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An Exploratory Analysis of Individual Differences in Mind Wandering Content and Consistency

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We conducted an exploratory study of adult individual differences in the contents of mind-wandering experiences and in the moment-to-moment consistency of that off-task thought content within tasks. This secondary analysis of a published dataset (Kane et al., 2016) examined the content-based thought reports that 472–541 undergraduates made within five probed tasks across three sessions, and tested whether executive-control abilities (working memory capacity, attention-restraint ability), or personality dimensions of schizotypy (positive, disorganized, negative), predicted particular contents of task-unrelated thought (TUT) or the (in)stability of TUT content across successive thought reports. Latent-variable models indicated trait-like consistency in both TUT content and short-term TUT-content stability across tasks and sessions; some subjects mind-wandered about some things more than others, and some subjects were more temporally consistent in their TUT content than were others. Higher executive control was associated with more evaluative thoughts about task performance and fewer thoughts about current physical or emotional states; higher positive and disorganized schizotypy was associated with more fantastical-daydream and worry content. Contrary to expectations, executive ability correlated positively with TUT instability: higher-ability students had more shifting and varied TUT content within a task. Post hoc analysis suggested that better executive control predicted inconsistent TUT content because it also predicted shorter streaks of mind-wandering; tuning back in to task-related thought may decouple trains of off-task thought and afford novel spontaneous or cued thought content. [Data, sample analysis scripts and output, and article preprint are available via the Open Science Framework: https://osf.io/guhw7/].

Keywords: mind wandering, executive control, working memory, schizotypy, consciousness

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What are the causes and consequences of mind wandering, and why do some people mind wander more than others? These questions, which have driven most contemporary research on mind wandering, hinge on whether or how frequently people experience off-task, context-unrelated thoughts. Recently, however, researchers have rediscovered what decades-old work had taken for granted (e.g., Bloom, 1953; Klinger, 1978–1979; Singer, 1966)—the theoretical potential of considering the contents of mind-wandering experiences (Smallwood & Andrews-Hanna, 2013). The current individual-differences study explored the grist of off-task thought via reanalyses of a multimeasure dataset (Kane et al., 2016). Our questions were: (a) do different people consistently think about some topics more than others when they mind-wander during laboratory tasks? (b) Do people show a traitlike inclination to maintain or to switch the subject matter of mind wandering within tasks? (c) Is either such tendency associated with cognitive abilities or personality characteristics?

The Importance and Multidimensionality of Mind-Wandering Content

Mind wandering seems to have obvious negative consequences, such as disruptions to learning, comprehension, and performance (e.g., McVay & Kane, 2012b; Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012; Seli, Cheyne, & Smilek, 2013; Smallwood, McSpadden, & Schooler, 2008). Yet, people report mind wandering during 25–50% of their waking moments (e.g., Kane et al., 2007; Killingsworth & Gilbert, 2010; Song & Wang, 2012), suggesting it might also be adaptive (e.g., Baars, 2010; Immordino-Yang, Christodoulou, & Singh, 2012; Schooler et al., 2011). Can we characterize mind wandering as inherently costly or beneficial? According to the Smallwood and Andrews-Hanna (2013) and Andrews-Hanna, Smallwood, and Spreng (2014) "content regulation hypothesis," the answer is "no": such judgments can only be made while considering what people mind wander about and the contexts in which they do so. Ruminative mind wandering about negative events, for example, may indicate or contribute to emotional distress (Poerio, Totterdell, & Miles, 2013; Watkins, 2008). Off-task thoughts about goals and plans, in contrast, may foster productivity and fulfillment in the long term, even as they derail ongoing activities (Klinger, 1971, 1999, 2009). Indeed, in healthy adults, mind wandering can be pleasant (e.g., Killingsworth & Gilbert, 2010; Song & Wang, 2012) and it can predict subsequent positive affect (Franklin et al., 2013; Poerio, Totterdell, Emerson, & Miles, 2015).

Early efforts to measure mind-wandering content used retrospective questionnaires to assess people's tendencies to experience different varieties of daydreams (e.g., Singer, 1975; Singer & Antrobus, 1963, 1966). More relevant to modern research, which probes momentary thought by interrupting subjects' ongoing activities, Klinger's daily life studies asked subjects to report on multiple aspects of their conscious states at each experience-sampling signal (Klinger, 1978–1979; Klinger & Cox, 1987–1988). Small samples of undergraduates carried a beeper for multiple days and completed thought-sampling questionnaires at each beep. Across studies, factor analyses of within-subject associations indicated that daily life thought varied along six to eight factors: subjects' thoughts were more versus less externally oriented, directed, controllable, and fanciful, and (whether mind wandering or not) varying in visual and auditory qualities and in temporal orientation.

Subsequent daily life studies asked subjects to report on a few mind-wandering-content dimensions at each probe (Franklin et al., 2013; Kane et al., 2007; Kane, Gross, et al., 2017; Marcusson-Clavertz, Cardeña, & Terhune, 2016; McVay, Kane, & Kwapil, 2009; Song & Wang, 2012), whereas laboratory studies—which represent most mind-wandering research—have tended to probe only about on- versus off-task thought or have relied on a multiple-choice question about content dimensions (e.g., temporal orientation; for a review, see Weinstein, 2018). Recently, however, Smallwood and colleagues have revived Klinger's approach through "multidimensional experience sampling" in the lab (MDES; Engert, Smallwood, & Singer, 2014; Medea et al., 2018; Ruby, Smallwood, Engen, & Singer, 2013; Ruby, Smallwood, Sackur, & Singer, 2013; Smallwood et al., 2016; Wang et al., 2018; see also Seli, Ralph, Konishi, Smilek, & Schacter, 2017). Procedures vary across studies, but typical MDES probes ask subjects to rate the extent to which their immediately preceding thoughts were on- or off-task, detailed or vague, and involved future or past events, themselves or others, images or words, and positive or negative valence.

Principal components analyses of MDES probe ratings typically yield 2–3 components.[1] One is loaded most heavily on future orientation, self-focus, and off task, and the other on past orientation, other focus, and off task; valence loads separately. Thus, subjects' thoughts can be characterized as more versus less future-, self-, and off-task oriented, and more versus less past-, other-, and off-task oriented; people think more about the future when focused on themselves and more about the past when focused on others. Both patterns suggest some functional roles for mind wandering, such as helping us to plan for the future and encouraging us to learn from prior social situations.

Content-Focused Thought Sampling

Most mind-wandering studies do not use MDES. Instead, those that probe for thought content typically focus on one dimension of task-unrelated thought (TUT), typically overlapping with those addressed in MDES studies (e.g., temporal orientation, self-orientation). Below we first highlight findings from several content dimensions that have been widely investigated, and then consider within-person stability of TUT content.

Temporal Orientation

Studies assessing TUTs temporality have used open-ended prompts (Baird, Smallwood, & Schooler, 2011; McCormick, Rosenthal, Miller, & Maguire, 2018) or forced-choice probes about whether TUTs were present-, past-, or future-oriented (Maillet & Schacter, 2016; McVay, Unsworth, McMillan, & Kane, 2013; Robison & Unsworth, 2017; Rummel & Nied, 2017; Smallwood, Nind, & O'Connor, 2009; Smallwood & O'Connor, 2011; Smallwood et al., 2011; Song & Wang, 2012; Stawarczyk, Cassol, & D'Argembeau, 2013). Regardless, TUTs focus more often on the future than the past, consistent with Klinger's (e.g., 1999) functional perspective that mind wandering is goal oriented. This future-oriented bias in mind wandering is greater, however, during easier tasks, suggesting that thoughts about the future are demanding (Spreng, Stevens, Chamberlain, Gilmore, & Schacter, 2010). Future-oriented TUTs increase, moreover, after subjects engage in self-reflection (Smallwood et al., 2011), consistent with MDES linking future- to self-orientation in mind wandering. TUTs about the past, in contrast, increase during low-interest activities (Smallwood, Fitzgerald, Miles, & Phillips, 2009) and predict less positive affect (Poerio et al., 2013; Ruby, Smallwood, Engen, et al., 2013; Smallwood & O'Connor, 2011).

Self-Relevance

External cues to subjects' personal concerns increase TUT rates (e.g., Antrobus, Singer, & Greenberg, 1966; Klinger, 1978; Kopp, D'Mello, & Mills, 2015; McVay & Kane, 2013), indirectly supporting the link between mind wandering and self-relevant thought. More directly, Huijser, Van Vugt, and Taatgen (2018) found that orienting subjects to self-relevance of descriptor words during a memory task increased TUTs relative to orienting to size of object words, and Baird et al.'s (2011) open-ended probes elicited self-related thoughts two thirds of the time during a reaction time (RT) task. Clinical research finds that, although patients with borderline personality disorder (BPD) report similar overall ratings of self- and other-relevant TUTs as controls, they are more likely to report occasional extreme ratings on those dimensions, particularly for negative thoughts (Kanske et al., 2016).

External-Internal Orientation

When people's thoughts drift from ongoing activities, they may focus on images or ideas completely removed from their environs, or they may be drawn to those external surroundings. Laboratory probes distinguishing inter-

[1] Engert et al. (2014) implied that their study and both the Ruby, Smallwood, Engen, et al. (2013) and Ruby, Smallwood, Sackur et al. (2013) studies analyzed thought-probe data with chain P-factor analysis, which centers responses within subjects (and thus eliminates between-person variance). The Ruby and colleagues' articles explicitly state, however, that their data were analyzed using principal components analysis and they do not report within-person centering (see also Medea et al., 2018; Smallwood et al., 2016). Thus, we are unsure about whether all but the Engert et al. (2014) studies confounded within- and between-person variance in probe responding.

nally from externally oriented TUTs yield non-negligible rates of both (.20–.25; Stawarczyk, Majerus, Catale, & D'Argembeau, 2014; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011; Stawarczyk, Majerus, Maquet, & D'Argembeau, 2011), but mean rates of "external" TUTs are sometimes lower than those of "internal" TUTs (.05–.15; Robison & Unsworth, 2018; Unsworth & McMillan, 2014), perhaps due to spartan laboratory contexts. Internally oriented TUTs may increase more over practice (Robison & Unsworth, 2015), more strongly activate the default-mode network (Stawarczyk, Majerus, Maquet, et al., 2011), and be more consistently associated with cognitive ability (Robison & Unsworth, 2018; Stawarczyk et al., 2014; Unsworth & McMillan, 2014, 2017) than are externally oriented TUTs.

Thoughts About Performance

Subjects' thoughts sometimes focus on task performance rather than task stimuli or responses, labeled as "task-related interference" (TRI; e.g., Matthews et al., 1999; Smallwood, Obonsawin, & Heim, 2003). TRI resembles both on- and off-task thought, and so it is not usually classified as either. Given the present focus on thought content, however, we consider TRI findings. Young adults typically show TRI rates of ~.20–.25, about half the rate of TUTs (McVay & Kane, 2009, 2012a; McVay, Meier, Touron, & Kane, 2013; Stawarczyk et al., 2014); moreover, unlike TUTs, TRI rates decrease across repetitive tasks (McVay & Kane, 2012a) and correlate less consistently than do TUTs with overall performance and ability (McVay & Kane, 2012a; Robison & Unsworth, 2018; Stawarczyk, Majerus, Maj, Van der Linden, et al., 2011; Unsworth & McMillan, 2017). Perhaps most notably, whereas older adults report fewer TUTs than do younger adults, they report more TRI (Frank, Nara, Zavagnin, Touron, & Kane, 2015; Jordano & Touron, 2017b; McVay, Meier, et al., 2013), perhaps reflecting older adults' concerns about their performance.

Other TUT Content

Our laboratory frequently uses thought probes that ask subjects to select among content categories to characterize their thoughts (Frank et al., 2015; Kane et al., 2016; Kane, Smeekens, et al., 2017; McVay & Kane, 2009, 2012a, 2013; McVay, Meier, et al., 2013; see also Banks, Tartar, & Tamayo, 2015; Banks, Welhaf, & Srour, 2015; Jordano & Touron, 2017a, 2017b; Rummel & Boywitt, 2014). In addition to TRI, these probe categories include: everyday things, personal worries, current physical or psychological state, and fantastical daydreams. Undergraduates endorse current-state content most frequently (*M* rate ~.25) and worries the least (*M* rate ~.05). Stawarczyk et al. (2014) argued that TUTs about one's current state are "stimulus-dependent," and so should be combined with reports of external distraction from the environment and kept separate from reports of internally directed TUTs (such as daydreams). The present study will assess whether our individual-differences predictors differentially correlate with current-state versus externally oriented thoughts.

TUT Content Stability

We know of only one prior study that assessed the moment-to-moment consistency of subjects' mind-wandering content across successive occasions.[2] To explore the stability of self- and other-representations in BPD, Kanske et al. (2016) tested BPD patients and controls in a simple choice-RT task that was interrupted by about 10–12 MDES probes (across 2 task sessions). At each probe, subjects rated their thoughts for self-relevance, other-relevance, and several other thought dimensions. Multilevel models assessed content stability by examining squared successive differences in ratings for each dimension. BPD patients and controls had similar TUT rates and mean ratings of self- and other-relevance. However, the patients showed greater instability than did controls in self- and other-relevance ratings across trials within the task.

The Present Study

Despite suggestions that mind wandering may be functional (e.g., Immordino-Yang et al., 2012; Klinger, 1999; Singer, 1966), few studies

[2] Allen et al. (2013) examined intraindividual variability in reports of the depth of mind wandering (at each probe, subjects rated the task-[un]relatedness of their thoughts on a 1–7 Likert scale), but not in mind-wandering content, so their findings do not directly apply here.

have examined individual differences in the propensity to experience different mind-wandering content or in the relative stability of TUT content across successive probes. Laboratory research demonstrates that, relative to controls, BPD patients report more TUTs as extremely self- or other-focused and show greater instability in self- and other-TUT ratings (Kanske et al., 2016), perhaps reflecting those patients' challenges in inter- and intrapersonal domains. Older adults report more TRI than do younger adults (e.g., McVay et al., 2013), possibly consistent with concerns about age-related cognitive decline, but TRI is inconsistently related to cognitive ability in young adults (e.g., McVay & Kane, 2012a; Robison & Unsworth, 2018), as are TUTs about external stimuli (e.g., Unsworth & McMillan, 2014, 2017). In daily life, undergraduates scoring higher in openness report more fantastical daydream TUT content than do those scoring lower, and students scoring higher in neuroticism report more worry-based TUTs than do those scoring lower (Kane, Gross, et al., 2017); momentary thought patterns thus seem to mirror long-standing emotional and behavioral tendencies. Finally, in a neuroimaging study that combined default-mode-network connectivity with MDES thought reports, Wang et al. (2018) found two replicable brain-by-thought components: (a) strong coupling among particular brain regions and thoughts rated as more emotionally positive, recurring, and evolving ("positive-habitual experience"), and (b) weak coupling among particular brain regions and thoughts rated as more off-task and spontaneous ("spontaneous off-task experience"). Of most importance here, the positive-habitual experience component correlated negatively with scores from batteries of executive-control tasks and of questionnaires reflecting affective disturbance; in contrast, the spontaneous off-task component correlated positively with scores from batteries of verbal-fluency tasks and affective disturbance questionnaires.

Here, we reanalyzed data reported by Kane et al. (2016) to assess whether normal variation in executive-control abilities (reflected in working memory capacity and attention restraint) and the personality construct of schizotypy (indicating vulnerability to schizophrenia-spectrum disorders and schizophrenia-related experiences) were reliably associated with either TUT contents or temporal instability of TUT content across five computerized attention and memory tasks (across multiple laboratory sessions).

The present work was exploratory, but prior research suggested some associations of interest. Regarding TUT content, we tested whether:

1. TRI was positively associated with cognitive ability, as prior results have been mixed (e.g., McVay & Kane, 2012a; Stawarczyk, Majerus, Maj, Van der Linden, et al., 2011; Unsworth & McMillan, 2014);
2. cognitive ability was more negatively associated with externally or internally oriented TUTs, given mixed results (e.g., Unsworth & McMillan, 2014, 2017);
3. positive and disorganized schizotypy, which covary with neuroticism (e.g., Kwapil, Gross, Burgin, et al., 2018), would predict higher rates of TUTs with worry-related content; and
4. positive schizotypy, characterized by unusual perceptual experiences and magical beliefs, would predict higher rates of TUTs with fantastical daydreaming content.

Regarding content (in)stability, we created two indicators for each subject in each task: (a) how often subjects reported a different TUT-content dimension across consecutive thought probes on which they mind wandered, and (b) how many total TUT-content dimensions subjects reported within a task. Higher scores thus reflected more switching among TUT topics and more total TUT topics in each laboratory assessment. We predicted that:

5. subjects with poorer executive control and more disorganized thought patterns would demonstrate more instability in their TUT contents than those with better control: students who better regulate their thought and behavior should be more likely to follow a single stream of off-task thought, consistent with Smallwood's (2013) claim that executive processes serve not only to block TUTs from on-task streams of thought (e.g., McVay & Kane, 2009, 2010), but also to block processing of the external world from off-task streams of thought once they begin.

Method

Below we report how we determined our sample size and all data exclusions, manipulations, and measures in the study (Simmons, Nelson, & Simonsohn, 2012). The study received institutional review board approval from the University of North Carolina at Greensboro (UNCG).

Subjects

Kane et al. (2016) assessed 545 undergraduates at UNCG, a comprehensive state university (and Minority-serving institution for African American students). Of these, 541 completed the first of three 2-hr sessions, 492 completed the second, and 472 completed all three. Full-information maximum likelihood estimation was used for missing data (see Kane et al. [2016] for details and demographics).

Cognitive Measures

For a detailed description of the tasks used for the present analyses (as well as nonanalyzed tasks and task order), see Kane et al. (2016). To keep our exploratory analyses focused on the key constructs that Kane et al. (2016) measured best, we used only two cognitive constructs as predictors in our statistical models—working memory capacity (WMC) and attention-restraint failures (i.e., we did not analyze performance from attention-constraint tasks here, which loaded only modestly onto a common constraint factor).

WMC. In six tasks, subjects briefly maintained items in memory while engaging in secondary tasks or mental updating. Four complex span tasks presented sequences of items that required immediate serial recall (operation span, reading span, symmetry span, rotation span); memory items were preceded by unrelated processing tasks requiring yes/no responses. Two memory-updating tasks (running span, updating counters) required subjects to maintain an evolving set of stimuli while disregarding previous stimuli. Higher scores indicated more accurate recall.

Attention restraint. Five restraint tasks required subjects to override a dominant response in favor of a novel one. Subjects completed two antisaccade tasks (with letter and arrow stimuli), a go/no-go task (sustained attention to response task [SART]), and two Stroop-like tasks (number Stroop, and spatial Stroop). Higher scores indicated worse performance (more errors, longer RTs, more RT variability).

Attention constraint. Subjects completed five flanker-interference tasks requiring response to a visual target surrounded by distractors. Although we did not use the performance data from these tasks here, two included mind-wandering thought probes.

Schizotypy Measures

Subjects also completed well-validated questionnaires on schizotypy (see Kane et al., 2016, for detailed descriptions). Here, we analyzed the Wisconsin Schizotypy Scale (subscales for Perceptual Aberration, Magical Ideation, Revised Social Anhedonia, and Physical Anhedonia; Chapman, Chapman, & Raulin, 1976, 1978; Eckblad & Chapman, 1983), the Schizotypal Personality Questionnaire (subscales for Ideas of Reference, Odd Behavior, and Odd Speech; Raine, 1991), the Cognitive Slippage Scale (Miers & Raulin, 1987), and the Dimensional Assessment of Personality Pathology-Basic Questionnaire (6 items from the Cognitive Dysregulation subscale; Livesley & Jackson, 2009). Following Kane et al. (2016), we derived latent variables from these to reflect positive, negative, and disorganized symptoms, with some measures divided into multiple parcels of items (for simplicity, here we did not analyze measures of paranoia included in Kane et al. (2016).

Thought Reports

Thought probes appeared randomly within five tasks (45 in SART, 20 in number Stroop, 20 in arrow flanker, 12 in letter flanker, and 12 in an otherwise-unanalyzed 2-back task). At each probe, subjects chose among eight presented options that most closely matched the content of their immediately preceding thoughts. TUTs were comprised of response options 3–8 in Kane et al. (2016): "everyday things" (thoughts about normal life concerns and activities), "current state of being" (thoughts about one's physical, cognitive, or emotional states), "personal worries" (thoughts about worries), "daydreams" (fantastical thoughts), "external environment" (thoughts about environmental stimuli), and "other." In the present study of thought content and consistency, we also included Option 2, "task performance/evaluation," or TRI, which reflects thoughts about one's own performance of the ongoing tasks; these thoughts do not reflect fully on-task experiences and so may be considered a variety of mind-wandering content for present purposes.

Thought-Content Measures Derived for the Present Study

Kane et al. (2016) analyzed mind-wandering rates by collapsing thought reports other than on-task and TRI into a single TUT variable. Here we explored individual thought types, including TRI, and their cognitive and personality predictors. To do so, we initially calculated, for each subject and task, the proportion of reports for each mind-wandering category (not including the ambiguous response option 8, "Other") out of all probe responses 2–8. We report in online supplementary Table 1, however, that many of these variables had problematic skewness or kurtosis (more than half had skewness ≥2.0; more than a third had kurtosis ≥8.0; Kline, 2011) because many subjects endorsed 0 instances of any one thought type during any one task (for 50% of the variables, *Mdn* proportion = .00).

To accommodate these positively skewed data distributions with excessive 0 values, we treated our outcomes as raw counts rather than proportions. Although these counts also were severely skewed and zero-heavy, we could model them using zero-inflated Poisson models. These models combine the logit distribution with the Poisson distribution and assume that counts are generated by two processes (or reflect membership in one of two groups): one process that determines whether any values greater than 0 may occur at all, and a Poisson process that creates count values from 0 upward.[3] For example, the lifetime number of gun crimes that people commit is determined by: (a) whether people have any access to guns (without access, the count cannot exceed 0), and (b) factors that cause people with access to guns to commit ≥0 gun crimes. Scores of 0 are inflated because they may come from either of two sources: people who are "certain 0s" because they could not produce the outcome (e.g., they had no gun access), as well as people who could have produced the outcome but did not (e.g., they had access but committed no offenses).

Predictor variables in zero-inflated Poisson models may be associated with the probability of being in the certain-0 group, or with the count from the Poisson component, or both. For example, being an avid hunter will negatively predict membership in the certain-0 group, but it may or may not positively predict the Poisson-component count of gun crimes. As a more relevant example here, positive schizotypy might negatively predict membership in the certain-0 group for fantasy-related TUTs and positively predict the number of fantasy reports during cognitive tasks. Because we measured thought content during five tasks, we took a latent-variable approach to modeling each thought type, assessing which cognitive and personality variables predicted the likelihood of being in the certain-0 group (a so-called "inflation" latent factor reflecting the logit component), and the propensity for lower versus higher counts (a latent factor reflecting the Poisson component).

Thought-Stability Measures Derived for the Present Study

We created two measures to quantify within-person and within-task variability of off-task thought: TUT switches and TUT topics. As we will discuss in the Results section, we found unanticipated positive associations between the cognitive-ability constructs and these TUT-variability indicators. To help explore possible causes for these positive correlations, we also created a measure of TUT streak length, which we describe below. (For all three indices, data from subjects without at least two thought reports of any choices 2–8 within a task were set to missing for that task.) See the Appendix for detailed scoring examples for each index.

TUT switches. Switches reflected the rate at which subjects experienced changing TUT content across consecutive reports of off-task thoughts within a task. For example, one switch would be counted if a subject reported thinking about TRI at one probe and then about personal

[3] The cost of this necessary strategy is that our conclusions about each thought type may not be independent of overall TUT rates. That is, subjects with generally high TUT rates might have relatively high counts in multiple content categories simply because they have more opportunities to report some form of mind-wandering content, and not because they have a specific propensity to experience those types of thought.

worries at the next probe on which they reported an off-task thought (i.e., any response choice 2–8). We then converted these counts into proportions by dividing the number of content switches between TUT reports by the total number of TUT reports (responses 2–8) for that subject in that task. Thus, greater switch scores indicated more content changes across consecutive mind-wandering reports per off-task thought report.

TUT topics. Topics reflected the diversity of TUT categories that subjects experienced in a task. We summed the different TUT categories (2–8) that were reported by each subject in each task and divided this by the corresponding number of TUT reports. Greater topic scores thus indicated more TUT topics per off-task thought report.

TUT streak length. To assess how long, on average, subjects mind wandered, we calculated the mean length of TUT report streaks (TUT Categories 2–8) for each subject and task. We defined a streak as any series of one or more consecutive TUT reports. A new streak started with any off-task report following an on-task report. We averaged the streak lengths for each subject within a task and divided that by the corresponding number of TUT reports. Thus, greater streak length scores indicated longer TUT streaks per off-task report.

Results

Data used for analyses, as well as sample analysis scripts and output, are available via the Open Science Framework (https://osf.io/guhw7/). We adopted an alpha level of .05 throughout this exploratory study to highlight findings as candidates for future replication. For details of data-analysis exclusions, cognitive-task scoring, and outlier treatment, see Kane et al. (2016). We modeled the cognitive and schizotypy predictor constructs as did Kane et al., including any residual correlations among indicators, with one exception: We did not allow residual correlations among the indicator parcels for the Revised Social Anhedonia Scale, because our measurement model for the cognitive and schizotypy measures that included them produced a covariance matrix that was not positive definite.

Thought-Content Measures

Descriptive statistics (and 95% confidence intervals) for the counts of each thought type, by task, are presented in Table 1 (the SART produced the highest counts because it had the most probes). Subjects reported higher counts of TRI and current-state thoughts than everyday things, daydreams, or worries, and very few externally oriented distractions (likely reflecting the austere testing rooms); at the same time, standard deviations around the mean counts indicated substantial between-person variation in these reports.

We did not calculate correlations among measures, nor model them as normally distributed variables, because of high skewness and kurtosis, and excessive prevalence of zero counts, as discussed in the Method section. Instead, we used Mplus 7.31 (Muthén & Muthén, 2012) to run confirmatory factor analyses with thought-content counts modeled as zero-inflated Poisson variables; each thought-content type (e.g., TRI; daydreams) was modeled separately, with one latent inflation factor for the likelihood of membership in the certain-0 group and a latent factor for the count of the Poisson component. (Factor loadings for these indicators can only be interpreted in their unstandardized form; these are presented for all thought-content models in Table 2 in the online supplemental materials.) Unlike typical latent-variable models, these do not provide interpretable fit statistics beyond Akaike and Bayesian information criteria, which are only useful for comparing one model with another. We do not report these because our goal was not to contrast competing models but rather to estimate correlations among latent factors within a single model type for each variety of TUT.

Executive control and schizotypy models. Here we tested whether different mind-wandering contents were predicted by normal variation in WMC, attention-restraint failures, or positive, disorganized, or negative schizotypy. Because the current models did not match those reported in Kane et al. (2016) exactly—here we didn't model attention constraint, TUT rate, or paranoid schizotypy—we conducted a measurement model of the predictor constructs to test whether they fit the data. They did, according to commonly used criteria for fit statistics (e.g., Schermelleh-Engel, Moosbrugger, & Müller,

Table 1
Descriptive Statistics for Number of Reports for Each Thought Probe Content Category, by Task

Thought type and task	Median	Mean	95% CI	*SD*	Skewness (*SE*)	Kurtosis (*SE*)
Task experience/performance (TRI)						
SART	11.00	12.35	[11.51, 13.18]	9.71	.87 (.11)	.32 (.21)
Number Stroop	3.00	4.34	[3.95, 4.74]	4.39	1.34 (.11)	1.66 (.22)
Letter flanker	1.00	1.57	[1.39, 1.75]	1.96	2.24 (.11)	6.95 (.23)
Arrow flanker	2.00	3.40	[3.04, 3.75]	3.99	1.72 (.11)	3.10 (.22)
2-back	2.00	3.11	[2.80, 3.42]	3.35	1.41 (.11)	1.67 (.23)
Everyday things						
SART	1.00	2.31	[2.03, 2.60]	3.35	2.49 (.11)	7.69 (.21)
Number Stroop	.00	1.26	[1.07, 1.46]	2.14	3.14 (.11)	15.66 (.22)
Letter flanker	.00	.91	[.79, 1.03]	1.29	2.17 (.11)	6.89 (.23)
Arrow flanker	1.00	1.34	[1.13, 1.55]	2.36	3.82 (.11)	21.24 (.22)
2-back	.00	.68	[.54, .82]	1.49	5.07 (.11)	36.85 (.23)
Current state of being						
SART	8.00	10.46	[9.68, 11.24]	9.14	1.15 (.11)	1.10 (.21)
Number Stroop	2.00	4.27	[3.80, 4.74]	5.19	1.41 (.11)	1.08 (.22)
Letter flanker	2.00	3.21	[2.95, 3.48]	2.93	.95 (.11)	.22 (.23)
Arrow flanker	3.00	4.15	[3.70, 4.59]	4.92	1.57 (.11)	1.94 (.22)
2-back	2.00	2.81	[2.51, 3.12]	3.34	1.41 (.11)	1.55 (.23)
Personal worries						
SART	1.00	2.11	[1.80, 2.41]	3.60	3.15 (.11)	13.33 (.21)
Number Stroop	.00	1.06	[.86, 1.27]	2.24	3.96 (.11)	21.22 (.22)
Letter flanker	.00	.77	[.65, .88]	1.27	2.51 (.11)	9.02 (.23)
Arrow flanker	.00	1.29	[1.06, 1.51]	2.49	3.15 (.11)	12.86 (.22)
2-back	.00	.75	[.60, .90]	1.69	3.69 (.11)	16.36 (.23)
Daydreams/fantasy						
SART	2.00	4.34	[3.81, 4.86]	6.12	2.31 (.11)	6.69 (.21)
Number Stroop	.00	1.42	[1.14, 1.70]	3.09	3.50 (.11)	13.91 (.22)
Letter flanker	1.00	1.15	[1.00, 1.29]	1.64	2.11 (.11)	9.02 (.23)
Arrow flanker	.00	1.96	[1.63, 2.28]	3.62	2.73 (.11)	7.87 (.22)
2-back	.00	1.22	[1.00, 1.43]	2.36	2.88 (.11)	9.13 (.23)
External environment						
SART	1.00	1.64	[1.40, 1.88]	2.82	3.66 (.11)	20.15 (.21)
Number Stroop	.00	.45	[.32, .57]	1.34	8.20 (.11)	101.08 (.22)
Letter flanker	.00	.54	[.44, .63]	1.04	3.33 (.11)	16.96 (.23)
Arrow flanker	.00	.44	[.35, .53]	1.00	3.60 (.11)	17.93 (.22)
2-back	.00	.26	[.18, .33]	.81	7.85 (.11)	100.00 (.23)

Note. 95% CI = 95% confidence interval; *SD* = standard deviation; *SE* = standard error; TRI = task-related interference; SART = sustained attention to response task. *N*s by task are 526 for SART, 478 for number Stroop, 462 for letter flanker, 479 for arrow flanker, and 461 for 2-back.

2003): $\chi^2(352) = 502.63$, $\chi^2/df = 1.43$, comparative fit index (CFI) = .949, Tucker-Lewis index (TLI) = .941, standardized root-mean-square residual (SRMR) = .060, root-mean-square error of approximation (RMSEA) = .039, 90% CI [.031, .047]. Factor loadings and correlations among constructs resembled those reported by Kane et al. (2016; see Figure 1 in the online supplemental materials), with significant correlations for only WMC with attention-restraint failure (standardized coefficient [β] = −.59), attention-restraint failure with disorganized schizotypy (β = .19), and positive with disorganized schizotypy (β = .63).

TRI. All TRI indicators loaded significantly onto the inflation and count factors, which correlated negatively with each other (β = −.46), as expected (i.e., subjects with higher counts were less likely to be in the certain-0 group). As reported in Table 2, no schizotypy factors were associated with either TRI factor. Relevant to our first major question, though, better cognitive ability predicted greater likelihood (and, to some extent, greater counts) of TRI. Specifically, membership in the cer-

Table 2
Standardized Path Coefficients (With 95% Confidence Intervals) Between Thought-Content Outcome Constructs and Executive-Control and Schizotypy Predictor Constructs, in All Structural Models of Thought Content

Thought content outcome	Predictor	Inflation (certain-0) factor	Count factor
Task-related interference (TRI)	Working memory capacity	−.25 [−.41, −.10][a]	.03 [−.09, .15]
	Attention-restraint failure	.29 [.13, .46][a]	−.14 [−.27, −.02][a]
	Positive schizotypy	.07 [−.06, .21]	−.05 [−.15, .05]
	Disorganized schizotypy	.01 [−.13, .15]	.00 [−.10, .11]
	Negative schizotypy	.08 [−.05, .21]	−.01 [−.11, .09]
Everyday things	Working memory capacity	−.07 [−.30, .17]	−.02 [−.19, .16]
	Attention-restraint failure	.12 [−.13, .37]	.13 [−.05, .32]
	Positive schizotypy	.01 [−.17, .20]	−.06 [−.20, .09]
	Disorganized schizotypy	−.10 [−.30, .10]	.02 [−.13, .16]
	Negative schizotypy	.05 [−.15, .25]	−.03 [−.18, .12]
Current state of being	Working memory capacity	−.03 [−.19, .13]	−.18 [−.30, −.06][a]
	Attention-restraint failure	−.04 [−.20, .11]	.22 [.11, .33][a]
	Positive schizotypy	−.04 [−.18, .10]	−.03 [−.14, .08]
	Disorganized schizotypy	−.12 [−.26, .02]	.05 [−.06, .15]
	Negative schizotypy	.10 [−.04, .23]	.02 [−.09, .12]
Personal worries	Working memory capacity	−.04 [−.21, .13]	.00 [−.14, .14]
	Attention-restraint failure	.04 [−.21, .29]	.23 [.07, .40][a]
	Positive schizotypy	−.20 [−.39, −.02][a]	.31 [.16, .45][a]
	Disorganized schizotypy	−.21 [−.41, .00]	.29 [.15, .43][a]
	Negative schizotypy	.06 [−.13, .25]	−.13 [−.29, .02]
Daydreams	Working memory capacity	−.20 [−.39, .00]	−.00 [−.14, .14]
	Attention-restraint failure	.15 [−.04, .33]	.09 [−.06, .24]
	Positive schizotypy	−.23 [−.38, −.07][a]	.17 [.05, .28][a]
	Disorganized schizotypy	−.32 [−.47, −.16][a]	.14 [.02, .26][a]
	Negative schizotypy	.01 [−.16, .19]	.06 [−.06, .19]
External environment	Working memory capacity	−.46 [−.86, −.05][a]	−.06 [−.23, .11]
	Attention-restraint failure	.17 [−.15, .50]	.05 [−.13, .24]
	Positive schizotypy	−.03 [−.28, .21]	.01 [−.15, .16]
	Disorganized schizotypy	.01 [−.21, .23]	.14 [.00, .28][a]
	Negative schizotypy	−.01 [−.30, .12]	.07 [−.04, .19]

[a] Path coefficient is statistically significant ($p < .05$).

tain-0 group correlated negatively with WMC (β = −.25) and positively with attention-restraint failure (β = .29). Moreover, attention-restraint failure correlated modestly with the TRI counts (β = −.14).

Everyday things. Only one indicator for everyday things content loaded significantly onto the inflation factor, but because this is an exploratory study and many loadings were close to significant, we report the results. As indicated in Table 2, none of the cognitive or schizotypy factors correlated with either the inflation or count factor for everyday thought content; low loadings may have reduced power to detect effects here.

Current state of being. All current-state content indicators loaded significantly onto the inflation and count factors, which correlated negatively with each other (β = −.28). Table 2 shows that no cognitive or schizotypy factors correlated with the inflation factor, but WMC correlated negatively with current-state thought counts (β = −.18) and attention-restraint failure correlated positively with them (β = .22). Thus, better cognitive ability was associated with fewer off-task thoughts about one's current physical or emotional state.

Personal worries. Only one personal worries indicator loaded significantly onto the inflation factor, but two nonsignificant loadings had *ps* < .10; these factors correlated negatively with each other (β = −.37). Despite the potential for reduced power due to some low factor loadings, Table 2 shows that positive and disorganized schizotypy correlated negatively with the inflation factor (βs = −.20 and −.21, respectively [for the latter, p = .051]) and positively with the count factor (βs = .31 and .29, respectively), as did attention-restraint failure (β = .23). Consistent with our Prediction 2, students higher in positive and disorganized schizotypy, but also those performing more poorly on attention-restraint tasks, reported more worries during ongoing tasks than did students lower in those factors.

Daydreams. All but one daydream indicator loaded significantly on the inflation and count factors, which correlated negatively (β = −.30). Consistent with Prediction 3, Table 2 shows that positive (and disorganized) schizotypy predicted fantastical thought content, with both factors correlating negatively with the inflation factor (people higher in positive schizotypy, β = −.23, and disorganized schizotypy, β = −.32, were less likely to be in the certain-0 group for daydreams than those who were lower) and positively with the count factor (people high in positive schizotypy, β = .17, and disorganized schizotypy, β = .14, reported higher counts of fantasy experiences than those who were lower).

External environment. None of the loadings were significant for the inflation factor, and path coefficients had very wide confidence intervals, so we report these results with caution. Inflation and count factors correlated nonsignificantly with each other (β = −.23, p = .316); Table 2 shows that the only significant predictions of either external factor was WMC's negative association with the inflation factor, β = −.46, and disorganized schizotypy's weak positive association with the count factor, β = .14. Addressing our Question 4, subjects higher in WMC were (counterintuitively) less likely to be in the certain-0 group for external distractions than were those lower in WMC, but subjects higher in disorganized schizotypy had higher counts of external distraction experiences than did those lower. (Because inflation-factor loadings were nonsignificant and two multivariate outliers had Cook's D scores >3.0, we reran the model after deleting these outliers. Most inflation-factor loadings were now significant, the inflation and count factors now correlated significantly [β = −.30, p = .050], and only the negative WMC association with the inflation factor remained significant, with a smaller effect size, β = −.30.)

Thought-Stability Measures

Descriptive statistics and bivariate correlations. Table 3 provides descriptive statistics (and confidence intervals) for TUT switches and TUT topics. A few variables were moderately leptokurtic, but no variables were both skewed and leptokurtic so we did not transform any. In all subsequent analyses we included data only from subjects who reported TUTs on at least two occasions for a given task, as it only makes sense to consider consistency in TUT content if subjects report more than one TUT; we thus set data to missing for a given subject in a given task if they reported fewer than two TUTs.

Correlations among TUT switches and TUT topics measures (Table 4) indicate both convergent and discriminant validity, as the indicators for each of these correlated more strongly with each other (for switches, $Mdn\ r$ = .38; for topics, $Mdn\ r$ = .34) than they did with the indicators of the other construct ($Mdn\ r$ = .23). We thus measured reasonably stable and trait-like propensities for subjects to be more or less consistent in TUT content.

Measurement model. As above, we conducted all models using Mplus 7.31 (Muthén & Muthén, 2012), and report multiple fit statistic for each model. We allowed residual correlations among indicators that came from the same task (e.g., SART TUT switches and SART TUT topics). Our a priori model tested whether TUT switches and TUT topics reflected separate but correlated latent factors. Indeed, this two-factor model provided adequate fit to the data: $\chi^2(29)$ = 54.88, χ^2/df = 1.89, CFI = .977, TLI = .965, SRMR = .041, RMSEA = .041 90% CI = [.024, .057]. All indicators loaded significantly onto their hypothesized factor (see Table 3 in the online supplemental materials for standardized factor loadings for all TUT-consistency models) and the model suggested two correlated latent variables (β = .56). Propensity to endorse more mind-wandering topics during a task and propensity to switch between mind-wandering topics during a task (relative to one's overall TUT rate) reflected stable and moderately related traits across multiple laboratory tasks and sessions.

Executive-control and schizotypy models. We tested whether TUT switches and TUT topics correlated with WMC, attention-restraint

Table 3
Descriptive Statistics for TUT Consistency Measures, by Task, Expressed as a Proportion of TUT Rate

Consistency variable and task	Median	Mean	95% CI	*SD*	Skewness (*SE*)	Kurtosis (*SE*)
TUT-switches						
SART	.47	.44	[.42, .46]	.21	−.22 (.11)	−.75 (.21)
Number Stroop	.40	.38	[.36, .40]	.25	−.02 (.11)	−1.01 (.22)
Letter flanker	.50	.47	[.44, .49]	.25	−.25 (.11)	−.82 (.23)
Arrow flanker	.44	.40	[.38, .43]	.25	−.13 (.11)	−1.06 (.22)
2-back	.38	.37	[.35, .39]	.27	.10 (.11)	−1.10 (.23)
TUT-topics						
SART	.14	.14	[.14, .15]	.08	2.35 (.11)	9.41 (.21)
Number Stroop	.25	.28	[.26, .29]	.18	1.59 (.11)	3.71 (.22)
Letter flanker	.38	.39	[.38, .41]	.17	.47 (.11)	.97 (.23)
Arrow flanker	.26	.30	[.28, .32]	.21	1.66 (.11)	3.24 (.22)
2-back	.30	.34	[.32, .36]	.21	1.19 (.11)	1.86 (.23)
TUT-streaks						
SART	.22	.36	[.33, .39]	.31	1.24 (.11)	.14 (.21)
Number Stroop	.33	.44	[.41, .46]	.30	1.08 (.11)	−.34 (.23)
Letter flanker	.50	.59	[.56, .62]	.30	.51 (.12)	−1.44 (.23)
Arrow flanker	.33	.49	[.46, .52]	.32	.77 (.12)	−1.07 (.23)
2-back	.50	.54	[.52, .57]	.30	.64 (.12)	−1.21 (.24)

Note. TUT = task-unrelated thought; 95% CI = 95% confidence interval; *SD* = standard deviation; *SE* = standard error; SART = sustained attention to response task. *N*s = 526 for SART, 478 for number Stroop, 462 for letter flanker, 479 for arrow flanker, and 461 for 2-back.

failures, or positive, disorganized, or negative schizotypy. The full model, with all predictor and outcome constructs, adequately fit the data: $\chi^2(661) = 1088.02$, $\chi^2/df = 1.65$, CFI = .940, TLI = .933, SRMR = .055, RMSEA = .035 90% CI = [.031, .038]. Figure 1 shows that WMC and attention-restraint failures correlated significantly with both TUT-consistency constructs. Against our fifth hypothesis, higher WMC and lower restraint failure were modestly associated with more topic switches between TUT experiences (β = .19 and −.18, respectively) and more total TUT topics (β = .20 and −.17, respectively). Subjects with better control abilities thus had less consistent mind-wandering experiences that did subjects with poorer control abilities.

More consistent with our fifth hypothesis, disorganized schizotypy correlated significantly but weakly with TUT switches in the expected direction (β = .16): Students reporting more confusing thought patterns via retrospective questionnaires also switched more between mind-wandering topics within laboratory tasks. Neither positive nor negative schizotypy correlated significantly with the TUT-consistency measures (βs = −.03 to .03).

To investigate the unexpected positive association between executive control and TUT-consistency factors, we tested whether subjects with better control have shorter TUT experiences: If subjects with better control mind wander for shorter periods before reorienting attention back to ongoing tasks, then these more frequent mental context changes may set the occasion for new topics to capture subjects' stream of thought. As described in the Method section, we calculated the lengths of subjects' TUT streaks for each task (relative to their overall TUT rate); Table 4 indicates that TUT streaks correlated positively with each other, suggesting traitlike variation across tasks and sessions.

We then conducted two structural equation analyses (a single model with both outcomes did not converge): (a) with a TUT streaks factor as a mediator between executive-control and TUT switches (Figure 2), which adequately fit the data ($\chi^2(195) = 334.53$, $\chi^2/df = 1.72$, CFI = .939, TLI = .927, SRMR = .048, RMSEA = .037, 90% CI [.030, .043]); (b) with TUT-streaks as a mediator between executive control and TUT topics (Figure 3), which also fit the data ($\chi^2(195) = 354.43$, $\chi^2/df = 1.82$, CFI = .937, TLI = .925, SRMR = .047, RMSEA = .039, 90% CI [.032, .045]). In both models, the direct paths from WMC and attention-restraint failures to TUT-consistency outcomes were not significant. Further, whereas restraint failures significantly predicted TUT streaks ($\beta = .20$), WMC did not ($\beta = -.14$).[4] The indirect effects of attention-restraint failures on TUT topics and on TUT switches, through TUT streaks, were both significant ($\beta = -.13$ and $-.11$, respectively).

A parallel analysis tested whether TUT streaks mediated the relation between disorganized schizotypy and TUT switches (Figure 4; $\chi^2(69) = 97.31$, $\chi^2/df = 1.41$, CFI = .985, TLI = .980, SRMR = .035, RMSEA = .028, 90% CI [.013, .040]). TUT Streaks was not predicted by disorganized schizotypy ($\beta = .06$) and the indirect effect was nonsignificant ($\beta = -.04$). Thus, disorganized schizotypy provides a path to TUT instability that is unrelated to the length of TUT episodes.

Discussion

We conducted an exploratory study of adult individual differences in the contents of mind-wandering experiences and in the short-term consistency of that thought content. As a secondary data analysis, our approach has strengths and weaknesses. On one hand, our sample reflected a diverse and large number of undergraduates, assessed for multiple executive-ability and schizotypy constructs with multiple measures each, who made in-the-moment TUT reports across five tasks over three laboratory visits. Whereas Kane et al. (2016) found compelling evidence for stability in how much students mind-wandered across occasions, here we were able to robustly assess stability in what students mind-wandered about. On the other hand, our thought probes forced subjects to select only one content category per report. Some content variables were thus rarely endorsed, leading to zero-inflated distributions and requiring a cautious statistical approach and interpretation. Specifically, counts of each thought type were confounded with overall TUT counts, such that subjects who reported more TUTs had more opportunities to report any content category. We also acknowledge that most significant associations we found between our predictors (executive ability and schizotypy factors) and TUT-content outcomes were modest, with βs ranging from ~.15–.30. Finally, although we assessed multiple executive and schizotypy dimensions, we did not assess other ability constructs (e.g., intelligence, task switching), personality constructs (e.g., emotional stability, hypomania), or other state or trait constructs (e.g., motivation, negative affect) that might account for some of the shared variance between thought content and our primary constructs of interest.

Individual Differences in TUT Content

Subjects most frequently endorsed off-task thoughts about: (a) evaluating task performance, and (b) reflecting on physical or emotional states, consistent with our prior findings from single tasks (e.g., McVay & Kane, 2009, 2012a), and arguably suggesting that some TUTs can be functional. Subjects least frequently reported TUTs about their external environment, which is not surprising because austere testing rooms did not provide much stimulation for thought (vs. everyday contexts; e.g., Kane, Gross, et al., 2017; Unsworth & McMillan, 2017). Most of our latent-variable models yielded significant factor loadings from most or all probed tasks, which indicated—critically—that subjects reliably endorsed particular TUT categories across tasks and sessions. Individual differences in subjects' TUT-content endorsement rates were consistent enough across tasks to form coherent factors.

Of primary interest, executive-attention abilities and schizotypy factors selectively correlated with content categories. Subjects with better executive-attention ability (greater WMC and fewer restraint failures) had lower counts of current-state TUTs than did subjects with poorer ability. As well, attention-restraint failure correlated positively with the count of worry-related TUTs. Executive-control abilities did not predict the propensity toward fantastical daydreams or thoughts about everyday concerns. None of these associations had been tested before, but they suggest that higher-ability subjects show less of an orientation to their internal context during the performance of

[4] Note that, in a confirmatory factor analysis that allowed all these latent variables to correlate, TUT-streaks correlated significantly with both attention-restraint failures ($\beta = .29$) and WMC ($\beta = -.27$). Thus, the null path from WMC to TUT-streaks in the structural equation model reflects the shared variance between WMC and attention-restraint failures, rather than a lack of association between WMC and TUT-streaks.

Table 4
Bivariate Correlations Among Executive-Control and Schizotypy Predictor Tasks and TUT Consistency Measures

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. OPERSPAN																				
2. READSPAN	.58																			
3. SYMMSPAN	.40	.38																		
4. ROTASPAN	.45	.32	.54																	
5. RUNNSPAN	.45	.37	.27	.20																
6. COUNTERS	.36	.23	.37	.29	.39															
7. ANTI-LET	−.21	−.18	−.34	−.21	−.25	−.35														
8. ANTI-ARO	−.25	−.19	−.30	−.36	−.27	−.33	.59													
9. SEM-SART *d′*	.15	.20	.19	.14	.21	.17	−.36	−.27												
10. SEM-SART rtsd	−.15	−.19	−.21	−.11	−.23	−.21	.36	.28	−.63											
11. N-STROOP	−.17	−.03	−.19	−.18	−.10	−.21	.22	.26	−.12	.21										
12. S-STROOP	−.04	−.05	−.08	−.18	−.09	−.07	.19	.21	−.17	.16	.08									
13. PERCABER1	−.02	−.01	.06	.04	−.06	−.04	.03	−.02	−.07	.03	.02	.02								
14. PERCABER2	.06	.06	.10	.08	−.09	−.03	.04	−.01	−.09	.08	.02	.03	.67							
15. PERCABER3	−.05	−.06	.03	.07	−.15	−.07	.08	.08	−.10	.10	.05	.05	.65	.64						
16. MAGCIDEA1	.00	−.03	.09	.07	−.08	−.09	.08	−.02	−.18	.11	.01	.07	.49	.49	.52					
17. MAGCIDEA2	.06	.00	.11	.09	−.04	−.00	.03	−.03	−.09	.03	.06	.05	.50	.48	.54	.63				
18. MAGCIDEA3	−.05	−.07	.05	.03	−.11	−.07	.02	−.04	−.10	.03	.01	.06	.43	.42	.45	.56	.62			
19. REFTHINK	−.05	−.09	−.01	.04	−.13	−.12	.09	.06	−.15	.13	.10	.03	.32	.34	.40	.56	.54	.46		
20. SOC-ANHD1	−.10	.00	.01	.03	−.07	−.02	.11	.08	−.03	.08	−.04	−.01	.15	.18	.22	.11	.11	.10	.08	
21. SOC-ANHD2	−.07	.01	−.00	−.01	−.06	−.01	.08	.06	−.08	.10	−.04	.00	.08	.11	.15	.07	.04	.01	.01	.65
22. SOC-ANHD3	−.02	.01	−.01	−.01	−.06	.04	.05	−.01	−.05	.04	−.03	−.06	.14	.18	.20	.13	.16	.07	.00	.66
23. PHY-ANHD1	−.09	−.08	−.10	.01	−.11	−.03	.05	.10	−.06	.08	−.08	.00	.01	.04	.02	−.10	−.13	−.10	−.12	.36
24. PHY-ANHD2	−.10	−.09	−.15	−.03	−.20	−.12	.08	.11	−.11	.09	−.03	−.02	.05	.05	.11	.04	−.02	−.04	.03	.34
25. PHY-ANHD3	−.07	−.03	−.08	−.02	−.15	−.06	.06	.10	−.15	.13	−.05	.04	.07	.10	.10	−.01	−.06	−.09	−.05	.37
26. COGSLIPG	−.07	−.06	.01	.06	−.17	−.08	.14	.05	−.13	.09	.06	.08	.34	.33	.45	.40	.41	.33	.39	.28
27. COGDYSRG	−.08	−.10	−.02	.02	−.16	−.13	.14	.02	−.14	.09	.06	.06	.28	.26	.36	.38	.35	.26	.40	.24
28. ODSPEECH	−.03	−.03	.01	.01	−.10	−.03	.05	−.04	−.06	.00	.01	.06	.30	.24	.36	.34	.34	.23	.38	.24
29. ODBEHAVR	.01	.01	.01	−.05	−.07	−.03	.09	.01	−.03	.00	.00	.07	.30	.29	.26	.32	.29	.22	.27	.22
30. TUT-SWITCH-SART	.11	.04	.07	.11	.09	.06	−.02	−.10	.14	−.11	.06	−.00	.06	.02	.01	.04	.05	−.02	.01	.01
31. TUT-SWITCH-NS	.07	.11	.08	.11	.04	.05	−.09	−.14	.07	−.06	.06	.02	.02	.00	−.03	−.02	−.02	−.10	−.04	−.02
32. TUT-SWITCH-LF	.14	.08	.15	.11	.02	.10	−.10	−.10	.06	−.10	−.01	−.03	.07	.05	.01	.02	.02	.04	−.03	−.08
33. TUT-SWITCH-AF	.08	.11	.10	.05	.05	.08	−.04	−.12	.08	−.04	.11	.04	.03	−.00	−.08	−.06	.05	−.06	−.07	−.01
34. TUT-SWITCH-2B	.04	.10	−.01	−.04	−.01	−.03	.12	.04	−.03	.06	−.03	.03	.12	.06	.08	.05	.04	.08	.04	.09
35. TUT-TOPICS-SART	.13	.08	.03	.01	.01	.00	−.03	−.02	.20	−.05	.02	−.05	.09	.04	.00	.05	.04	−.01	.00	.01
36. TUT- TOPICS-NS	.08	.18	.04	.09	.15	.04	−.12	−.09	.11	−.10	−.02	−.01	−.03	.01	−.02	−.05	−.05	−.09	−.10	−.01
37. TUT-TOPICS-LF	.11	.12	.13	.05	.02	.11	−.14	−.14	.16	−.16	−.03	−.08	−.03	−.01	−.06	−.02	.00	−.02	−.04	−.07
38. TUT-TOPICS-AF	.13	.15	.09	.04	.11	.02	−.09	−.07	.20	−.07	−.00	−.02	−.03	−.00	−.11	−.08	.02	−.03	−.12	.01
39. TUT-TOPICS-2B	.03	.13	−.01	.04	.03	.01	.06	.05	.05	−.02	.01	−.08	.06	−.00	.02	.03	.02	−.03	.02	.04
40. TUT-STREAK-SART	−.12	−.07	−.10	−.02	−.10	−.06	.11	.05	−.22	.17	.01	.02	−.05	−.06	.02	.03	−.02	.07	.09	−.01
41. TUT-STREAK-NS	−.05	−.08	−.11	−.04	−.13	−.09	.16	.13	−.17	.15	.01	.11	.02	.03	.06	.09	.02	.10	.09	.02
42. TUT-STREAK-LF	.00	−.02	−.10	−.03	−.09	−.04	.09	.13	−.11	.07	−.01	.05	.02	−.03	.04	.04	.06	.05	.12	.04
43. TUT-STREAK-AF	−.10	−.15	−.18	−.08	−.17	−.12	.16	.17	−.15	.11	−.00	−.00	.07	.05	.14	.09	.03	.09	.08	.01
44. TUT-STREAK-2B	−.02	−.11	−.01	−.10	−.12	−.08	.00	.10	−.14	.10	.11	.14	.04	.04	.04	.09	.03	.09	.05	−.04

(*table continues*)

Note. OPERSPAN = operation span; READSPAN = reading span; SYMMSPAN = symmetry span; ROTASPAN = rotation span; RUNNSPAN = running span; COUNTERS = updating counters; ANTI-LET = antisaccade with letters; ANTI-ARO = antisaccade with arrows; SEM-SART *d′* = *d′* score from semantic sustained attention to response task (SART); SEM-SART rtsd = intrasubject standard deviation in reaction time from semantic SART; N-Stroop = number Stroop; S-Stroop = spatial Stroop; PERCEABER1 = Perceptual Aberration scale (Parcel 1); PERCEABER2 = Perceptual Aberration scale (Parcel 2); PERCEABER3 = Perceptual Aberration scale (Parcel 3); MAGIDEA1 = Magical Ideation scale (Parcel 1); MAGIDEA2 = Magical Ideation scale (Parcel 2); MAGIDEA3 = Magical Ideation scale (Parcel 3); REFTHINK = Referential Thinking subscale from the Schizotypal Personality Questionnaire (SPQ); SOC-ANHD1 = Social Anhedonia scale (Parcel 1); SOC-ANHD2 = Social Anhedonia scale (Parcel 2); SOC-ANHD3 = Social Anhedonia scale (Parcel 3); PHY-ANHD1 = Physical Anhedonia scale (item Parcel 1); PHY-ANHD2 = Physical Anhedonia scale (Parcel 2); PHY-ANHD3 = Physical Anhedonia scale (Parcel 3); COGSLIPG = Cognitive Slippage Scale; COGDYSRG = Cognitive Dysregulation subscale of the Dimensional Assessment of Personality Pathology—Basic Questionnaire; ODSPEECH = SPQ Odd Speech subscale; ODBEHAVR = SPQ Odd Behavior subscale; TUT-SWITCH = number of switches between TUT categories within a task; TUT-TOPICS = number of total TUT topics endorsed within a task; TUT-STREAKS = streak lengths of TUTs within a task; NS = number Stroop task; LF = letter flanker task; AF = arrow flanker task; 2B = 2-back task.

Table 4 (*continued*)

	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
22. SOC-ANHD3	.67																							
23. PHY-ANHD1	.31	.22																						
24. PHY-ANHD2	.31	.21	.55																					
25. PHY-ANHD3	.30	.22	.61	.57																				
26. COGSLIPG	.25	.21	.00	.12	.09																			
27. COGDYSRG	.16	.15	.01	.15	.08	.60																		
28. ODSPEECH	.18	.19	−.04	.11	−.00	.70	.61																	
29. ODBEHAVR	.22	.25	−.02	−.02	−.00	.47	.43	.56																
30. TUT-SWITCH-SART	.06	.04	−.11	−.06	−.08	.07	.11	.13	.12															
31. TUT-SWITCH-NS	.02	.01	−.14	−.09	−.13	.05	.06	.05	.06	.52														
32. TUT-SWITCH-LF	−.01	.03	−.18	−.11	−.19	.06	.08	.10	.10	.47	.33													
33. TUT-SWITCH-AF	.00	.02	−.18	−.12	−.15	−.01	.06	.06	.08	.36	.44	.33												
34. TUT-SWITCH-2B	.03	.03	−.05	.00	−.02	.13	.13	.16	.15	.42	.38	.22	.38											
35. TUT-TOPICS-SART	.02	.04	−.11	−.06	−.07	−.00	−.02	.04	.10	.44	.24	.16	.15	.19										
36. TUT- TOPICS-NS	.02	.01	−.09	−.06	−.07	−.07	−.07	−.02	−.01	.30	.56	.14	.26	.25	.40									
37. TUT-TOPICS-LF	−.02	.02	−.16	−.10	−.15	.03	.04	.06	.03	.34	.25	.63	.34	.16	.32	.26								
38. TUT-TOPICS-AF	−.04	−.04	−.12	−.10	−.13	−.07	−.04	.01	−.03	.22	.22	.23	.53	.22	.36	.40	.39							
39. TUT-TOPICS-2B	−.03	.05	.06	.02	.02	.00	.00	.06	.07	.19	.22	.16	.23	.54	.24	.32	.21	.35						
40. TUT-STREAK-SART	−.05	−.07	−.01	−.01	.03	.06	.08	.01	.00	−.41	−.28	−.24	−.21	−.17	−.38	−.31	−.34	−.24	−.22					
41. TUT-STREAK-NS	−.01	−.05	.06	.05	.08	.06	.04	−.01	−.03	−.28	−.41	−.21	−.35	−.22	−.20	−.42	−.28	−.27	−.22	.44				
42. TUT-STREAK-LF	.03	−.04	.06	.05	.04	.10	.04	.05	.02	−.15	−.18	−.24	−.27	.00	−.19	−.22	−.36	−.24	−.10	.35	.35			
43. TUT-STREAK-AF	.00	−.03	.14	.15	.14	.10	.05	.00	.02	−.25	−.24	−.23	−.47	−.14	−.19	−.32	−.25	−.36	−.19	.39	.51	.27		
44. TUT-STREAK-2B	−.04	−.06	.00	.04	.04	.01	.02	.00	−.01	−.19	−.19	−.10	−.23	−.25	−.19	−.29	−.13	−.24	−.35	.29	.35	.21	.32	

challenging tasks. Despite the potential for such TUTs to be functional for everyday life purposes, higher-ability subjects seem to more effectively shut them down in favor of improved task performance.

Prior studies investigated WMC's association with TRI, and the findings from those reasonable but smaller samples were mixed (McVay & Kane, 2012a; Robison & Unsworth, 2018; Unsworth & McMillan, 2014). Here, subjects with greater WMC and fewer attention-restraint failures were more likely to report any TRI experiences, reflected by the TRI inflation factor, and less restraint failure further predicted higher counts of TRI reports. Given our larger sample than in other studies, and our arguably more appropriate analytic strategy for dealing with zero-inflated distributions, we provisionally put greater stock in our positive TRI findings than in prior negative ones. Additional research is obviously needed to more convincingly demonstrate and understand any ability-TRI association, but it is currently unclear whether methodological differences might account for the discrepant published results. All the relevant studies have probed subjects' thoughts during

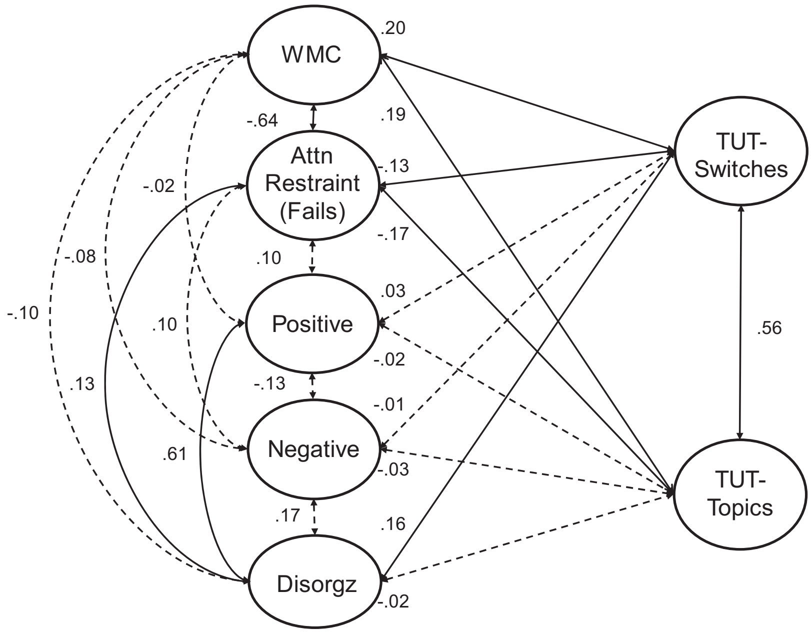

Figure 1. Confirmatory factor analysis depicting the relations between the cognitive and personality predictor constructs and the TUT consistency outcome constructs. The circles represent the latent variables for working memory capacity (WMC), attention restraint failure (Attn Restraint (Fails)), positive schizotypy (Positive), negative schizotypy (Negative), disorganized schizotypy (Disorgz), switches among TUT categories (TUT-Switches), and total TUT topics (TUT-Topics). TUT = task unrelated thought. Double-headed arrows represent correlations between constructs. All solid paths are statistically significant at $p < .05$; all dotted paths are nonsignificant. For ease of interpretation, factor loadings for manifest variables are not depicted (see Table 3 in the online supplemental materials).

similar laboratory tasks and have tested similar undergraduate samples. We hope such additional research will be conducted, because TRI experiences and non-TRI TUTs show theoretically interesting dissociations: although in-the-moment TRI reports are similarly associated with immediate performance errors as are (non-TRI) TUT reports (McVay & Kane, 2012a), TRI rates tend to decrease over the course of a task whereas TUTs tend to increase (e.g., McVay & Kane, 2012a), TRI reports increase with adult age whereas TUTs tend to decrease (e.g., Frank et al., 2015; McVay et al., 2013), and TRI reports may increase with higher WMC and attention-restraint ability whereas TUTs tend to decrease.

Unexpectedly, and inconsistent with laboratory findings on cognitive ability and self-reported distraction (e.g., Robison & Unsworth, 2018; Stawarczyk et al., 2014; Unsworth & McMillan, 2014) and objectively measured distraction (e.g., Conway, Cowan, & Bunting, 2001; Heitz & Engle, 2007), higher WMC was associated with a higher probability of external distraction than was lower WMC. Absent future replication, however, we are skeptical about this result because it lacks empirical precedent, it makes little theoretical sense, its effect size had extremely wide confidence intervals, and it came from a seemingly ill-fitting model resulting from very low endorsement rates of external distraction in this sample. (Although Unsworth and McMillan, 2017 suggest that studies testing subjects in groups may be more likely to find negative associations between cognitive ability and external distraction than studies that test subjects in isolation—where fewer distractions are available—we found a positive association despite testing most subjects in groups).

Schizotypy dimensions (positive, negative, disorganized) offer promising constructs for examining thought processes in the laboratory and

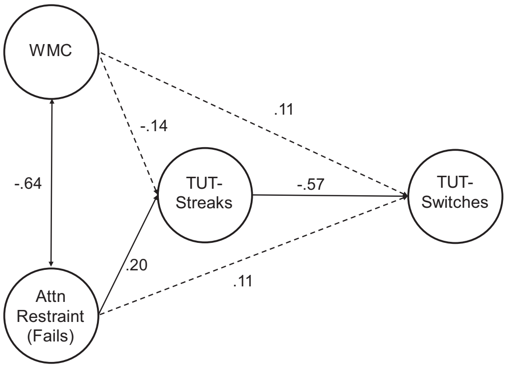

Figure 2. Structural equation model depicting the prediction of TUT switches by the executive-control predictor constructs, mediated by TUT streaks. The circles represent the latent variables for working memory capacity (WMC), attention restraint failure (Attn Restraint (Fails)), TUT streak lengths (TUT-Streaks), and switches among TUT categories (TUT-Switches). Arrows represent the modeled direction of pathway between constructs. All solid paths are statistically significant at $p < .05$; all dotted paths are nonsignificant. TUT = Task-unrelated thought. For ease of interpretation, factor loadings for manifest variables are not depicted (see Table 3 in online supplemental materials).

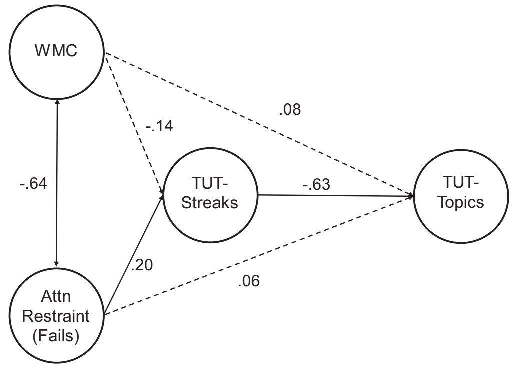

Figure 3. Structural equation model depicting the prediction of TUT topics by the executive-control predictor constructs, mediated by TUT streaks. The circles represent the latent variables for working memory capacity (WMC), attention restraint failure (Attn Restraint (Fails)), TUT streak lengths (TUT-Streaks), and total TUT topics (TUT-Topics). Arrows represent the modeled direction of pathway between constructs. All solid paths are statistically significant at $p < .05$; all dotted paths are nonsignificant. TUT = Task-unrelated thought. For ease of interpretation, factor loadings for manifest variables are not depicted (see Table 3 in online supplemental materials).

in daily life, as each is conceptualized as involving unique patterns of disruptions of thought form and content; at the same time, in-the-moment thought reports may also help validate retrospective schizotypy questionnaires. Here, positive and disorganized constructs, which are theoretically characterized by abundant and unusual thought content (and are moderately associated with emotional instability; e.g., Kemp, Gross, Barrantes-Vidal, & Kwapil, 2018; Kwapil, Gross, Burgin, et al., 2018), showed some theory-consistent associative patterns with modest effect sizes. As predicted, subjects who were higher in positive schizotypy were more likely to endorse some, rather than no, fantastical-daydream thought content when mind wandering, and they produced more daydreams (as did disorganized schizotypy). Moreover, positive and disorganized schizotypy similarly predicted worry-based TUT factors, with greater probability of endorsing worry and with higher worry counts. We note that parallel findings for positive and disorganized factors should be interpreted considering their strong correlation, which likely reflects limitations of available self-report disorganization measures (Kwapil, Gross, Silvia, Raulin, & Barrantes-Vidal, 2018). Moreover, future work should assess whether the associations between schizotypy factors and worry are independent of trait emotional instability or state negative affect; negative emotionality is less likely to account for schizotypy's associations with daydreaming than with worry, so future studies should include other personality

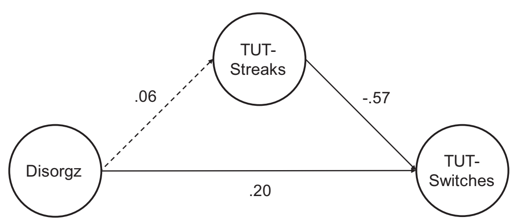

Figure 4. Structural equation model depicting the prediction of TUT switches by disorganized schizotypy, mediated by TUT streaks. The circles represent the latent variables for disorganized schizotypy (Disorgz), TUT streak lengths (TUT-Streaks), and switches among TUT categories (TUT-Switches). Arrows represent the modeled direction of pathway between constructs. All solid paths are statistically significant at $p < .05$; all dotted paths are nonsignificant. TUT = Task-unrelated thought. For ease of interpretation, factor loadings for manifest variables are not depicted (see Table 3 in online supplemental materials).

and clinical measures to assess positive and disorganized schizotypy's unique prediction of fantastical TUT content.

Finally, we sought— but didn't achieve— clarity regarding the Stawarczyk et al. (2014) claim that researchers should collapse subjects' reports of external distractions with current-state TUTs because they both represent TUTs that are stimulus-dependent (driven by external vs. internal stimuli). Our goal was to assess how these TUTs correlated with cognitive ability, with convergent but not divergent associations lending support to their reflecting a single construct. We found evidence for divergence, with WMC correlating negatively with current-state TUTs and positively with external-distraction TUTs. However, as noted above, the external distraction analyses are suspect due to low endorsement rates, uncertainty around path estimates, and apparently ill-fitting models. We cannot be confident, then, that current-state and external-distraction TUTs are meaningfully different.

Individual Differences in TUT Content Instability

Our data provide the first demonstration that subjects show a general, traitlike tendency for stable versus variable TUT content on a given occasion. We characterized stability as: (a) the rate at which subjects switched the endorsed content of TUT from one off-task report to the next, and (b) the total number of TUT topics subjects reported within a given task. These indicators were substantially correlated with each other but were not redundant, and both exhibited consistent individual differences across the five probed tasks.

We expected that poorer executive ability (and higher disorganized schizotypy, which can reflect confusion and disruptive thought patterns) would be associated with greater instability and variation in thought content (i.e., more switching and more topics). Only our prediction about disorganized schizotypy was confirmed, however, as it was associated with more TUT switches. Contrary to expectations, WMC and attention restraint correlated positively with both TUT switches and TUT topics. We were surprised that better cognitive control predicted what seemed to be less regulated thinking, and that these TUT-instability correlations went in the same direction as that with disorganized schizotypy.

Our only plausible explanation for positive correlations between cognitive ability and thought-instability was that subjects with better control may have mind wandered for less time for each TUT experience, and so they may have shifted their mental context back to the ongoing task more frequently—and perhaps more effectively—than did subjects with poorer control. Such mental context shifts might then allow any subsequent TUT to be cued by something novel or to spontaneously take a new content direction.

We explored this possibility by assessing the lengths of subjects' streaks of consecutive TUT reports. As with switches and topics, we found that people varied reliably in streak lengths across occasions. Moreover, WMC and attention restraint correlated negatively with streak length and, critically, a structural equation model indicated that streak length mediated the associations between executive control and TUT instability (these effects were more clearly seen for attention-restraint failure than for WMC because its correlations with TUT measures were stronger, and restraint and WMC were so strongly correlated with each other). Note that the correlation between disorganized schizotypy and TUT switches was not similarly mediated by streak length, suggesting a different cause; in line with the nature of the disorganized-schizotypy construct, people with more disorganized thought patterns were less locally consistent in their off-task thought content.

Although we did not predict the positive correlation between executive control and TUT instability, or the mediation of this association by the duration of subjects' mind-wandering episodes, we suggest that they are interesting and potentially important findings for mind-wandering and executive-control theory to consider in future work. On one hand, they seem most likely to suggest that people with better executive abilities mind wander less, at least in part, because they terminate TUT episodes sooner after they begin, perhaps due to better meta-awareness. On the other hand, it is also possible that fluctuations in TUT content may be functional, acting as a meta-awareness trigger that signals subjects with better abilities to bring their control processes to bear on shifting awareness back to the "here and now." Or, it may even be that greater fluctuations in TUT content prevent subjects from getting too deep into any one mental "rabbit hole" and thus allows their thoughts to be more easily brought back to the task or environmental context. Future work on the content-regulation hypothesis (Smallwood & Andrews-Hanna, 2013) should therefore examine the links among TUT content fluctuation, meta-awareness, and cognitive ability.

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Appendix

Scoring Examples for the Variables TUT-Switches, TUT-Topics, and TUT-Streaks

ID	NS1	NS2	NS3	NS4	NS5	NS6	NS7	NS8	NS9	NS10	NS11	NS12	Switches	Topics	*M* streak length
1,100	1	1	4	1	1	5	1	4	5	7	5	4	6	3	.33
1,116	1	2	2	4	4	1	5	4	4	4	4	4	3	3	.50
1,114	2	2	2	2	2	2	2	2	2	2	2	2	0	1	1.00

Note. Each column labeled "NS" represents one of 12 probes presented within the numerical Stroop task. Rows represent sequential probe-screen responses given by each of three subjects (ID 1100, 1116, 1114). The Switches variable was scored by tallying changes between sequential probes that yielded a non-on-task response (2–8). For example, Subject 1,100 would get 1 point for switching from NS3 to NS6 (Response 4 to 5). Another point would be given for switching from NS6 to NS8, NS8 to NS9, NS9 to NS10, NS10 to NS11, and NS11 to NS12; this total of 6 switches would then be divided by the total number of mind-wandering responses (Choices 2–8) made by the subject (here, 7). To score Topics, we counted the number of different non-on-task responses (Responses 2–8), and divided by the number of non-on-task responses. Subject 1,114 responded with only Response 2, thus reflecting one topic, which would then be divided by the subject's 12 mind-wandering reports. For *M* streak length, we counted the number of consecutive mind-wandering responses (any responses of 2–8) between any on-task, reports, each of which was a "streak," and then averaged the length of all streaks. For example, Subject 1,116 had a mind-wandering streak from NS2-NS5 (streak of 4), then another from NS7-NS12 (streak of 6); these two streaks averaged five probes in length.

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