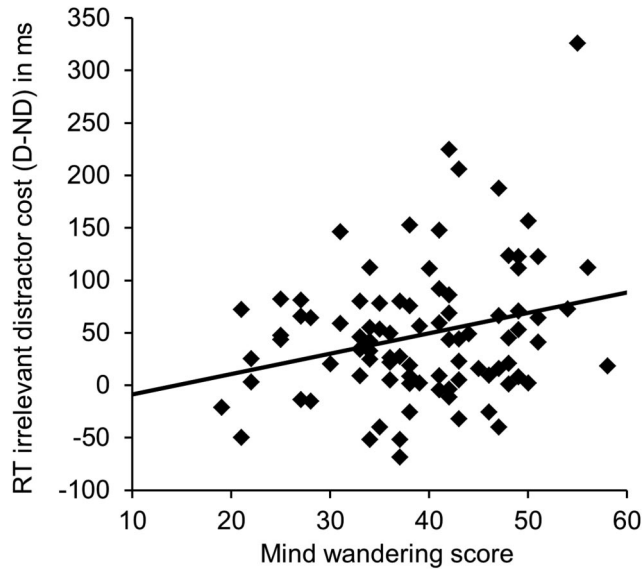


Figure 1. Mind wandering and irrelevant distractor interference in Experiment 1. Mind wandering (score on the Daydreaming Frequency subscale) correlated positively with mean irrelevant distractor cost (mean RT for distractor trials – mean RT for no-distractor trials, in milliseconds). RT = reaction time; D = distractor; ND = no distractor.

further characterizing the positive association between mind wandering and our irrelevant distraction measure.

Experiment 2

The correlation between mind wandering and task-irrelevant external distraction in Experiment 1 appears to support our hypothesis that mind wandering propensity is driven by overall differences in susceptibility to irrelevant distraction. However, it remains possible that the increased mind wandering reported by the more distracted individuals could instead reflect an effect of the irrelevant distractors on mind wandering. For example, the meaningful distractor cartoons may have triggered associations not just directly related to the cartoon images themselves but also related to other topics that could stimulate mind wandering (e.g., a current ongoing goal or concern; e.g., Klinger, 1971, 2009; Smallwood & Schooler, 2006). For example, the Spider-Man image might trigger mind wandering about personally relevant concerns or goals relating to the friend with whom one saw the Spider-Man movie (e.g., “I must remember to call him tonight”). Such mind wandering during the task could explain the results of Experiment 1 if it led participants to overestimate their general susceptibility to mind wandering in the questionnaire report following the experiment.

To examine this account, in Experiment 2, we incorporated intermittent thought probes into our paradigm, thus allowing comparison of levels of mind wandering versus external distraction during task performance. To assess effects of distractor presentation on participant thoughts, we varied whether thought probes were presented immediately following a distractor or following five or more consecutive no-distractor trials.

If our results are explained by a direct effect of the distractor cartoons, then a greater rate of task-unrelated thought should be

found immediately after a distractor compared with after several trials without any distractors. In contrast, our hypothesis that mind wandering and irrelevant external distraction are linked via the same trait (of general susceptibility to irrelevant distraction) does not lead to any prediction regarding the effects of distractor presence on mind wandering.

To test our hypothesis further, we also increased the number of task blocks, allowing us to examine variation in both variables as a function of time on task. Mind wandering is typically found to increase with time on task (e.g., Smallwood, Obonsawin, & Reid, 2003; Teasdale et al., 1995). Conversely, irrelevant distractor effects might be expected to get smaller over time because of increased habituation to the distractor (e.g., Forster & Lavie, 2008a). Such a contrasting pattern would also serve to rule out an alternative account in terms of a task-specific relationship between the irrelevant distractor and mind wandering.

Method

Participants. Fourteen new participants (seven men), between the ages of 19–35 years ($M = 24.5$ years) participated in Experiment 2. All subjects had normal or corrected-to-normal vision.

Stimuli and procedure. Participants performed a computerized task similar to that used in Experiment 1, with the following exceptions. No response-competition distractors were presented, so the composition of trials was 10% irrelevant distractor present and 90% no distractor present. At the end of each block, participants were presented with a thought probe consisting of the on-screen question, “What were you thinking just now?” Onscreen instructions prompted participants to make button-press responses indicating whether their thoughts at the time of the probe were either about the letter search task, related to the cartoon images, or unrelated to either task or distractor stimuli. Participants were given definitions and examples of all three categories of thoughts prior to participation. They were instructed to respond to the thought probes in their own time and not prepare for them in any way during the task block (e.g., by keeping fingers on the response keys).

Participants performed two practice blocks of 12 trials (each ending in a practice thought probe) before completing 16 blocks of the task (each ending in a thought probe). The probes were presented either immediately after a distractor trial or after a minimum of five no-distractor trials. Given the low frequency of distractor trials, to discourage participants from associating distractor presentation with probes, we presented the majority (10/16) of probes after no-distractor trials. In addition, to make the appearance of thought probes less predictable, block length was varied: Blocks were equally likely to be 20, 40, or 60 trials in length. Block length was counterbalanced with block type (distractor before probe, no distractor before probe). The order of block types was random, with the restriction that both types were equally represented in the first and second halves of the task.

Results and Discussion

Responses to thought probes. Participants reported task-unrelated thoughts on 40% ($SEM = 4.82$) of the probes on average. The rate of thoughts related to the cartoon images ($M = 16\%$)

was significantly smaller, $t(13) = 3.85$, $SEM = 5.87$, $p = .002$, and these were more likely to be reported for a probe following a distractor ($M = 29\%$) versus a probe following five or more no-distractor trials ($M = 11\%$), $t(13) = 2.57$, $SEM = 6.97$, $p = .024$. This suggests that on a minority of trials, the presence of the distractors may have triggered thoughts directly relating to the content of the cartoon images. It is important to note, however, that the distractor did not appear to trigger task-unrelated mind wandering: Task-unrelated thoughts were no more likely to be reported after distractor presentation ($M = 36\%$) than after no distractor ($M = 42\%$), $t(13) = -1.02$, $SEM = 6.30$, $p = .326$.

Effects of time on task. Mean RTs and error rates in Experiment 2 are presented in Table 1. As in Experiment 1, the presence of an irrelevant distractor produced significant interference relative to the no-distractor baseline, $t(13) = 4.62$, $SEM = 7.55$, $p < .001$. Mean irrelevant distractor RT costs and percentage of task-unrelated thought reports as a function of time on task can be seen in Table 2.

To directly compare effects of time on task on internal versus external distraction, we standardized both variables (into Z scores) and entered them into a repeated-measures analysis of variance with the factors of distractor type (internal, external) and time on task (Blocks 1–8, Blocks 9–16). The analysis of variance revealed no significant main effect of distractor type, $F < 1$, or time on task, $F(1, 13) = 3.05$, mean square error (MSE) = 1.36, $p = .104$. However, there was a significant interaction between time on task and distractor type, $F(1, 13) = 7.94$, $MSE = 0.869$, $p = .015$, reflecting the opposite effects of time on task (see Figure 2): Whereas interference from irrelevant external distractors was significantly reduced with increased time on task (see Table 2), $t(13) = 3.34$, $SEM = 10.38$, $p = .005$, the level of task-unrelated thoughts showed only a weak trend toward increasing ($t < 1$).

Thus, the results of Experiment 2 show no increase in mind wandering after distractor presentation, and time on task was found to have differential effects on internal (i.e., task-unrelated mind wandering) versus external distraction. Therefore, the results of Experiment 2 do not support the notion of any direct influence of moment-to-moment fluctuations in one form of distraction on the other. Rather, the correlation with mind wandering scores appears to be driven by a more general propensity.

Experiment 3

Having established a positive association between mind wandering and task-irrelevant external distraction that is not driven by direct effects of irrelevant distraction on mind wandering, we now examine the second key finding of Experiment 1: Unlike irrelevant

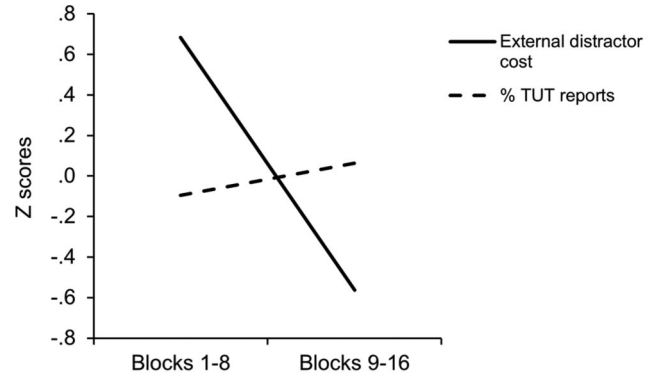


Figure 2. Percentage of task-unrelated thought (TUT) reports and external distractor cost (mean reaction time for distractor trials – mean reaction time for no-distractor trials) as a function of time on task. Both measures are standardized to Z scores. As can be seen, the two types of distractors show contrasting patterns of variation as a function of time on task.

distractor interference, response-competition interference was not related to mind wandering. This dissociation highlights that mind wandering is not related to all forms of external distractor interference. We propose that mind wandering may be specifically related to task-irrelevant forms of distraction. As mind wandering is, by definition, the propensity to have task-unrelated thoughts, it seems plausible that this would be positively linked to distraction from external stimuli that are also unrelated to the current task. By contrast, response-competition interference effects are defined on the basis of the relevance of the distractors to the task response and reflect not only the ability to ignore distractors but also processes relating to the specific task–distractor relationship (e.g., response-conflict resolution; Botvinick, Braver, Barch, Carter, & Cohen, 2001). It is unclear to what extent the latter processes are related to the general ability to ignore salient yet irrelevant distractors: Indeed, we note that the two forms of external distraction were not correlated in Experiment 1. Thus, task relevance may be the critical factor underlying the contrasting relationships of the two external distraction measures to mind wandering.

However, before drawing such a conclusion, it was important to test other accounts for our findings. We note that the two distractor types in Experiment 1 differed not only in terms of task relevance but also in terms of salience, novelty (recall that the irrelevant distractors appeared considerably less frequently than the response-competition distractors), visual complexity, and semantic meaningfulness. To rule out the possibility that any of these factors could alternatively account for our dissociation, we designed Experiment 3 to directly examine the role of task relevance while keeping these other characteristics constant across distractor type. Participants performed a task in which cartoon image distractors were presented either as task-irrelevant distractors (as in Experiment 1) or as task-relevant response-competition characters. Participants were asked to classify centrally presented names of cartoon characters as either a superhero or a Disney character while ignoring cartoon distractor images, presented on the minority of trials in the periphery. These were equally likely to be congruent or incongruent response-competition distractors (selected from images of the six Disney characters and six superheroes whose names were used as target stimuli) or task-irrelevant

Table 2

Mean Reaction Time Distractor Costs (in Milliseconds) and Percentage of Reported Task-Unrelated Thoughts as a Function of Time on Task in Experiment 2

| Distractor measure | Blocks 1–8 | Blocks 9–16 |
|-------------------------------------|------------|-------------|
| Irrelevant distractor cost (SE) | 54 (9) | 19 (10) |
| % task-unrelated thought (SE) | 39 (6) | 41 (6) |

Note. Irrelevant distractor cost = mean reaction time with the irrelevant distractor – mean reaction time with no distractor.

distractors (cartoon characters who were neither Disney nor superhero characters; e.g., Bart Simpson). Each distractor image was repeated the same number of times to keep the same level of novelty across the distractor types. By using meaningful, visually complex cartoon images of equivalent visual salience and novelty as both task-relevant and task-irrelevant distractors, we sought to isolate differences in task relevance.

In addition, we sought to establish that the observed relation between irrelevant distraction and mind wandering was not influenced by differences in awareness of cognitive processes or confidence in cognitive abilities. For example, as a result of the negative outcomes that tend to be associated with distraction (e.g., car accidents, losing work while computing, problems in the workplace; see Forster & Lavie, 2008a, for brief review), highly distractible individuals may be more aware of their general vulnerability to cognitive failure and thus overestimate their mind wandering. For this purpose, participants also completed the Meta-Cognitions Questionnaire (Cartwright-Hatton & Wells, 1997), which contains subscales measuring cognitive confidence and cognitive self-consciousness. Finally, in Experiment 1, the mind-wandering questionnaire was always administered after task performance, so the questionnaire response may have been influenced by the degree of distraction and mind wandering during the task rather than representing general tendencies. To rule out this possibility, we administered the questionnaires before the task in Experiment 3.

Method

Participants. Forty new participants (15 men), 19–28 years old ($M = 23$ years) participated in Experiment 3. All participants had normal or corrected-to-normal vision and were able to recognize the cartoon images (this was assessed after their participation in the experiment).

Stimuli and procedure. Participants first completed the DFS of the Imaginal Processes Inventory (Singer & Antrobus, 1970) before performing the new attention task. In this task, all stimuli were presented on a black background. In each trial, a 500-ms presentation of a light gray fixation point was immediately followed by the task display, which remained onscreen either until response or for 2,000 s in the case of no response. The task display consisted of the name of either a superhero (from the set Superman, Spiderman, Hulk, Wolverine, Batman, Robin) or a Disney character (from the set Mickey, Donald, Pluto, Pooh, Piglet, Tigger) presented with equal likelihood in one of six positions with the nearest edge either 0.3° , 1.3° , or 2.3° of visual angle above or below fixation. The names were presented in light gray (RGB = 180, 180, 180), with title case, subtending 0.5° vertically by $0.9^\circ \times 2.3^\circ$ horizontally. Participants were instructed to respond by pressing the 0 key for a superhero and 2 for a Disney cartoon as fast as possible while maintaining a high level of accuracy. During the task instructions, participants were shown a list of the names of the superheroes and Disney characters and asked to classify them verbally; all participants were able to do this. A beep was heard if the participant made an error or failed to respond within the 2,000-ms time window.

On 90% of trials, the cartoon names appeared alone—this was the no-distractor condition. On 10% of trials, a cartoon image subtending $3.8^\circ\text{--}5^\circ \times 2.4^\circ\text{--}3.8^\circ$ appeared either to the right or to

the left (4.4° from fixation, minimum of 0.7° nearest edge to edge of target stimuli) of the screen. This distractor image was selected with equal probability from task-relevant images of the 12 superhero or Disney cartoon characters whose names served as target stimuli and task-irrelevant images of six other cartoon characters that were neither superheroes nor Disney stimuli: SpongeBob SquarePants, Hello Kitty, Cartman from the South Park cartoon, Bart Simpson, an Angry Bird, and Pikachu. The distractor image was equally likely to be either response-congruent (the same cartoon character whose name appeared as the target stimulus), response-incongruent (a cartoon character from the opposite character to the target stimulus; e.g., an image of the superhero Batman accompanying the name of the Disney character Piglet), or task irrelevant or neutral (a cartoon character who was neither superhero nor Disney cartoon) in relation to the target name stimuli.

Participants completed a practice block of 12 trials before completing 12 blocks of 60 trials. The first three trials of each block were considered warm-up trials and so always had no distractors—these trials were therefore excluded from analysis. After the attention task, participants completed the Meta-Cognitions Questionnaire. Finally, to confirm that all participants were familiar with the cartoon images prior to the experimental session (this was critical given that the identity of the characters determined their task relevance), participants were shown images of each cartoon character distractor and asked to name and provide details of the character.

Results and Discussion

See Table 1 for mean RTs in each distractor condition. As in Experiment 1, the two indices of external distraction were calculated as response-competition effects (incongruent minus congruent) and irrelevant distractor effects (irrelevant distractor minus no distractor). Once again, the task proved a sensitive measure of distraction, as both types of distractor produced significant RT interference: For the response-competition distractor effects, $t(39) = 7.67$, $SEM = 12.81$, $p < .001$; for the irrelevant distractor effects, $t(39) = 14.94$, $SEM = 6.97$, $p < .001$.

In contrast to Experiment 1, the two forms of distractor interference were significantly correlated in Experiment 3, $r(40) = .309$, $p = .026$. This seems likely to reflect effects of the additional factors that the two types of external distractor have in common in Experiment 3 (e.g., visual salience, meaning, novelty).

Critically, the relationship of these measures to mind wandering replicated the pattern found in Experiment 1. Mind wandering scores showed a similar range to that in Experiment 1 (22–58, $M = 40$). As in Experiment 1, mind wandering was positively related to the degree of interference from task-irrelevant distractors: $r(40) = .378$, $p = .016$, see Figure 3. In contrast, mind wandering was not significantly related to interference from the task-relevant response-competition distractors, showing only a weak negative trend: $r(40) = -.119$, $p = .465$. Mind wandering showed no relation to either error measures: For irrelevant distraction, $p > .45$; for RC effect, $r = .185$, $p > .25$. Note that the measures of cognitive confidence and cognitive self-consciousness were not related to either form of external distraction ($ps > .24$), suggesting that the above correlations are specific to mind wandering rather than a generally increased awareness of or tendency to report cognitive failure.

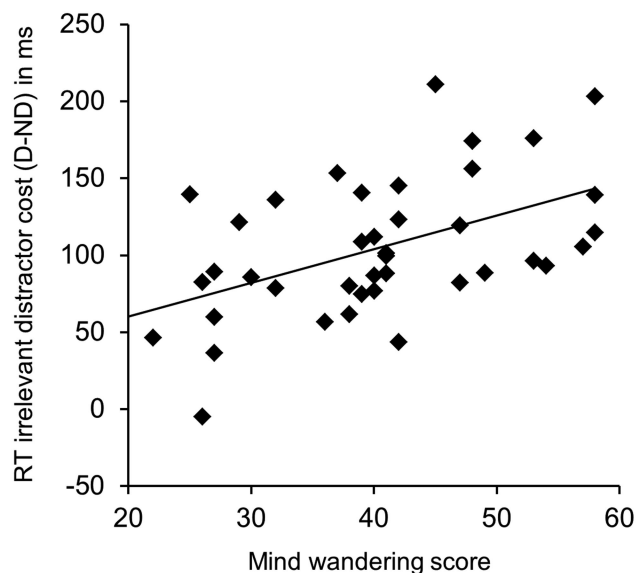


Figure 3. Mind wandering and irrelevant distractor interference in Experiment 3. Mind wandering (score on the Daydreaming Frequency subscale) correlated positively with mean irrelevant distractor cost (mean RT for distractor trials – mean RT for no-distractor trials, in milliseconds). RT = reaction time; D = distractor; ND = no distractor.

The results of Experiment 3 provide a striking replication of Experiment 1's key finding that mind wandering is related to interference from the task-irrelevant distractors but not from the task-relevant response-competition distractors. As the two distractor types were equal in visual and semantic salience, as well as novelty, it appears that irrelevance to the task is indeed a key factor in determining the relationship with mind wandering. As in Experiment 2, irrelevant distractor interference decreased as a function of time on task: Interference effects in Blocks 1–6 were significantly greater than those in Blocks 7–12, $t(39) = 3.34$, $SEM = 15.82$, $p < .01$; see Table 3 (although it is interesting that no such reduction was found on the response-competition effects, $t < 1$).

The greater number of no-distractor trials in Experiment 3 also allowed us to examine the relation between mind wandering and individual differences in baseline (i.e., the no-distractor condition) mean RT, RT variability (standard deviation), and error rate. No relation was found between mind wandering scores and any of these measures (all $ps > .2$). The lack of relation of mind wandering scores to RT variability may appear inconsistent with previous findings (McVay & Kane, 2009; Seli, Cheyne, & Smilek, 2013) that increased reports of task-unrelated thoughts during sustained attention or rhythm-keeping tasks are associated with increased RT variation. However, although higher mind wandering scores on the DFS questionnaire may be linked to a greater rate of task-unrelated thought during our task, it is not clear how sensitive this particular task is to revealing individual differences in task-unrelated thoughts online, that is, during task performance. For example, unlike a sustained attention task, the request to make choice responses to cartoon categories and the presence of distractors on some of the task trials may have led the participants to be more attentive and task engaged overall, reducing their tendency to

lapse into task-unrelated thought. Moreover, in contrast to the continuous response methods used in previous studies on RT variability, our task was likely to be less sensitive to show effects on RT variability because of its discrete trial-by-trial nature that allowed for a degree of self-pacing (because each trial was terminated by the participant's response and thus participants' RT determined the trial duration, a factor that may encourage a more regular pacing).

General Discussion

The present study establishes for the first time a link between the propensity for mind wandering and a behavioral measure of susceptibility to external irrelevant distraction. In two experiments, we have demonstrated a positive correlation between mind wandering propensity and distraction by the presence of salient yet task-unrelated distractor images. This finding is important in establishing mind wandering as a symptom of a more general susceptibility to irrelevant distraction. However, our findings also highlight that not all forms of distractor interference are related: Mind wandering is not related to interference from task-relevant response-competition distractors. These findings have implications both for the understanding of mind wandering and for the selective attention study of distraction. We consider these implications in the following sections.

Selective Attention and the Study of Distraction

Selective attention research has previously largely neglected internal forms of distraction (although see Forster & Lavie, 2009, for an exception). The present work allows us to extend selective attention research to also accommodate distraction by internal sources. Our results suggest that distraction from task-irrelevant sources, both external and internal, may be driven by common attentional mechanisms, which vary in efficiency between individuals.

Task irrelevance appears to be a key factor in determining the relationship between mind wandering and external distraction: This is highlighted by the contrasting correlations with mind wandering found for the two distractor measures in the present study. Individuals prone to off-task mind wandering also appear more likely to be distracted by task-irrelevant stimuli in the external environment. On the one hand, they are no more likely to suffer interference from stimuli that are relevant to the task, even when these are highly salient and meaningful (Experiment 3). These findings suggest that the interference produced by response-competition distractors reflects, at least in part, a different mecha-

Table 3
Mean Reaction Time Distractor Costs (in Milliseconds) by Distractor Measure and Time on Task in Experiment 3

| Distractor measure | Blocks 1–6 | Blocks 7–12 |
|--|------------|-------------|
| Irrelevant distractor cost (<i>SE</i>) | 131 (10) | 78 (11) |
| Response-competition cost (<i>SE</i>) | 98 (18) | 94 (13) |

Note. Irrelevant distractor cost = mean reaction time with the irrelevant distractor – mean reaction time with no distractor; response-competition cost = mean reaction time with an incongruent distractor – mean reaction time with a congruent distractor.

nism from that underlying irrelevant distraction (whether from external stimuli or mind wandering). It is, for example, possible that although both sources of distraction reflect a failure to focus attention, the distraction from sources that are entirely irrelevant and unrelated to the task may reflect a different level of inability to focus on the current task. On the other hand, distraction from response-competition items may reflect a more specific type of failure to control task performance in line with the current task priorities (and thus a failure to consider target information with a higher priority than potentially competing distractor information). Further examination of this new dissociation between task-relevant versus task-irrelevant distraction should be an important topic for future investigations of individual differences in attention, as well as for elucidating the shared mechanisms underlying both task-irrelevant external distraction and mind wandering.

Implications for Mind Wandering

Given the well-established role of executive control in overcoming external distraction (e.g., De Fockert, Rees, Frith, & Lavie, 2001, 2004; Lavie, 2000; Lavie & De Fockert, 2006), our suggestion of a common mechanism underlying both mind wandering and task-irrelevant external distraction may be taken to allude to executive control and thus initially appear consistent with the view of mind wandering as reflecting a failure of executive control (e.g., see McVay & Kane, 2010). Previous evidence for this viewpoint has been drawn primarily from studies demonstrating that individuals scoring highly on a behavioral index of working memory capacity (a classic executive control function) reported reduced task-unrelated mind wandering (e.g., Kane et al., 2007; McVay & Kane, 2009; although see Levinson, Smallwood, & Davidson, 2012, for a conflicting finding). However, we note that the contrasting relationship with response-competition interference (which is also thought to depend on executive control processes; Botvinick et al., 2001; Lavie et al., 2004) is inconsistent with the notion of mind wandering being determined simply by differences in the generic efficiency of executive control. Indeed given the multitude of executive control functions (e.g., Shallice & Burgess, 1996), it appears likely that the executive functions involved in the propensity for both mind wandering and irrelevant distraction are different from those involved in the propensity for interference in response-competition paradigms. The propensity for task-unrelated thoughts and distraction may reflect a control failure at a different level from that reflected in response-competition, as we mentioned in the previous section.

Despite the correlation between individual differences in mind wandering and task-irrelevant external distraction, Experiment 2 did not reveal any online relationship between the two forms of distraction during task performance. In fact, our time-on-task analyses in Experiments 2 and 3 found contrasting patterns for the effect of time-on-task on fluctuations in levels of mind wandering versus external distraction. In this respect, our findings remain consistent with previous suggestions that mind wandering involves perceptual decoupling of executive resources from external stimuli (see Schooler et al., 2011, for review). Such suggestions have been supported by demonstrations that periods of task-unrelated thought are associated with reduced event-related potential (ERP) response to, as well as

reduced encoding or comprehension of, external task-relevant stimuli. Taken together with these previous findings, our results imply that highly distractible individuals are likely to experience such decoupling from external tasks with particularly high frequency. However, it is important to note that our findings are incompatible with the notion that habitual mind wanderers have enhanced ability to insulate internal processing against all forms of external disruption (cf. Smallwood et al., 2012), as this would be expected to lead to reduced interference from the task-irrelevant external distractors. To the contrary, even though the individuals most prone to mind wandering may have experienced more periods of decoupling from our task, they were nevertheless more, rather than less, distracted by the presentation of salient task-irrelevant external distractors.

Measuring Distraction in Daily Life

Our measure of distraction by salient yet task-irrelevant external stimuli was designed to parallel a form of distraction that, like distraction from task-unrelated thoughts, is common in daily life. The positive relationship we established between these two common, yet quite different, sources of daily life distraction adds validity to our measure as an index of general daily life distractibility (regardless of whether the source is internal or external). Indeed, our findings are consistent with a recent report of positive correlations between questionnaire measures of mind wandering and of selective attention failures in daily life (Carriere, Seli, & Smilek, 2013). Our demonstration that mind wandering is associated with increased irrelevant distraction, as measured behaviorally rather than on the basis of self-report, allows us to further substantiate this claim.

In contrast, it is more difficult to think of an example of daily life distraction in which, as in the response-competition paradigm, the distractor interference is contingent on the conflicting relationship between the task-relevant distractor identity and the stimuli involved in the task being performed. The present findings support the view that our measure of task-irrelevant distraction may be a more reliable paradigm for the investigation of general daily life distraction than the frequently used response-competition paradigm. Such a measure could be particularly useful in clinical research, given that clinical diagnostic forms and checklists may often refer to increased daily life distraction without clarifying whether the source is internal or external (see Forster, Robertson, Jennings, Asherson, & Lavie, in press). With future replications and validation, our measure could also be developed into a predictive tool for identifying heightened vulnerability to mind wandering without having to rely on subjective reports.

In summary, the present study integrates the previously separate literatures of mind wandering and external distraction, demonstrating that both phenomena may be determined by common individual differences. These findings highlight that internal distraction from mind wandering is a highly understudied category of task-irrelevant distraction. To achieve a full understanding of the ubiquitous and often disruptive daily life phenomenon of failure to ignore irrelevant distractors, future researchers should include consideration of both internal and external forms of distraction in their studies.

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