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Similarities and differences between mind-wandering and external distraction: A latent variable analysis of lapses of attention and their relation to cognitive abilities

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A B S T R A C T

The current study examined the extent to which task-unrelated thoughts represent both vulnerability to mind-wandering and susceptibility to external distraction from an individual difference perspective. Participants performed multiple measures of attention control, working memory capacity, and fluid intelligence. Task-unrelated thoughts were assessed using thought probes during the attention control tasks. Using latent variable techniques, the results suggested that mind-wandering and external distraction reflect distinct, yet correlated constructs, both of which are related to working memory capacity and fluid intelligence. Furthermore, the results suggest that the common variance shared by mind-wandering, external distraction, and attention control is what primarily accounts for their relation with working memory capacity and fluid intelligence. These results support the notion that lapses of attention are strongly related to cognitive abilities.

1. Introduction

One hallmark of our cognitive system is our ability to focus attention on goal-related information and to maintain and sustain attention on goal-relevant information among potent distractors. This ability to focus attention is needed in a host of activities where any lapses of attention could result in unwanted outcomes such as driving accidents, lower academic performance, failures to spot weapons during baggage screening, and many others (e.g., Reason, 1990; Reason & Mycielska, 1982; Unsworth, Brewer, & Spillers, 2012; Unsworth, McMillan, Brewer, & Spillers, 2012). Understanding lapses of attention, whereby attention has shifted away from goal-relevant information due to external (distractions) or internal stimuli (mind-wandering) is important for understanding the attentional system more broadly and for predicting when and for whom attention failures are most likely. The current study examined the extent to which mind-wandering and external distraction are the same or different constructs and the extent to which they are related to other cognitive abilities such as attention control, working memory capacity, and fluid intelligence.

1.1. Task-unrelated-thoughts

A great deal of research has recently examined the extent to which we can maintain attentional focus on a task or whether our attention drifts to task-unrelated-thoughts. Task-unrelated-thoughts (TUTs) refer to situations in which attention has shifted from the current task to thoughts unrelated to the current task. For example, mind-wandering refers to a situation in which attention has shifted away from what a person is doing to self-generated thoughts unrelated to the task being performed. A number of laboratory techniques have been developed to examine TUTs including thought probe techniques in which periodically throughout a task participants are probed as to their current state (on-task or off-task) and this is examined as a function of various experimental manipulations and individual differences correlates (see Smallwood & Schooler, 2006 for a review). This research has found that TUTs vary as a function of task variables such as time on task, task complexity, and task difficulty (McVay & Kane, 2010; Smallwood & Schooler, 2006). Importantly, TUT rates correlate with task performance such that performance is lower when participants report TUTs on the preceding trial compared to when participants report that they are currently focused on the task (McVay & Kane, 2010; Smallwood & Schooler, 2006). In terms of individual differences, a number of recent studies have demonstrated that variation in TUTs is related to a number of cognitive variables including working memory capacity, attention

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control, reading comprehension, and fluid intelligence such that high performing participants typically report fewer TUTs than low performing participants in particularly attention demanding tasks (Kane et al., 2007; McVay & Kane, 2012b; Mrazek et al., 2012; Unsworth & McMillan, in press; see Mooneyham & Schooler, 2013 for a review). This work suggests that the probe techniques for examining TUTs have been shown to be both reliable and valid and have demonstrated the importance of examining TUTs during a number of tasks and situations.

1.2. Distinguishing mind-wandering and external distraction

Although the work reviewed above suggests the importance of TUTs to a number of domains, more work is needed to better understand the nature of TUTs. Typically, TUTs are associated with mind-wandering, in which attention is shifted from the current task to internal thoughts unrelated to the task at hand (Smallwood & Schooler, 2006). Indeed, in most of the studies reviewed previously, when referring to TUTs, the authors of those studies are primarily only talking about mind-wandering. However, given the way in which TUTs are typically assessed it is not possible to distinguish TUTs that are due to mind-wandering exclusively versus TUTs that are due to distractions from external stimuli. That is, prior work has typically relied on thought probe techniques where participants indicate that they were just on-task or off-task.[1] It is possible that when participants indicate that they are off-task that some of the time they are referring to the fact that they were mind-wandering, whereas other times they may be referring to the fact that they were distracted from external stimuli (such as the experimenter walking around). In order to better examine possible differences between mind-wandering and external distraction Stawarczyk, Majerus, Maj, Van der Linden, and D'Argembeau (2011; see also Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011) introduced a novel experience sampling method to distinguish the different varieties of TUTs. Specifically, Stawarzyk et al. used a thought probe technique in which participants were not simply instructed to indicate if they were on- or off-task, but rather participants had to indicate if they were on-task, if they were experiencing task-related interference (interfering thoughts related to the appraisal of the current task such as worry about performance), if they were distracted by external stimuli, or if they were mind-wandering. Thus, with this technique it is possible to examine the extent to which mind-wandering and external distraction similarly result in poorer task performance. Implementing this technique in the sustained attention to response task (SART; Robertson, Manly, Andrade, Baddeley, & Yiend, 1997) Stawarczyk, Majerus, Maj, et al. (2011) found that roughly 20% of the responses to the thought probes were external distractions and roughly 21% were mind-wandering. Additionally, when participants reported that they experienced either external distraction or mind-wandering performance was worse than when participants reported that they were focused on the task. Furthermore, examining individual differences Stawarzyk et al. found that individuals with high levels of either external distraction or mind-wandering tended to demonstrate worse performance than participants who reported fewer external distraction or mind-wandering. Therefore TUTs likely represent a combination of external distraction and mind-wandering, both of which are related to performance. These results point to the importance of distinguishing mind-wandering and external distraction in order to better understand the broad nature of TUTs in terms of similarities and differences between mind-wandering and external distraction.

Current theorizing has, for the most part, suggested that mind-wandering is distinct from external distraction and is not simply another form of a lapse of attention (Barron, Riby, Greer, & Smallwood, 2011; Schooler et al., 2011; Smallwood, 2013). In particular, Smallwood and colleagues have suggested that mind-wandering is a state where attention is shifted from external events to internal thoughts and is thus, decoupled from perceptual inputs (e.g., Barron et al., 2011; Smallwood, 2013). Accordingly, given that mind-wandering reflects a state of attention that is decoupled from external information, this view suggests that mind-wandering and external distraction are distinct. That is, when attention is shifted internally and decoupled from the external environment, individuals are less likely to process external information whether it be task-relevant information or external distractors. Evidence consistent with this claim comes from a study by Barron et al. (2011) in which participants performed a visual oddball task where on some trials a novel distractor stimulus was presented. Following the oddball task participants reported their propensity for mind-wandering via a self-report questionnaire. Barron et al. found that individuals who reported more mind-wandering demonstrated reductions in cortical processing (specifically reductions in the P3a) for target and distractor stimuli. Barron et al. suggested that these results provide evidence for the idea that mind-wandering is a state in which attention is decoupled from the external environment and that mind-wandering is not simply a state of distraction (see also Smilek, Carriere, & Cheyne (2010) who demonstrated that instances of mind-wandering are associated with increased blinking). Because Barron et al. found that participants who reported the most mind-wandering demonstrated the smallest cortical responses to the distractor stimuli, they suggested that mind-wandering and external distraction do not reflect common processes. However, one issue with this study is that the distractor stimuli were actually task-relevant distractors in that the distractor stimuli were of the same shape and appeared in the same visual location as target stimuli, and in order to distinguish target from distractor, some minimal amount of processing would be needed. Clearly, these task-relevant distractors are very different from other external distractors (such as the fire alarm going off during an experiment) which are not relevant to the task at hand. Thus, it is unclear whether mind-wandering and external distraction from task-unrelated information are distinct.

An alternative view is that mind-wandering and external distraction both reflect failures of attention control and thus, both reflect general lapses of attention (Kane & McVay, 2012; McVay & Kane, 2010; Unsworth, Redick, Lakey, & Young, 2010). According to these views attention control is needed to maintain task goals in a readily accessible state in working memory to bias responding for correct behaviors. Any lapse of attention due to internal (e.g., mind-wandering) or external stimuli (e.g., loud noises) will cause the task goal to be temporarily lost from working memory potentially resulting in goal neglect in which prepotent response tendencies will guide behavior. Therefore, according to attention control views, TUTs should be related to performance on a number of attentional control tasks, which is exactly the case (McVay & Kane, 2009, 2012b). Furthermore, according to attention control views, mind-wandering and external distraction should be positively correlated such that individuals who experience more mind-wandering should also experience more external distraction in situations where attention control is needed to maintain task goals. Evidence consistent with this position comes from a recent diary study in which participants performed a number of working memory capacity and attention control tasks in the lab and were required to carry a diary for week listing their various everyday attentional failures (as well as other failures; Unsworth, Brewer, et al., 2012). It was found that the majority of attentional failures were due to external distraction or mind-wandering. Importantly, it was found that everyday mind-

[1] Not all studies simply have participants report whether they are on- or off-task, but also have them report the contents of their thoughts. For example, some studies have had participants report what they had been thinking prior to the probe (e.g., Baird, Smallwood, & Schooler, 2011) whereas other studies have had participants respond based on different categories of thoughts (e.g., thinking about the past or the future; McVay & Kane, 2012b; Unsworth & McMillan, 2013). Given that participants are specifically reporting the contents of their thoughts in terms of mind-wandering, these approaches do not confound mind-wandering and external distraction.

wandering and external distraction were positively correlated with one another ($r = .43$) and both were related to latent variables of working memory capacity and attention control. In a follow-up study these attentional failures were further broken down and it was found that the most common everyday attentional failures were due to distraction and mind-wandering while in class or while studying (Unsworth, McMillan, et al., 2012). Importantly, both mind-wandering and external distraction failures were correlated and loaded on the same latent variable which was related to working memory capacity, attention control, and SAT scores. Thus, this preliminary work suggests that mind-wandering and external distraction are related and both are related to cognitive abilities in a similar fashion.

1.3. The present study

Our goal in the present study was to better examine whether mind-wandering and external distraction are similar or distinct. Given the amount of prior research that has examined mind-wandering and external distraction separately; an important goal of the current study was to examine the relation between these two types of attentional lapses. As noted previously, some research suggests that mind-wandering and external distraction are not related, whereas other work suggests that they are related. As noted by Smallwood (2013) the attention control and decoupling theories make distinct predictions in regard to the relationship between mind-wandering and external distraction. Specifically, from an individual difference perspective the attention control and decoupling theories make opposite predictions regarding the relation between mind-wandering and external distraction. In terms of the attention control theory, Smallwood (2013) suggested that this theory predicts that those individuals who experience the most mind-wandering should, in general, experience the most external distraction given that both reflect general failures of attention control and thus, are both lapses of attention (e.g., McVay & Kane, 2010; Unsworth et al., 2010). Specifically, Smallwood (2013) noted that according to attention control views "those individuals who mind-wander the most should spend more time in a state where (a) attention to task relevant events is reduced and (b) attention to processing of external irrelevant distracter events (which is normally reduced by the process of attentional constraint is either unaffected or increased" (p. 528). Thus, mind-wandering should, in general, be linked to greater levels of external distraction. The decoupling theory, however, suggests that individuals who experience the most mind-wandering should experience the least amount of external distraction (Smallwood, 2013). Specifically, Smallwood (2013) noted that "those individuals who mind-wander the most should show a reduced processing of external events regardless of their relevance to the task" (p. 528). At a given time if an individual is mind-wandering then they are not susceptible to external distraction. That is, those individuals who mind-wander more, will spend more time with their attention decoupled from the external environment, and thus will have fewer opportunities to experience external distraction. Note that in general both the attention control and decoupling theories make similar predictions regarding individual differences in mind-wandering and explain different aspects of mind-wandering (i.e., what can cause mind-wandering vs. what happens when the mind-wanders), but for the current issue of the relation between mind-wandering and external distraction they make opposite predictions.

To test the competing aspects of these theories we tested a large number of participants on a variety of attention control, working memory capacity, and fluid intelligence measures. While performing the attention control measures participants were periodically probed to as to the contents of their current thoughts in the same manner as Stawarczyk, Majerus, Maj, et al. (2011). Specifically, participants indicated if they were on-task, if they were experiencing task-related interference, if they were distracted by external stimuli, or if they were mind-wandering.

Using confirmatory factor analysis and structural equation modeling we addressed two main goals. First, we examined whether we could break TUTs down into mind-wandering and external distraction to determine if these two types of TUTs are similar or distinct and to examine how they relate with other cognitive ability constructs. Specifically, we examined whether mind-wandering and external distraction could be considered the same with both loading on the same latent variable, or whether they were different with each loading on their own factors. Furthermore, if mind-wandering and external distraction can be considered different constructs we examined how these two constructs would be related to one another and to the other cognitive ability measures. If mind-wandering and external distraction are distinct constructs, it is important to examine how these constructs relate to other cognitive abilities to determine if the prior relations seen with TUTs were due primarily to mind-wandering, primarily to external distraction, or some combination of both.

Second, assuming that mind-wandering and external distraction are distinct, yet correlated constructs, we examined the extent to which a common attentional control construct could account for the shared variance between mind-wandering and external distraction and could account for their shared relation with working memory capacity and fluid intelligence. The decoupling theory suggests that mind-wandering and external distraction are distinct and should therefore have independent contributions to working memory capacity and fluid intelligence. The attention control theory, however, suggests that both mind-wandering and external distraction reflect lapses of attention, and thus what is important is the shared variance between these constructs and not their independent contributions.

We used a latent variable approach to examine these issues. In order to derive latent variables for the constructs of interest, multiple indicators of each cognitive construct were used. This was done in order to ensure that any lack of a relation found between mind-wandering and external distraction with each other and with the other cognitive abilities would not be due to unreliability or idiosyncratic task effects. Therefore, multiple measures of each cognitive construct were used to create latent variables of mind-wandering, external distraction, attention control, working memory capacity, and fluid intelligence. By examining a large number of participants and a large and diverse number of measures we should be able to better characterize individual differences in lapses of attention and address our questions of primary interest.

2. Method

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in our study.

2.1. Participants

A total of 252 participants (64% female) were recruited from the subject-pool at the University of Oregon. Data from 11 participants were dropped because the participants failed to complete two or more tasks. The remaining 241 participants were between the ages of 18 and 35 ($M = 19.59$, sd $= 1.61$) and received course credit for their participation. Each participant was tested in groups of 1–6 in a laboratory session lasting approximately 2 h. We tested participants over two full academic quarters, using the end of the second quarter as our stopping rule for data collection.

2.2. Materials and procedure

After signing informed consent, all participants completed operation span, symmetry span, reading span, Raven Advanced Progressive Matrices, number series, letter sets, sustained attention to response task, antisaccade, flankers, Stroop, and psychomotor vigilance task. All tasks were administered in the order listed above. Following the tasks participants filled out a battery of questionnaires that were part of a different aspect of a larger project.

2.3. Thought probes

During the attention control tasks, participants were periodically presented with thought probes asking them to classify their immediately preceding thoughts. The thought probes asked participants to press one of five keys to indicate what they were thinking just prior to the appearance of the probe. Specifically, participants saw

Please characterize your current conscious experience

1. I am totally focused on the current task
2. I am thinking about my performance on the task or how long it is taking
3. I am distracted by information present in the room (sights and sounds)
4. I am zoning out/my mind is wandering
5. Other

These thought probes were based on those used by Stawarczyk, Majerus, Maj, et al. (2011). During the instructions participants were given specific instructions regarding the different categories. Similar to prior research, responses three and four were considered TUTs, with response three being classified as external distraction and response four being classified as mind-wandering. Response one was considered as on-task thoughts, while response two was considered as task-related interference. Task-related interference refers to evaluative thoughts about the task or about task performance (i.e., "I'm not very good at this," "This task is boring", e.g., Sarason, Sarason, Keefe, Hates, & Shearin, 1986; Smallwood et al., 2004). As such these thoughts might also reflect a form of a lapse of attention as attention is not fully focused on the task. Therefore, task-related interference was also examined in the five attention control tasks.

2.4. Attention control (AC) tasks

2.4.1. Sustained attention to response task (SART)

Participants completed a version of a sustained attention to response task (SART) with semantic stimuli adapted from McVay and Kane (2009, 2012b). The SART is a go/no-go task where subjects must respond quickly with a key press to all presented stimuli except infrequent (11%) target trials. In this version of SART, word stimuli were presented in Courier New font size 18 for 300 ms followed by a 900 ms mask. Most of the stimuli (non-targets) were members of one category (animals) and infrequent targets were members of a different category (foods). The SART had 470 trials, 50 of which were targets. The dependent variables were accuracy for targets and each individual's standard deviation of response time for go trials. Thought probes followed 60% of target trials. The task took approximately 10 min to complete.

2.4.2. Antisaccade

In this task (Kane, Bleckley, Conway, & Engle, 2001) participants were instructed to stare at a fixation point which was onscreen for a variable amount of time (200–2200 ms). A flashing white "=" was then flashed either to the left or right of fixation (11.33° of visual angle) for 100 ms. This was followed by a 50 ms blank screen and a second appearance of the cue for 100 ms making it appear as though the cue (=) flashed onscreen. Following another 50 ms blank screen the target stimulus (a B, P, or R) appeared onscreen for 100 ms followed by masking stimuli (an H for 50 ms and an 8 which remained onscreen until a response was given). All stimuli were presented in Courier New with a 12 point font. The participants' task was to identify the target letter by pressing a key for B, P, or R (keys 1, 2, or 3 on the number keypad) as quickly and accurately as possible. In the prosaccade condition the flashing cue (=) and the target appeared in the same location. In the antisaccade condition the target appeared in the opposite location as the flashing cue. Participants received, in order, 10 practice trials to learn the response mapping, 10 trials of the prosaccade condition, and 50 trials of the antisaccade condition. The dependent variable was accuracy on the antisaccade trials. Thought probes followed 16% of antisaccade trials. The task took approximately 5 min to complete.

2.4.3. Arrow flankers

Participants were presented with a fixation point for 400 ms. This was followed by an arrow directly above the fixation point for 1700 ms. The participants' task was to indicate the direction the arrow was pointing (pressing the F for left pointing arrows and pressing J for right pointing arrows) as quickly and accurately as possible. On 30 neutral trials the arrow was flanked by two horizontal lines on each side. On 30 congruent trials the arrow was flanked by two arrows pointing in the same direction as the target arrow on each side. Finally, on 30 incongruent trials the target arrow was flanked by two arrows pointing in the opposite direction as the target arrow on each side. All trial types were randomly intermixed. The dependent variable was the reaction time difference between incongruent and congruent trials. Thought probes followed 40% of incongruent trials. The task took approximately 7 min to complete.

2.4.4. Stroop

Participants were presented with a color word (red, green, or blue) presented in one of three different font colors (red, green, or blue). The participants' task was to indicate the font color via key press (red = 1, green = 2, blue = 3). Participants were told to press the corresponding key as quickly and accurately as possible. Participants received 15 trials of response mapping practice, and 6 trials of practice with the real task. Participants then received 135 total real trials. Of these trials 67% were congruent such that the word and font color matched (i.e., red printed in red) and the other 33% were incongruent (i.e., red printed in green). The dependent variable was the reaction time difference between incongruent and congruent trials. Thought probes followed 44% of incongruent trials. The task took approximately 7 min to complete.

2.4.5. Psychomotor vigilance task (PVT)

The psychomotor vigilance task (Dinges & Powell, 1985) was used as the primary measure of sustained attention. Participants were presented with a row of zeros on screen and after a variable amount of time the zeros began to count up in 1 ms intervals from 0 ms. The participants' task was to press the spacebar as quickly as possible once the numbers started counting up. After pressing the spacebar the RT was left on screen for 1 s to provide feedback to the participants. Interstimulus intervals were randomly distributed and ranged from 1 to 10 s. The entire task lasted for 10 min for each individual (roughly 75 total trials). The dependent variable was the average reaction time for the slowest 20% of trials (Dinges & Powell, 1985). Thought probes followed 20% of trials.

2.5. Working memory capacity (WMC) tasks

2.5.1. Operation span (Ospan)

Participants solved a series of math operations while trying to remember a set of unrelated letters (F, H, J, K, L, N, P, Q, R, S, T, Y). Participants were required to solve a math operation and after solving the operation they were presented with a letter for 1 s. Immediately after the letter was presented the next operation was presented. Three trials of each list-length (3–7) were presented for a total possible of 75. The order of list-length varied randomly. At recall, letters from the current set were recalled in the correct order by clicking on the appropriate letters (see Unsworth, Heitz, Schrock, & Engle, 2005 for more details). Participants received three sets (of list-length two) of practice. For all of the span measures, items were scored if the item was correct and in the correct position. The score was the proportion of correct items in the correct position. The task took approximately 20 min to complete.

2.5.2. Symmetry span (Symspan)

In this task participants were required to recall sequences of red squares within a matrix while performing a symmetry-judgment task. In the symmetry-judgment task participants were shown an 8 × 8 matrix with some squares filled in black. Participants decided whether the design was symmetrical about its vertical axis. The pattern was symmetrical half of the time. Immediately after determining whether the pattern was symmetrical, participants were presented with a 4 × 4 matrix with one of the cells filled in red for 650 ms. At recall, participants recalled the sequence of red-square locations in the preceding displays, in the order they appeared by clicking on the cells of an empty matrix (see Unsworth, Redick, Heitz, Broadway, & Engle, 2009 for more details). There were three trials of each list-length with list-length ranging from 2 to 5 for a total possible of 42. The same scoring procedure as Ospan was used. The task took approximately 15 min to complete.

2.5.3. Reading span (Rspan)

Participants were required to read sentences while trying to remember the same set of unrelated letters as Ospan. For this task, participants read a sentence and determined whether the sentence made sense or not (e.g. "The prosecutor's dish was lost because it was not based on fact.?"). Half of the sentences made sense while the other half did not. Nonsense sentences were made by simply changing one word (e.g. "dish" from "case") from an otherwise normal sentence. Participants were required to read the sentence and to indicate whether it made sense or not. After participants gave their response they were presented with a letter for 1 s. At recall, letters from the current set were recalled in the correct order by clicking on the appropriate letters (see Unsworth et al., 2009 for more details). There were three trials of each list-length with list-length ranging from 3 to 7 for a total possible of 75. The same scoring procedure as Ospan was used. The task took approximately 20 min to complete.

2.6. Fluid intelligence (gF) tasks

2.6.1. Raven Advanced Progressive Matrices

The Raven is a measure of abstract reasoning (Raven, Raven, & Court, 1998). The test consists of 36 items presented in ascending order of difficulty (i.e. easiest–hardest). Each item consists of a display of 3 × 3 matrices of geometric patterns with the bottom right pattern missing. The task for the participant is to select among eight alternatives, the one that correctly completes the overall series of patterns. Participants had 10 min to complete the 18 odd-numbered items. A participant's score was the total number of correct solutions. Participants received two practice problems.

2.6.2. Number series

In this task participants saw a series of numbers and were required to determine what the next number in the series should be (Thurstone, 1962). That is, the series follows some unstated rule which participants are required to figure out in order to determine which the next number in the series should be. Participants selected their answer out of five possible numbers that were presented. Following five practice items, participants had 4.5 min to complete 15 test items. A participant's score was the total number of items solved correctly.

Table 1
Descriptive statistics and reliability estimates for the cognitive ability measures.

Measure	M	SD	Skew	Kurtosis	Reliability
Ospan	55.33	12.89	−1.33	1.94	.77
Symspan	29.24	7.38	−.87	1.03	.71
Rspan	50.74	13.62	−.81	.91	.82
Raven	8.08	2.97	−.20	−.35	.70
LS	9.15	2.78	.23	−.31	.64
NS	8.61	2.45	.05	.05	.70
Anti	.48	.12	.48	.01	.76
Flanker	110.52	74.33	1.75	3.17	.60
SART acc	.53	.16	−.04	−.40	.83
SART sd	156.12	49.74	.73	1.34	.92
Stroop	163.52	98.50	1.02	1.54	.58
PVT	640.92	266.99	2.98	3.76	.90

Note. Ospan = operation span; Rspan = reading span; Symspan = symmetry span; Raven = Raven Advanced Progressive Matrices; LS = letter sets; NS = number series; anti = antisaccade; Flanker = arrow flankers; SART acc = accuracy on sustained attention to response task; SART sd = standard deviation of response time on the sustained attention to response task; Stroop = color word Stroop task; PVT = psychomotor vigilance task.

2.6.3. Letter sets

In this task participants saw five sets of four letters, and participants were required to induce a rule that applies to the composition and ordering of four of the five letter sets (Ekstrom, French, Harman, & Dermen, 1976). Participants are then required to indicate the set that violates the rule. Following two examples participants had 5 min to complete 20 test items. A participant's score was the total number of items solved correctly.

3. Results

3.1. Descriptive statistics for the cognitive ability measures

Table 1 presents descriptive statistics for all of the cognitive ability measures. As can be seen, the measures had generally acceptable values of internal consistency and most of the measures were approximately normally distributed with values of skewness and kurtosis under the generally accepted values (i.e., skewness < 2 and kurtosis < 4; see Kline, 1998). Correlations among the laboratory tasks, shown in Appendix A, were weak to moderate in magnitude with measures of the same construct generally correlating stronger with one another than with measures of other constructs, indicating both convergent and discriminant validity within the data.

Table 2
Proportions of each thought probe response for each attention control task.

	On-task	TRI	ED	MW	Other
Anti	.36 (.34)	.27 (.27)	.08 (.14)	.20 (.25)	.09 (.20)
Flanker	.46 (.35)	.19 (.23)	.07 (.12)	.24 (.24)	.04 (.15)
SART	.35 (.26)	.30 (.20)	.10 (.11)	.21 (.17)	.04 (.11)
Stroop	.54 (.35)	.17 (.24)	.07 (.08)	.13 (.17)	.09 (.20)
PVT	.37 (.33)	.19 (.22)	.14 (.15)	.27 (.27)	.03 (.11)

Note. Anti = antisaccade; Flanker = arrow flankers; SART = Sustained Attention to response task; Stroop = color word Stroop task; PVT = psychomotor vigilance task; on-task = on-task thoughts; TRI = task-related interference; ED = external distraction; MW = mind-wandering. Standard deviations are in parentheses.

3.2. Mind-wandering and external distraction

To examine one of our main questions of interest we next examined whether TUTs could be broken down into mind-wandering and external distraction. Shown in Table 2 are the proportions of each thought probe response for each attention control task. As can be seen, participants spent much of their time either focused on the task or thinking about their performance on the task (task-related interference). Furthermore, both external distraction and mind-wandering were reported in each task, with participants reporting more mind-wandering than external distraction in each task (each $t > 6.5$, each $p < .01$).

Next, we examined the relations between the different external distraction and mind-wandering measures more thoroughly. Specifically, we tested whether external distraction and mind-wandering were best conceptualized as a single unitary factor, or whether there were sufficient differences between the two to suggest two separate, yet potentially correlated factors. To examine this we specified two models. Model fits were assessed via the combination of several fit statistics. These include chi-square, root mean square error of approximation, standardized root mean square residual, non-normed fit index, and comparative fit index. The chi-square statistic reflects whether there is a significant difference between the observed and reproduced covariance matrices. Therefore, nonsignificant values are desirable. However, with large sample sizes even slight deviations can result in a significant value. Test between nested models were examined via a chi-square difference test. Also reported are the root mean square error of approximation (RMSEA) and the standardized root mean square residual (SRMR) both of which reflect the average squared deviation between the observed and reproduced covariances. In addition, the non-normed fit index (NNFI) and the comparative fit index (CFI) which compare the fit of the specified model to a baseline null model are reported. NNFI and CFI values greater than .90 and RMSEA and SRMR values less than .08 are indicative of acceptable fit (Kline, 1998). Finally, the Akaike information criterion (AIC) examines the relative fit between models in which the model with the smallest AIC is preferred.

In the first model we specified all of the measures to load onto a single factor (TUTs). The fit of the model was quite poor, χ^2 (35) = 162.85, $p < .01$, RMSEA = .12, SRMR = .09, NNFI = .70, CFI = .77, AIC = 202.85. Shown in Fig. 1a is the resulting model. As can be seen all of the measures loaded significantly onto the single factor. However, the external distraction measures tended to load more strongly than the mind-wandering measures. In the second model we specified that all of the external distraction measures from the five attention control tasks loaded onto one factor and all of the mind-wandering measures from the tasks loaded onto a second factor. These two factors were allowed to correlate. The fit of the model was acceptable, χ^2 (34) =83.93, $p < .01$, RMSEA = .08, SRMR = .06, NNFI = .90, CFI = .90, AIC = 123.93. Shown in Fig. 1b is the resulting model. As can be seen, the external distraction measures loaded onto an external distraction factor (ED) and the mind-wandering measures loaded onto the mind-wandering factor (MW), and these two factors were significantly correlated. Importantly, the two-factor model fit significantly better than the one factor model, $\Delta\chi^2$ (1) = 78.92, $p < .01$, suggesting that external distraction and mind-wandering are distinct yet correlated factors. Indeed, fixing the correlation between mind-wandering and external distraction to zero resulted in a significantly worse fit, $\Delta\chi^2$ (1) = 21.18, $p < .01$, χ^2 (35) = 105.11, $p < .01$, RMSEA = .09, SRMR = .11, NNFI = .81, CFI = .85, AIC = 145.11. Thus, mind-wandering and external distraction are distinct, yet correlated constructs.

In our next set of analyses was examined how mind-wandering and external distraction would relate with the other cognitive ability measures. Therefore, separate factors were formed for mind-wandering (MW), external distraction (ED), attention control (AC), working memory capacity (WMC), and fluid intelligence (gF). All of the factors were allowed to correlate. This model tests the extent to which different measures can be grouped into separate yet correlated factors, and examines the latent correlations among the factors.[2] All of the factors

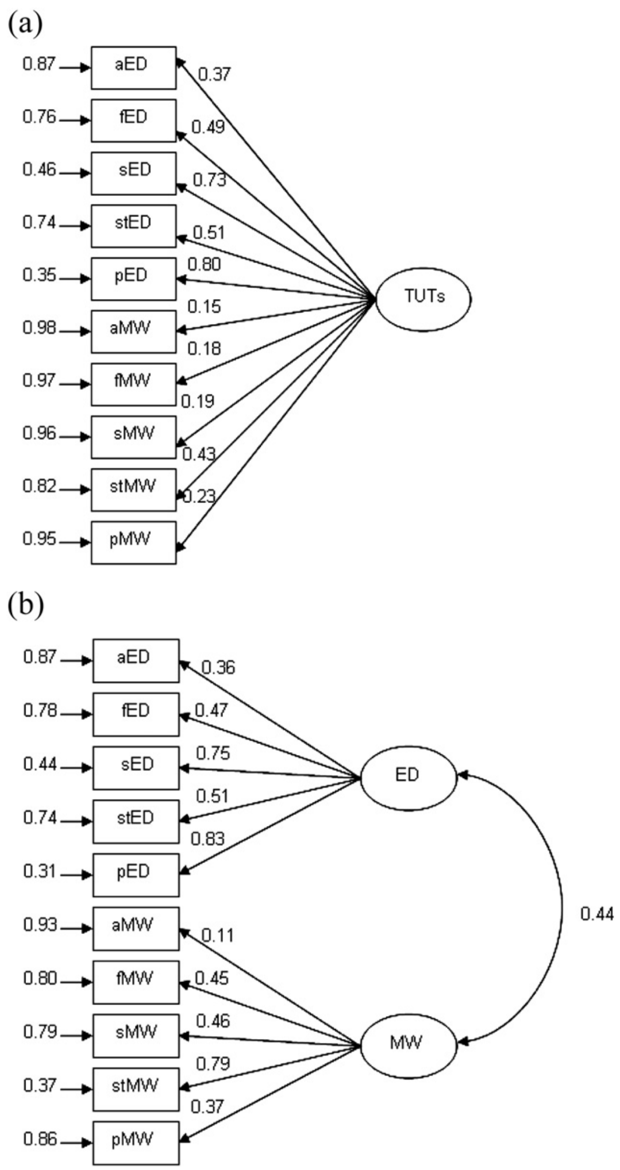

Fig. 1. a) Confirmatory factor analysis for unitary task-unrelated thought (TUTs) model for external distraction (ED) and mind-wandering (MW); (b) confirmatory factor analysis for separate external distraction (ED) and mind-wandering (MW) model. aED = antisaccade external distraction; fED = flanker external distraction; sED = sustained attention to response external distraction; stED = Stroop external distraction; pED = psychomotor vigilance external distraction; aMW = antisaccade mind-wandering; fMW = flanker mind-wandering; sMW = sustained attention to response mind-wandering; stMW = Stroop mind-wandering; pMW = psychomotor vigilance mind-wandering. All loadings and paths are significant at the $p < .05$ level.

[2] Note that we also examined a model with a task-related interference factor. A task-related interference (TRI) factor was formed by examining TRI responses across the five attention control tasks. As shown in Table A1 all of the TRI measures were inter-related and all significantly loaded on the TRI factor (antisaccade TRI = .43; flanker TRI = .76; SART TRI = .52; Stroop TRI = .79; PVT TRI = .63). Although the fit of the model was acceptable, χ^2 (307) = 535.02, $p < .01$, RMSEA = .06, SRMR = .07, NNFI = .90, CFI = .90, the TRI factor did not significantly correlate with any of the other factors (TRI-MW = −.10; TRI-ED = −.01; TRI-AC = −.03; TRI-WMC = −.07; TRI-gF = .08). Thus, although TRIs can be seen as being not fully on task, these thoughts are not the same as mind-wandering or external distraction and are unrelated to cognitive abilities within the current data.

were allowed to correlate with one another. The fit of the model was acceptable, χ^2 (199) = 375.46, $p < .01$, RMSEA = .06, SRMR = .07, NNFI = .90, CFI = .91, AIC = 483.46. As can be seen in Fig. 2 both the ED and MW factors correlated significantly with the cognitive ability factors. Specifically, both ED and MW were moderately correlated with AC, WMC, and gF. Thus, TUTs can be broken down into both ED and MW, both of which are related to cognitive ability measures. Furthermore, consistent with prior research AC, WMC, and gF were all strongly correlated with one another (e.g., Unsworth & Spillers, 2010; Unsworth, Fukuda, Awh, & Vogel, in press).

Given that the ED, MW, and AC latent variables were interrelated and the fact that prior theory suggests that a common attentional system underlies these factors, the next confirmatory factor analysis examined the notion that there is substantial common variance between the three attention latent variables and that this common variance is related to WMC and gF. Therefore, we specified a bifactor model in which the common variance between the ED, MW, and AC measures forms one factor and the unique variances shared across the ED and MW measures form separate factors. This type of model tests the notion that each task is composed of

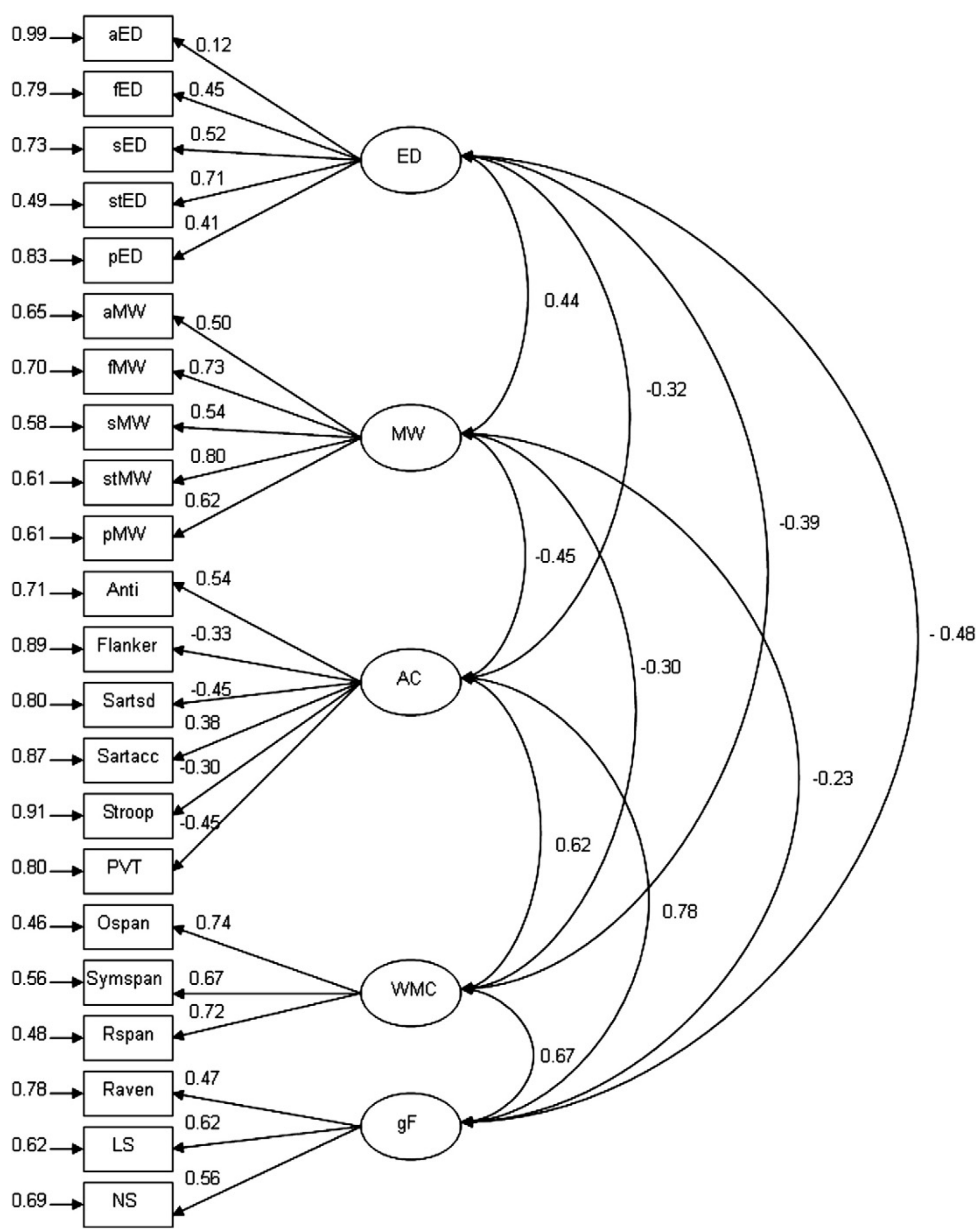

Fig. 2. Model for external distraction (ED), mind-wandering (MW), attention control (AC), working memory capacity (WMC), and fluid intelligence (WMC). All loadings and paths are significant at the $p < .05$ level.

multiple different sources of variance (common and unique) and examines how the common and unique sources of variance correlate with other factors (e.g., WMC and gF). To test this model we specified a common general attentional (AttnG) factor with all of the attention measures loading onto it. We also specified an ED factor with only the ED measures loading on it and an MW factor with only the MW measures loading on it. The correlations between these factors were all fixed to zero. In addition, we specified separate WMC and gF factors and allowed the AttnG, ED, and MW factors to correlate with these factors. Thus, this model tests whether the common attention variance is important to the relations with WMC and gF, or whether there is something particularly special about ED and MW that relates with WMC and gF over and above that accounted for by the general attention factor. The fit of the

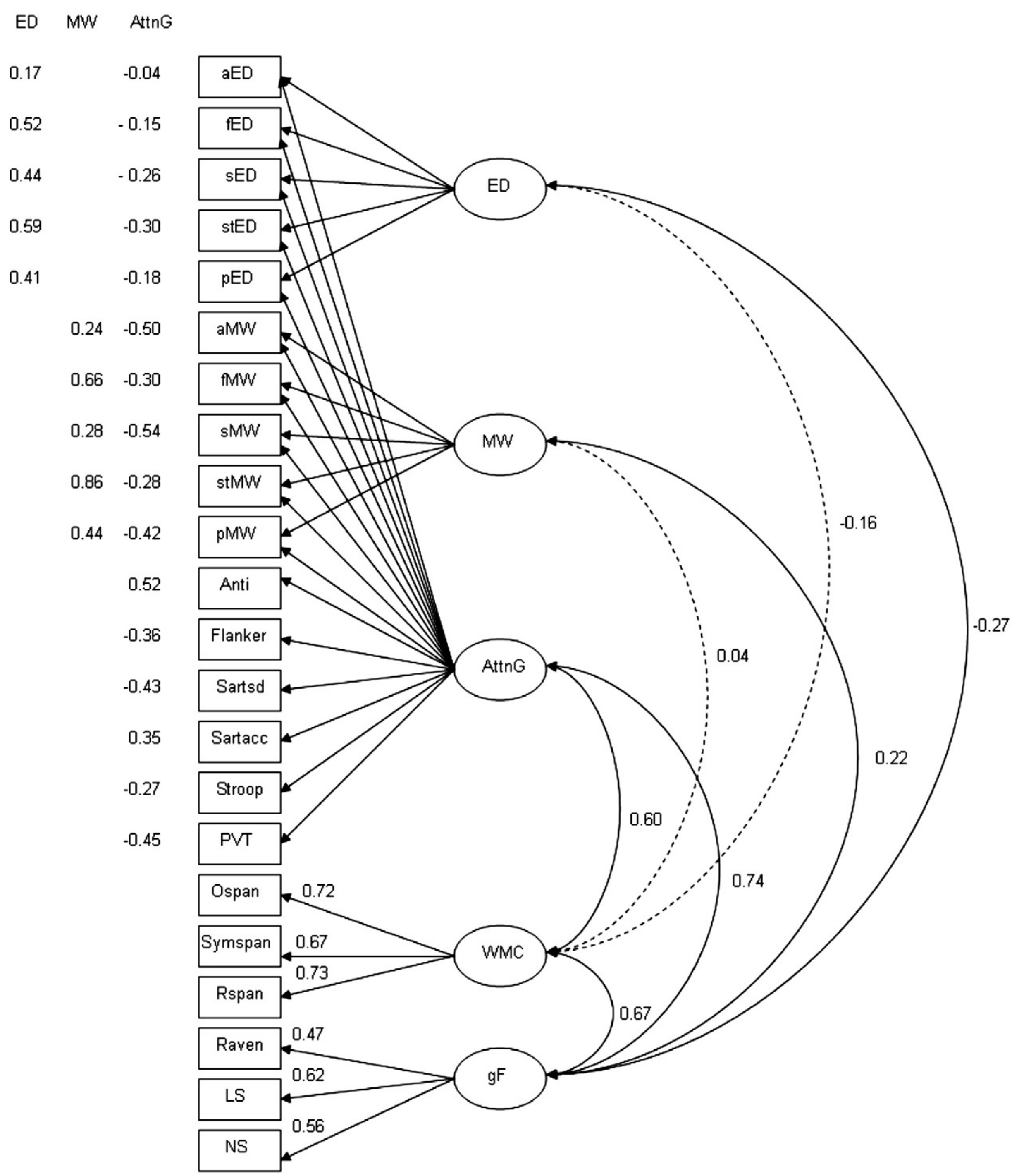

Fig. 3. Bifactor model for external distraction (ED), mind-wandering (MW), general attention (AttnG), working memory capacity (WMC), and fluid intelligence (WMC). The numbers in the ED column represent the factor loadings for each task onto the ED factor; the numbers in MW column represent the factor loadings for each task onto the MW factor; the numbers in AttnG column represent the factor loadings for each task onto the AttnG factor.

model was acceptable, χ^2 (192) = 320.49, $p < .01$, RMSEA = .05, SRMR = .06, NNFI = .90, CFI = .92, AIC = 442.49. Shown in Fig. 3 is the resulting model. As can be seen, the general attention factor (AttnG) correlated very strongly with both WMC and gF. Additionally, the residual ED factor correlated with gF, but not with WMC. Interestingly, the residual MW factor correlated positively with gF, but did not correlate with WMC. Thus, once the common variance across the attention measures was extracted, the residual variance associated with the MW measures now correlated positively with gF. As will be discussed later, this is consistent with prior research suggesting that mind-wandering might have a beneficial influence on problem solving (e.g., Baird et al., 2012).

For our final analysis we examined how the general attention, residual ED, residual MW, and WMC factors would predict gF. Specifically, we were interested in examining whether these factors would all account for some unique variance in gF, or whether the bulk of the variance accounted for in gF would come from the shared variance represented by the general attention factor. Therefore, we specified a SEM in which ED, MW, AttnG, and WMC each predicted gF. In the specified SEM ED, MW, and AttnG were allowed to correlate with WMC based on the previous confirmatory factor analysis, and all were allowed to predict gF. This model examines the extent to which each of these factors accounts for unique variance in predicting gF. The fit was acceptable, χ^2 (192) = 320.49, $p < .01$, RMSEA = .05, SRMR = .06, NNFI = .90, CFI = .92, AIC = 442.49. As shown in Fig. 4, all four factors accounted for unique variance in gF, accounting for roughly 72% of the variance in gF. Specifically, the residual ED factor accounted for 5% of the variance in gF, while the residual MW factor accounted for 4% of the variance. The AttnG factor accounted for 32% unique variance and the WMC factor accounted for 8% unique variance, suggesting that the remaining 23% of the variance was shared between the general attention and WMC factors. These results suggest that the common variance shared between all the factors accounted for substantial variance in gF, with each factor also accounting for some proportion of unique variance in gF.

3.3. General discussion

In the current study we examined the nature of task-unrelated thoughts (TUTs) in terms of similarities and differences between

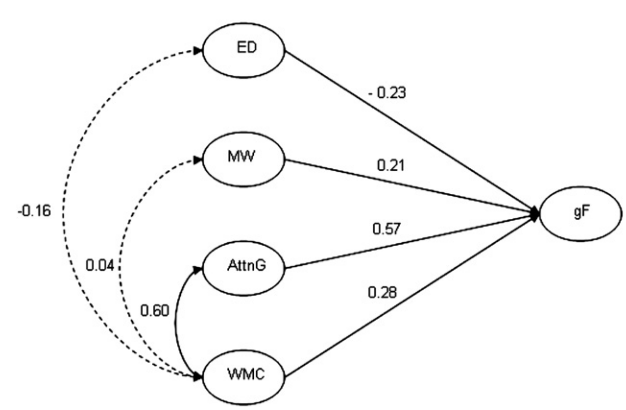

Fig. 4. Structural equation model predicting fluid intelligence with ED, MW, AttnG, and WMC. Single-headed arrows connecting latent variables (circles) represent standardized path coefficients indicating the unique contribution of the latent variable. Double headed arrows connecting the latent factors represent the correlations among the factors. Solid lines are significant at the $p < .05$ level and dotted lines are not significant at the $p < .05$ level.

mind-wandering and external distraction and their relation to one another and to other cognitive abilities. In particular, using latent variable techniques we investigated whether TUTs could be broken down into differences in mind-wandering and differences in susceptibility to external distraction. The results suggested that mind-wandering and external distraction were best reflected as two distinct, yet correlated factors. In fact, the correlation between mind-wandering and external distraction ($r = .44$) measured in the laboratory was nearly identical to prior work examining everyday mind-wandering and external distraction ($r = .43$) measured with diary methods (Unsworth, Brewer, et al., 2012; Unsworth, McMillan, et al., 2012). This suggests that although mind-wandering and external distraction are distinct, they are also clearly related and share a good deal of common variance. As such, these results help clarify the nature of TUTs by suggesting that off-task thoughts measured either in the laboratory or in more ecologically valid contexts can be due to multiple factors including mind-wandering and external distraction (Stawarczyk, Majerus, Maj, et al., 2011) and that individual differences in one are related to individual differences in the other. Furthermore, these individual differences are strongly linked to individual variation in AC, WMC, and gF.

Given that mind-wandering and external distraction were found to be correlated with one another and correlated strongly with AC, we investigated whether the common variance shared across these factors was important, or whether the unique variance associated with each factor was important. Recall that the decoupling theory suggests that mind wandering and external distraction are largely distinct and should therefore have independent contributions to variation in WMC and gF. The attention control theory, however, suggests that both mind-wandering and external distraction reflect general lapses of attention, and thus the common variance is what is important. To investigate these competing accounts we specified a bifactor model in which a general attention factor and residual mind-wandering and external distraction factors were extracted and the results suggested that the general attention factor was strongly related to WMC and gF. This suggests that there is a great deal of common variance across external distraction, mind-wandering, and AC measures and this common variance is strongly related to other cognitive abilities. In particular, these results provide strong support for the attention control account of TUTs suggesting that mind-wandering and external distraction both reflect lapses of attention and that only the common variance shared among the external distraction, mind-wandering, and attention control measures is related to WMC. Once the common variance was accounted for, neither external distraction nor mind-wandering was related to WMC, suggesting that individual differences in attention control account for the important relation between TUTs and WMC.

Overall, these results suggest that while an individual is in a state of mind-wandering their current thoughts are likely decoupled from the external environment and thus less prone to external distraction. That is, during task unrelated thoughts (if the task is external) people's attention is decoupled from external input. Yet, those individuals with low attention control abilities are the most likely to have their attention captured by powerful internal and external distraction leading to a lapses of attention. Thus, while the decoupling theory explains what is happening during an instance of mind-wandering (attention is focused internally and thoughts are insulated from external stimuli), the attention control theory explains who is most likely to experience lapses of attention (both internally and externally) during tasks that require task-focused attention (Kane & McVay, 2012; Smallwood, 2013). Thus, aspects of both views are correct. Overall these results suggest that TUTs are clearly complex and are multifaceted in what they represent. As such the overall results from the current study are very much in line with recent theoretical reviews of TUTs suggesting the rich complexity of TUTs and highlighting the need for greater integration across theories (e.g., Kane & McVay, 2012; Smallwood, 2013).

Furthermore, results from the bifactor model suggested that the residual external distraction factor was negatively correlated with gF suggesting that problems with distraction can hinder performance on gF measures over and above that accounted for by general lapses of attention. That is, when potent external distractors are present one's attention will likely be captured by the distractor, and thus not available for problem solving. Such an effect likely occurs across all individuals. At the same time, there may be a certain proportion of individuals that are especially prone to distraction and these individuals have particular problems on measures of intelligence. The bifactor model also suggested that the residual mind-wandering factor positively correlated with gF. That is, initially mind-wandering was negatively correlated with gF suggesting that individuals who mind-wander more perform more poorly on fluid intelligence measures. However, after statistically controlling for general attentional abilities we see that mind-wandering now positively predicts gF. This result is generally consistent with prior work suggesting that mind-wandering might facilitate problem solving abilities (e.g., Baird et al., 2012). Although mind-wandering is generally detrimental to performance on a number of tasks including measures of gF (Mrazek et al., 2012), on some proportion of trials or for some proportion of individuals, mind-wandering might actually be beneficial to problem solving. Clearly more work is needed to replicate and extend the current finding. Understanding under what conditions mind-wandering helps vs. hurts performance and how this changes as a function of individual differences is an important topic for future research.

Given the complexity of TUTs, the current results have clear implications for future research. In particular, given that TUTs seem to reflect variation in both mind-wandering and external distraction, future research needs to make sure to measure both in order to clarify what exactly is being studied. This is true not only for basic behavioral studies (Stawarczyk, Majerus, Maj, et al. (2011), but also for studies that are examining the neural correlates of TUTs (Stawarczyk, Majerus, Maquet, et al., 2011). Making sure that one is clearly measuring mind-wandering or external distraction will go a long way towards gaining a better understanding of these constructs and their neural underpinnings. Furthermore, in terms of individual differences, the current results suggest that both mind-wandering and external distraction need to be assessed given that there are both common and unique sources of variance to each, and in order to understand one source of variation you likely need to understand the other. That is, if one is only measuring mind-wandering the overall results might not be clear because it is possible that the resulting individual differences are due to mind-wandering only, due to the common variance between mind-wandering and external distraction, or some combination of both. This is true for both assessments in and out of the laboratory. In the current study most of the TUTs were due to mind-wandering, with much fewer TUTs being due to external distraction. Thus, in most laboratory studies where participants are being tested alone in quiet rooms, it is likely that most TUTs will reflect mind-wandering. However, in other situations where more potent external distractors are present; it is possible that more TUTs will be due to external distraction. Future research should examine the extent to which rates of mind-wandering and external distraction vary as a function of a number of factors including the presence or absence of external distractors, task pacing, task difficulty, and others. Furthermore, future research could take a more dimensional approach whereby each state is measured in a more graded fashion (e.g., Marchetti et al., 2012; Unsworth & McMillan, in press). By measuring each state in a graded fashion it should be possible to examine differences between mind-wandering and external distraction in terms of both frequency and intensity. That is, do low attention control individuals simply have more lapses of attention than high attention control individuals, but when both individuals have a lapse it is of the same intensity? Or, is it possible that low attention control individuals not only have more lapses of attention, but these lapses are also of greater intensity? By measuring both mind-wandering and external distraction in a more graded fashion we should be able to gain a better understanding of lapses of attention and their relation to cognitive abilities.

Finally, it would be remiss not to address several limitations of the current study. For example, one limitation is that we only measured TUTs in the attention control tasks. In hindsight it would have been desirable to measure TUTs in all tasks including the WMC and gF measures as has been done previously (Mrazek et al., 2012). Doing so would have allowed us to examine much broader mind-wandering and external distraction factors and better examine how both types of lapses directly influence performance on measures of WMC and gF. A further limitation of the current study was that attention control tasks with the TUT assessments were performed at the end of the two hour session and participants could have been fatigued and this fatigue could have not only influenced the relations among the constructs, but also inflated the reported rates of mind-wandering. That is, prior research has shown that mind-wandering rates increase with time on task and thus one might expect that as time during the session increased participants became more fatigued and started mind-wandering more. It is unclear what role, if any, fatigue is playing in the current data, but it does not seem to be the case that having participants perform the attention control tasks at the end of the session is unduly influencing rates of mind-wandering and external distraction. Specifically, we completed another study with some of these measures (antisaccade, SART, PVT) with the same TUT assessments and these tasks were performed much earlier in the session. In this new study the rates of mind-wandering and external distraction were nearly identical to those reported in the current study. Thus, although it is certainly possible that fatigue is a factor, it does not seem to be the case that fatigue is unduly influencing rates of mind-wandering and external distraction or artificially inflating the relation between the constructs. Future work is needed to better examine how fatigue influences mind-wandering and external distraction and the extent to which fatigue is a contributor to performance on attention control and other measures.

4. Conclusions

Vulnerability to task-unrelated thoughts represents susceptibility to both mind-wandering and external distraction. Mind-wandering and external distraction reflect distinct, yet correlated constructs that are related to important cognitive abilities like working memory capacity and fluid intelligence. Furthermore, the results from the current study suggest that the common variance shared by mind-wandering and external distraction is what primarily accounts for their relation with working memory capacity and fluid intelligence. This suggests that individual differences in general lapses of attention are strongly related to individual differences in cognitive abilities. Understanding these lapses of attention will provide us valuable information in terms of predicting when and for whom attention failures are most likely and developing interventions to reduce lapses and increase overall performance in a variety of situations.

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Appendix A

Correlations among all measures.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
1. Ospan	–																										
2. Symspan	0.48	–																									
3. Rspan	0.56	0.45	–																								
4. Raven	0.22	0.31	0.22	–																							
5. LS	0.26	0.35	0.32	0.24	–																						
6. NS	0.23	0.30	0.19	0.32	0.35	–																					
7. Anti	0.26	0.29	0.24	0.21	0.30	0.24	–																				
8. Flanker	−0.08	−0.26	−0.08	−0.14	−0.17	−0.13	−0.17	–																			
9. SART sd	−0.15	−0.19	−0.21	−0.15	−0.26	−0.19	−0.21	0.16	–																		
10. SART acc	0.14	0.06	0.17	0.08	0.17	0.23	0.24	−0.07	−0.23	–																	
11. Stroop	−0.20	−0.25	−0.19	−0.07	−0.13	−0.17	−0.18	0.22	0.12	−0.03	–																
12. PVT	−0.15	−0.12	−0.24	−0.14	−0.22	−0.10	−0.23	0.13	0.20	−0.15	0.13	–															
13. aMW	−0.15	−0.26	−0.22	−0.15	−0.18	−0.20	−0.29	0.14	0.16	−0.15	0.07	0.15	–														
14. fMW	−0.17	−0.21	−0.06	−0.03	−0.13	−0.06	−0.12	0.01	0.06	−0.13	−0.01	0.18	0.36	–													
15. sMW	−0.10	−0.22	−0.29	−0.17	−0.23	−0.12	−0.22	0.22	0.25	−0.20	0.04	0.30	0.45	0.33	–												
16. stMW	−0.17	−0.05	−0.12	−0.08	−0.02	−0.02	−0.03	−0.02	0.11	−0.12	−0.06	0.31	0.32	0.65	0.39	–											
17. pMW	−0.12	−0.12	−0.17	−0.01	−0.10	−0.14	−0.12	0.23	0.15	−0.13	0.05	0.40	0.27	0.40	0.36	0.50	–										
18. aED	−0.10	−0.03	0.05	0.04	0.06	−0.07	−0.02	−0.02	0.00	−0.03	−0.04	0.03	0.01	0.13	0.09	0.11	0.02	–									
19. fED	−0.13	0.01	−0.02	−0.14	−0.09	−0.14	−0.08	−0.02	0.07	−0.07	0.08	0.06	0.06	0.05	0.05	0.12	0.06	0.16	–								
20. sED	−0.20	−0.17	−0.24	−0.20	−0.16	−0.23	−0.14	−0.04	0.11	−0.11	0.04	0.14	0.12	0.05	0.05	0.11	0.29	0.13	0.20	–							
21. stED	−0.21	−0.17	−0.15	−0.12	−0.17	−0.16	−0.04	0.05	0.09	−0.10	0.06	0.25	0.31	0.21	0.18	0.32	0.22	−0.01	0.36	0.38	–						
22. pED	−0.12	−0.24	−0.09	−0.20	−0.13	−0.18	0.00	0.01	0.05	0.01	−0.01	0.07	0.13	0.20	0.06	0.11	0.06	0.10	0.24	0.17	0.26	–					
23. aTRI	0.11	0.01	0.12	0.16	0.15	0.18	0.20	−0.05	−0.11	0.14	−0.05	−0.03	−0.27	0.04	−0.17	0.05	0.09	−0.10	−0.02	−0.01	0.01	−0.05	–				
24. fTRI	−0.01	−0.10	−0.05	−0.03	0.06	0.00	−0.08	0.03	0.03	−0.01	−0.03	−0.02	−0.02	−0.17	−0.01	−0.07	0.01	−0.05	−0.02	−0.03	0.03	0.05	0.28	–			
25. sTRI	−0.06	−0.10	0.04	0.05	0.08	0.05	0.01	−0.04	−0.06	−0.15	−0.04	−0.02	−0.11	−0.02	−0.24	−0.08	0.02	0.00	−0.01	−0.08	−0.06	0.02	0.41	0.35	–		
26. stTRI	−0.04	−0.11	−0.05	−0.05	−0.04	−0.03	0.01	−0.01	0.04	0.02	0.01	0.00	−0.02	0.00	0.06	−0.03	0.05	−0.01	0.02	−0.02	0.03	0.03	0.30	0.63	0.40	–	
27. pTRI	0.04	0.09	0.00	0.09	0.20	0.04	0.00	−0.09	−0.04	0.06	−0.01	−0.09	−0.08	−0.14	−0.11	−0.14	−0.13	−0.03	−0.03	−0.08	0.00	−0.06	0.28	0.48	0.32	0.49	–

Note. Ospan = operation span; Rspan = reading span; Symspan = symmetry span; Raven = Raven Advanced Progressive Matrices; LS = letter sets; NS = number series; anti = antisaccade; flanker = arrow flankers; SART acc = accuracy on sustained attention to response task; SART sd = standard deviation of response time on the sustained attention to response task; Stroop = color word Stroop task; PVT = psychomotor vigilance task; aMW = antisaccade mind-wandering; fMW = flanker mind-wandering; sMW = sustained attention to response mind-wandering; stMW = Stroop mind-wandering; pMW = psychomotor vigilance mind-wandering; aED = antisaccade external distraction; fED = flanker external distraction; sED = sustained attention to response external distraction; stED = Stroop external distraction; pED = psychomotor vigilance external distraction; aTRI = antisaccade task-related interference; fTRI = flanker task-related interference; sTRI = sustained attention to response task-related interference; stTRI = Stroop task-related interference; pED = psychomotor vigilance task-related interference. Correlations > .12 are significant at the $p < .05$ level.

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