External Distractions or More Mind Wandering?

Evaluating a Recent Model of Conscious Thoughts

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Abstract

Mind wandering is a very exciting topic in cognitive science, and as such, different researchers have come up with different hypotheses and models to explain it. One model, introduced by Stawarczyk, Majerus, Maj, Van der Linden, and D'Argembeau in 2011, conceptualizes conscious thoughts along the two dimensions of task-relatedness and stimulus-dependency. From these two dimensions they generated a four-way model of thoughts, including mind wandering and external distractions. The current study aimed to evaluate this model, particularly regarding the empirical distinction between mind wandering and external distractions, by using confirmatory factor analyses to see how external distractions and mind wandering relate to one another and to other variables, such as working memory capacity and attentional restraint. It was found that the distinction made by Stawarczyk and colleagues – especially regarding the inclusion of interoceptive stimuli with external distractions – did not seem to hold up.

Introduction

On Mind Wandering

People lead rich mental lives disconnected from their surroundings and the tasks they are engaged in. Classic examples of this include drifting away from the meaning of text while reading and considering one's future plans during the drive home. These internal mental experiences are often referred to as task-unrelated thoughts or mind wandering. Recently, research on mind wandering has come to focus on determining why it occurs, how it operates, and how it is distinct from other types of mental activity.

In a 2013 review, Smallwood presents four hypotheses about the underlying mechanisms of mind wandering: current concerns, decoupling, executive failure, and meta-awareness. The current concerns hypothesis (Klinger, 1975, 2013) suggests that mind wandering occurs when external perceptual information lacks salience, causing the mind to be drawn away from the outside world and toward more salient personal matters that are cued by both external stimuli and the internal stream of thought. The decoupling hypothesis relies on the notion of domain-general mental processes the likes of executive control, proposing that such processes act to keep a particular train of thought on track once it has been initiated (Smallwood & Schooler, 2006). The executive failure hypothesis characterizes mind wandering as potentially distracting internal thoughts which wrest attention from the task at hand when executive control fails to keep the mind directed toward it (McVay & Kane, 2009, 2010, 2012). Finally, the meta-awareness hypothesis postulates that mind wandering represents a deviation from a desired mental goal state, and that meta-awareness may generally act to correct this deviation (Schooler, 2002; Schooler et al., 2011).

Of note, Smallwood makes the point that his own decoupling hypothesis is fundamentally not in conflict with any of the other hypotheses presented. He characterizes this hypothesis as being about how mind wandering is maintained once it has begun – the process of mind wandering. Meanwhile, the other three hypotheses constitute mechanisms by which mind wandering gets started in the first place – the occurrence of mind wandering. Additionally, he makes mention of a Control × Concerns and Control Failure × Concerns models of mind wandering. The first of these suggests that mind wandering is triggered by personal concerns, which then recruit domain-general executive resources for processing (Smallwood & Schooler, 2006). The second treats mind wandering as a loss of executive control over ongoing, automatically cued thoughts (McVay & Kane, 2010). All told, Smallwood is suggesting that one or more of these mechanisms of occurrence could fit together with his process of decoupling, forming a so-called process–occurrence framework of mind wandering.

Being that the decoupling account is not mutually exclusive with any of the other three, it is strange that recent research (e.g., Stawarczyk, Majerus, Catale, & D'Argembeau, 2014) has set it at odds with the executive failure account. Although the debate in the past was certainly lively (McVay & Kane, 2009, 2010; Smallwood, 2010), the strongest proponents of the executive failure hypothesis are no longer committed to mutual exclusivity between their hypothesis and the decoupling hypothesis (Kane & McVay, 2012). Clearly, neither is Smallwood, given the review described above. Thus, going forward, it makes more sense to treat these hypotheses as complementary, rather than conflicting.

For much of the history of mind wandering research, subjects' self-reported thoughts have been assessed along dimensions of either task-relatedness or stimulus-dependency (Smallwood & Schooler, 2006; Smallwood, 2009). Task-relatedness is the degree to which a person is currently focused on the task at hand, and ranges from completely focused to completely off-task. Stimulus-dependency refers to whether or not a person's thoughts are directly related to stimuli present in the environment, including both the task and other stimuli. Thoughts completely unrelated to these stimuli are considered to be stimulus-independent. Both off-task and stimulus-independent reports were considered to be indicative of mind wandering, although they may also reflect different sorts of thoughts. For example, a thought which is captured by stimuli, yet unrelated to the task at hand might be importantly different from one which is neither stimulus-dependent nor task-related (Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011). Thus, it becomes important to see whether this and other distinctions have empirical merit.

By no means has this need been lost on the field – various researchers have pointed it out, leading to the implementation of a widening variety of thought probes. For example, Ward & Wegner (2013) conducted a series of experiments – including both open ended and forced choice thought probes – aimed at differentiating mind wandering from mind blanking. Mind blanking is thought of as a momentary halt in cognitive activity, rather than the ongoing thoughts of mind wandering. Smallwood, McSpadden, and Schooler (2007) assessed the effects of mind wandering with awareness (tuning out) and without awareness (zoning out) on task performance, and later used the same probe to assess the temporal effects of mind wandering (Smallwood, McSpadden, & Schooler, 2008). McVay & Kane (2012) used a six-choice thought probe, including three temporal content options: *a memory from the past, something in the future,* and *current state of being*. Finally, Stawarczyk et al. (2011a) introduced the model to be evaluated – a two-by-two model of thoughts based on dimensions of stimulus dependency and task relatedness. In the following sections, I will discuss this model in further detail, followed by my concerns about it. I will then propose a study designed to evaluate it using data on mind wandering, attentional control, and working memory.

The Model

Perceiving a need for a more systematic approach to thought probes in mind wandering research, Stawarczyk et al. (2011a) moved to formulate a more fine-tuned conception of the sorts of thoughts people have. Given the fact that much research had previously treated either stimulus-independent or task-unrelated thoughts as mind wandering, they argued that mind wandering may consist of thoughts that are both independent of stimuli in the environment and unrelated to the task at hand. Therefore, they suggested that thoughts be measured along the two dimensions of task-relatedness and stimulus-dependency. From this, they generated a four-way model of thoughts which could be translated into a four-item thought probe.

This model (Figure 1) combines the two aforementioned dimensions in four possible ways. The first is stimulus-dependent/task-related thoughts, or fully on-task. The second combination is stimulus-independent/task-related thoughts, or task-related interference (TRI). That is, being distracted by one's appraisal of task features, such as one's performance on the task. Third, there are stimulus-dependent/task-unrelated thoughts, or external distractions (ED). External distractions are said to come from both exteroceptive perceptions (e.g., sounds or visual stimuli) and interoceptive sensations (e.g., hunger or thirst). Finally, stimulus-independent/task-unrelated thoughts (SITUTs) are characterized as mind wandering, daydreaming, and similar phenomena.

Evidence for the validity of this model comes primarily from three studies. The first, in which the model was originally introduced, consisted of two experiments (Stawarczyk et al., 2011a), although only the first is relevant in the current context. This experiment was a simple validation of the new model. It used a classic go/no-go task known as the sustained attention to response task (SART) combined with a four-item thought probe based on the four-quadrant model. The principal findings were that both types of task-unrelated thoughts (EDs and SITUTs) were associated with lower SART performance (slower response times and more errors to the target), but that SITUTs were distinguishable from EDs by self-report. The major takeaway from this was that thought probes in general needed to be more precise and more comprehensive, because subtle differences in types of thoughts might be missed.

The second study (Stawarczyk, Majerus, Paquet, & D'Argembeau, 2011) was meant to determine the neural correlates of the researchers' thought type distinctions. Participants completed the SART with thought probes while undergoing fMRI scans. It was found that areas of the default mode network – a neural network known to be associated with mind wandering (Gruberger, Ben-Simon, Levkovitz, Zangen, & Hendler, 2011; Smallwood, Baird, Brown, & Schooler, 2012) and internally directed attention (Dang, O'Neil, & Jugast, 2012) – were active when participants reported TRIs, EDs, or SITUTs. Notably, there was considerable overlap of activity in certain areas across dimensions of stimulus-dependence and task-relatedness, including the medial prefrontal cortex (MPFC), the posterior cingulate cortex (PCC), and the precuneus. That is, these areas of the DMN showed greater activity just prior to participant reports of TRIs, EDs, and SITUTs than they did just prior to on-task reports. However, rather than finding an interaction effect between stimulus-dependence and task-relatedness in these areas, the researchers reported an additive effect of SITUTs on neural activity over and above TRIs and EDs.

Third, Stawarczyk et al. (2014) used their thought probe to assess the relationships among different types of internal cognition, working memory capacity, proactive and reactive attentional control, and general fluid intelligence (gF) in young adults and adolescents.

Adolescents were chosen as a group because, according to the researchers, they should be expected to show weaker attentional control abilities than their older counterparts. The researchers assessed WMC with a listening span task, both forms of attentional control with a continuous performance task, and general fluid intelligence with Raven's Progressive Matrices. They also included items from several questionnaires, most notably the Daydreaming Frequency Scale (DDFS). Thought probes were included within a version of the SART, as in the other two studies. SITUTs and EDs were carefully distinguished in the instructions, with particular focus on the notion that a thought triggered by a distracting perception, but about something else, counted as mind wandering, not an external distraction.

SITUTs and EDs negatively affected SART performance (lower accuracy to the targets and higher response time variability) to a similar degree among both young adults and adolescents. SITUT reports were associated with reports of mind wandering in daily life on the DDFS in both groups. A variance partitioning analysis found that EDs, SITUTs, and an attentional composite Z-score (WMC, Raven's matrices, and both forms of attentional control) predicted 41% of the variance in SART accuracy in young adults. Most relevant to the focus of the current study, SITUTs significantly accounted for 7% of SART accuracy variance over and above the attentional composite and EDs. EDs only accounted for 1% of accuracy variance over and above SITUTs and the attentional composite.

My Concerns

Concerns about this model arise primarily from the characterization of external distractions as being reliably different from mind wandering. Conceptually, it makes sense to distinguish the two. On the one hand, an external distraction might draw attention away from the task at hand without generating any conscious thoughts. On the other, mind wandering consists of conscious thoughts – in some form or another – by definition. Both would be expected to cause problems with task performance, although perhaps for different reasons.

In the model in question, any thoughts about stimuli not related to the task are considered external distractions. However, given the above understanding, it is questionable whether external distractions can be classified as a type of thought, rather than just a momentary attentional shift. There is an important conceptual disconnect here. Because participants are being asked to report their conscious thoughts about interoceptive and exteroceptive perceptions, it may be that the thought probe is merely capturing another form of mind wandering, rather than actual external distractions. In other words, despite the careful instructional distinction made by Stawarczyk et al. (2014), it is not entirely clear that EDs and SITUTs are reliably separable in a self-report framework.

Furthermore, defining mind wandering as a stimulus-independent task-unrelated thought has its own conceptual complications. It may be that a distracting stimulus could generate mind wandering. For instance, if a participant were distracted by a small bit of chipped paint on the wall, he or she might be thrown into a mind wandering episode about painting his or her bedroom walls. Because this new thought is not wholly independent of the stimulus that inspired it, it may not be easily classified as a *stimulus-independent* task-unrelated thought. Yet, it would be difficult to dispute its nature as mind wandering. Thus, SITUTs may be too restrictive of a category to capture all of what constitutes mind wandering.

Additionally, even if mind wandering and external distraction are fundamentally different, it may not make sense to include both interoceptive and exteroceptive stimuli in the same category. It may be the case that, because of their different perceptual loci, they are themselves different in some important way.

Aside from the conceptual issues raised above, there are a few methodological flaws which merit discussion. In the first study (Stawarczyk et al, 2011a), there are no references to external criteria of validity. People were able to self-report EDs or SITUTs when asked about them, however, this does not guarantee that they were actually reporting experiences of the sorts intended by the researchers. For example, some participants may have been reporting external distractions when they were really thinking about something else, but those thoughts were triggered by a distracting stimulus.

Stawarczyk et al. (2011b) again did not have any reliable external criteria of validity. Although their thought probes were related to neural activity, they were still relying on people to accurately report their thoughts in relation to the categories provided to them. Therefore, just by relating thought probe responses to neural activity, there is no guarantee that they are relating actual experiences to neural activity. Because of this, it is not clear what conclusions can actually be drawn from the finding that SITUTs had an additive effect on activity in certain brain areas.

Given the questionable nature of the distinction between mind wandering and external distraction in the first two studies, it is not clear that distinguishing between them was necessary or beneficial in the latest study (Stawarczyk, 2014). That said, it is worth noting that a recent study (Unsworth & McMillan, 2014) showed that latent variables of mind wandering and external distraction showed best fit in a model in which they were separate-but-correlated. The researchers also tested two other models – one in which mind wandering and external distraction were treated as a single latent variable and one in which they were treated as completely separate. Both of these showed comparatively poor fit. Given these results, it may be that there is empirical merit to the distinction despite the concerns that have been raised.

My Study

The data being used to evaluate this model come from a previously collected data-set, one of the most extensive studies of its type on the relationships between mind wandering, working memory capacity, attentional control, creativity, and schizotypy. Because of our large sample size, we have an impressive pool of data to analyze, as well as a high level of statistical power. Additionally, of our various measures, WMC and attentional control are known to correlate with mind wandering (Kane & McVay, 2012; McVay & Kane, 2012). In this case, mind wandering has been operationalized as a composite of various kinds of task-unrelated thoughts (TUTs), rather than SITUTs. The types of TUT reports collected include external distraction-like categories of *current state of being* and *external environment*, as well as SITUT-like categories of *everyday things*, *personal worries*, and, *daydreams*. This will provide the means of evaluating the relationship between mind wandering and external distraction, and more particularly, the findings from Stawarczyk et al. (2014).

In addition to the general wealth of data afforded by such a large sample, we also have a wide variety of tasks covering our various measures. For example, in measuring working memory capacity, we used six different tasks. Of these, four were complex span tasks and two were memory updating tasks. By approaching each construct with a variety of tasks, we gain a significant advantage over approaches that use only one or two: performance differences on the specific processing skills involved in one given task (e.g., math problems in operation span) do not have as much of an overall effect on the variance measured. That is, we get a clearer picture of each participant's actual WMC, attentional restraint, etc. Finally, we have also included thought probes in both attention and working memory tasks, meaning we can better assess how performance on each type of task is affected by mind wandering.

Method

Participants

Five hundred forty-five (545) undergraduates from the University of North Carolina Greensboro participated in this study for partial fulfillment of a Psychology course requirement. A total of 543 participants completed the first session of the study, of which 492 completed the second session, and 472 finished all three.

Mind Wandering Probes

Thought probes were included in five tasks. The probes themselves were the same across tasks, although the probe instructions were altered slightly to fit different tasks. For instance, in the numerical Stroop task, they referred to objects on the screen; in the n-back, they referred to the words on the screen. The participants were occasionally interrupted during certain tasks with a popup screen which said:

What were you just thinking about?

1. The task

2. Task experience/performance

3. Everyday things

4. Current state of being

5. Personal worries

6. Daydreams

7. External environment

8. Other

Subjects responded by pressing a number key matching the type of thoughts they were experiencing when the probe popped up. Two types of probe instructions were used in each session of the study. In the first task per session to include thought probes, a longer, more verbose set of probe instructions was presented. In each subsequent task per session to include thought probes, a more compact version of the same set of instructions was used to save on time. As Figure 2 shows, the response choices should readily map onto the model created by Stawarczyk et al. The first response is on-task and the second is TRI. Responses 4 and 7 seem to be analogous to EDs. Responses 3, 5, and 6 seem to be like SITUTs. Response 8 might also map onto one of these categories, but there were conceptual concerns about how to interpret it, so it was left out of all analyses.

WMC Tasks

Working memory capacity was measured using six different tasks across the three sessions of the study. Of these, four were complex span tasks, while three were memory updating tasks.

Complex span tasks. The complex span tasks used were operation span, symmetry span, rotation span, and reading span. Each of these tasks consists of completing a relatively simple processing task while trying to keep an ordered list of information in mind for later recall, with the to-be-recalled items presented one-by-one in between processing trials. Operation span (OPERSPAN) required participants to indicate whether or not compound equations (e.g., [3 + 6]/ 3 = 3) were correct, while keeping in mind ordered sets of letters. Symmetry span (SYMMSPAN) required them to judge whether pictures containing patterns of black and white boxes were symmetrical on the vertical axis, while simultaneously keeping in mind ordered patterns of red boxes presented in a 4 x 4 white grid. Reading span (READSPAN) required participants to judge whether sentences made sense, while at the same time keeping sequences of words in mind. Finally, for rotation span (ROTASPAN), participants decided whether letters that had been rotated out of regular alignment were facing the normal direction or mirror reversed, after mentally rotating them back to normal. At the same time, participants had to keep in mind sequences of large and small arrows pointing in one of eight different directions.

For each span task, participants were given separate practice trials for both the processing and the memory portions. As well, participants were required to recall the memory items in order (from an array that consisted of all possible memory items for the task). They had to keep their performance on the processing portions at or above 85% in order to ensure that they were engaged in processing, rather than just rehearsing memory items. Finally, they were given feedback on both processing performance and number of items recalled after each trial.

Memory updating tasks. The two memory updating tasks were updating counters (COUNTERS) and running span (RUNNSPAN). In the counters task, participants were shown 3-5 square frames in a row on the screen. A number then appeared in each frame, in a random order, and participants had to keep these numbers in mind. Then, a random set of these numbers were "updated" by displaying a number with a plus or minus sign in random frames. Participants had to add or subtract this number from the previous number in that frame. At the end of the "updating" portion of the task, participants were asked to fill in the most recent number values of each frame in a random order. The ending number in each frame was always between 1 and 9.

In the running span task, participants were presented with series of letters which varied in length. Trials were split into blocks. Before each block, participants were given a particular number of the last letters in each trial (usually shorter than the list length). They had to recall these last letters, in the order presented, at the end of each trial.

Attention Restraint Tasks

Attention restraint tasks ask participants to stop themselves from engaging in a dominant response in favor of a different goal-directed response. To assess attention restraint ability, participants were given two anti-saccade tasks, a semantic sustained attention to response task, a numerical Stroop task, and a spatial Stroop task.

Antisaccade tasks. The first antisaccade task involved judging which of three letters appeared on the opposite side of the screen from a flashing cue symbol (=) before being masked (ANTI-LETT). The three letters were B, P, and R and the mask was a rapid sequence of the letter H, followed by the number 8. In the second antisaccade task (ANTI-ARO), participants had to indicate which of four arrows – pointing up, down, left, or right – appeared on the opposite side of the screen from a flashing cue symbol (=). In both tasks, participants were given a practice session that involved identifying targets presented briefly in the center of the screen, in order to familiarize them with the targets. This type of task is challenging because the quick flashing cues pull attention away from the location where the target will appear. If participants do not quickly suppress the prepotent response to look at the cue, they will miss the target.

SART. The version of the SART used in this study had participants judge whether a word presented in the center of the screen belonged to either of two categories – animal or vegetable. Between each word was presented a row of X's. For each presentation of an animal, the more common of the two categories at 89% of trials, participants pressed the spacebar. For each presentation of a vegetable (only 11% of trials), participants had to refrain from pressing the spacebar. This task included thought probes.

Numerical Stroop (N-STROOP). In this task, participants had to indicate the number of digits displayed on the screen by pressing one of three keys (B, N, or M) with the index, middle, or ring finger. The digits consisted of sets of 2's, 3's, and 4's in a row on the midline of the screen. Each set could contain two, three, or four digits, and participants were told to attend to the number of digits in each set, rather than digit identity. They were also told that the important trials in the task were those in which the digit identities and the number of digits on the screen did not match (e.g., 222, 3333, or 44), rather than those in which identity and number of digits did match (e.g., 22, 333, or 4444). This task included thought probes.

Spatial Stroop (S-STROOP). This task was split into two blocks, only the first of which was analyzed here. The displays consisted of an asterisk placed above, below, or to the left or right of the midpoint of the screen. The words, “above,” “below,” “left,” and “right” each might appear above, below, or to the left or right of the asterisk. Participants were instructed to report the location of each word relative to the asterisk, ignoring both the meaning of the word and the absolute location of the word and the asterisk on the screen. All responses were made using the arrow keys of the numerical keypad (8, 4, 6, and 2) on a standard keyboard.

Other Tasks

The full study includes three other sets of tasks. One set measured attention constraint ability, once measured dimensions of schizotypy, and the third measured divergent thinking as a test of creativity. For a description of these tasks, see Kane, Meier, Smeekens, Gross, Gates, Silvia, and Kwapil (under revision). For the purposes of the current study, schizotypy and creativity measures are not relevant, as they do not readily contribute to understanding the relationship between external distractions and mind wandering; the attention constraint construct was not modeled very well by its marker tasks. Of the constraint tasks, two included thought probes, and so the data from these probes will be included in analyses.

Procedure

Participants carried out the tasks over three approximately two-hour sessions. They sat in front of a computer, either in a small room alone with an experimenter or in a larger room with up to three other participants. The experimenter read task instructions aloud directly from the computer screen and directed the participant(s) when it was time to advance to a new screen of instructions. In group sessions, new tasks were not started until after each participant had finished the previous task. In single participant sessions, new tasks were started as soon as the participant finished. All programs were coded in Eprime, and were only opened by experimenters.

Results

Descriptive Statistics and Correlations

Table 1 presents descriptive statistics for all WMC and attention restraint tasks for subjects whose data were usable; see Kane et al. (under revision) for detailed descriptions and justifications for excluded data points. All of these variables were normally distributed. Table 2 shows a correlation matrix containing all WMC and attention restraint measures. The correlations provide evidence of convergent and discriminant validity – measures of WMC and attention restraint each show stronger correlations with measures of their own construct than they do with measures of the other construct (but correlations with the other construct are sizeable). Additionally, there is evidence of domain specificity and domain generality in the WMC tasks. Tasks with similar features, such as operation span and reading span, were more strongly correlated with one another, while correlations between tasks with different features were still substantial.

Because the aim of this study is to get at very fine distinctions between types of off-task thought reports, the probe data were broken down on a task-by-task basis and proportions were calculated for responses 2-7 in two ways. First, they were calculated as a proportion of each response type to all thought probe responses (ALL). Second, they were calculated as a proportion of each response type to only the off-task responses (responses 2-8; OFF). Tables 3 and 4 provide descriptive statistics for the ALL and OFF, respectively. In general, these proportions were highly positively skewed and highly leptokurtic. This is not surprising at all, as any given thought category would have had relatively few responses. In both cases, the minimum proportion of all thought responses was zero. Maximum proportions were variable in both cases, but less so in OFF. Medians were also variable in both cases, with many medians being at or near zero. This is again indicative of the fact that any one thought category would have relatively few responses overall.

Tables 5 and 6 present full correlation matrices for ALL and OFF, respectively. In general, these correlations have a few important features. First, the proportions of any particular response type were positively correlated across any two tasks. For example, the correlation between the proportion of response 3 in the n-back task and the numerical Stroop task was .211 for ALL and .152 for OFF. Second, response proportion correlations across tasks increased for tasks that were completed in the same session – for instance, the correlation between response 3 in arrow flanker and the numerical Stroop was .514 for ALL and .433 for OFF. Taken together, these observations indicate that people showed a certain amount of consistency in thought reports across tasks, and that this consistency was increased when thought probes were included in same-session tasks.

Confirmatory Factor Analyses

Originally, the plan was to use latent variable analyses with response types as the latent variables. However, none of the latent variable models tested showed acceptable fit. Upon review of the data, it seems likely that this is due to the high skew and kurtosis values of the thought probe proportion distributions. Latent variable models assume normality in the measured variables, and good fit is highly unlikely (if the model even runs) when this assumption is violated (Schreiber, Nora, Stage, Barlow & King, 2006). Because of this unfortunate fit problem, we turned instead to a hybrid from confirmatory factor analyses (CFAs) in which the predictors (WMC and attention restraint) were modeled as latent variables while the outcome measures (proportions of each thought type) were modeled as manifest variables.

In order to conduct CFAs with manifest outcome variables, we first computed the means of response proportions across all tasks (e.g., proportion of “daydream” responses across all 5 tasks), creating composite thought category variables. These were correlated with WMC and attention restraint failure factors. These latent factors represent the shared variance of all WMC tasks and attention restraint tasks, respectively. As well, the composite thought category variables were correlated pairwise. Separate models were created for ALL and OFF. These models are shown in Figures 3 and 4, leaving out correlations between composites as a matter of space. These correlations are instead displayed in Tables 7 and 8.

To assess the degree to which each model fits the data, several common fit statistics were calculated. Chi square significance tests with non-significant results show good fit (although, with large samples such as ours, the chi square is almost always significant, and so other fit indices are also used). The comparative fit index (CFI) and the Tucker-Lewis index (TLI) both show adequate fit at values at or above .90. The Root Mean Square Residual of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR) both indicate adequate fit with values at or below .08.

ALL Model. The first model shows how WMC and attention restraint factors related to the ALL composites, which reflect the proportion of each response type to all thought probe responses. Fit statistics for this model were as follows: χ^2 (110) = 245.71, p < .001, CFI = .913,

TLI = .880, SRMR = .044, RMSEA = .048 [95%CI .040, .056]. Of these, only the TLI did not meet the standard for good fit (≥ .90). However, given that all of the other statistics indicated good fit and the TLI was very close to the .90 threshold, this model fit the data well enough to draw useful conclusions. Factor loadings were significant at $p < .001$ for all task measures related to both factors. Residual correlations between certain tasks (OPERSPAN and READSPAN; SYMMSPAN and ROTASPAN; SART_D and SART_SD) were modeled to account for variance shared by those specific task measures over and above the variance captured by the WMC and attention restraint factors. These residuals capture variance attributed to similar task features (i.e., OPERSPAN and READSPAN are both verbal span tasks, and so they have similar features). The correlation between WMC and attention restraint failures is -.644 [95%CI -.738, -.550] – higher working memory capacity was associated with fewer restraint failures. This lines up with the findings of several studies (e.g., McVay & Kane, 2012; Unsworth & McMillan, 2014).

Of the composite variables, WMC was significantly correlated ($p < .05$) with only one: personal worries (-.116, [-.230, -.003]). Attention restraint failure was correlated significantly with only two: personal worries (.140 [.034, .246]) and daydreams (.103 [.016, .189]).

Turning to the correlations among thought content composites, only everyday thoughts were significantly correlated with all the other composites. They were negatively correlated with everything but TRIs, meaning that people were generally either reporting everyday thoughts or they were reporting something else. That said, these negative correlations were weak to modest (ranging from -.093 to -.294). The correlation between everyday thoughts and TRIs (.086 [.001, .171]) was very weak, and it was only just below the $p < .05$ threshold with a p-value of .048, so it is not entirely clear how it should be interpreted. Aside from everyday thoughts, the personal worries variable was the only one to show any significant correlations with any of the other composites. Specifically, it showed modest negative correlations with TRIs (-.113[-.189, -.038]) and external environment (-.198[-.264, -.132]). Finally, it is actually important to note that external environment showed significant correlations with only the two variables mentioned thus far – everyday thoughts and personal worries. The rest were non-significant, including the correlation between current state and external environment. Of note, according to the Stawarczyk et al. model, this correlation would be expected to be positive and significant, since thoughts about current state and external environment are both supposed to indicate external distraction.

OFF Model. The second model shows how WMC and attention restraint correlated with the OFF composite variables, which again reflect the proportions of each response type to off-task thoughts. Essentially, the purpose of this model was to take a closer look at the breakdown of thought contents considered to be off-task. In other words, when subjects were off-task, what were they thinking about? This model showed good fit: χ^2 (110) = 220.38, $p < .001$, CFI = .948, TLI = .927, SRMR = .044, RMSEA = .043 [95%CI .035, .052]. Factor loadings were again significant at $p < .001$, showing similar magnitudes to the loadings in the ALL model. There were residual correlations between the same pairs of tasks as in the ALL model. The correlation between restraint and WMC (-.650 [-.744, -.556]) was again similar in magnitude to the ALL model. These similarities show that narrowing the breadth of the analysis had minimal impact on the proportion of variance captured by the two predictor factors of interest.

In this model, WMC had significant correlations with only two composite variables: TRIs (.111 [.015, .207]) and current state of being (-.123 [-.236, -.011]). Attention restraint failure was also significantly correlated with TRIs (-.265 [-.368, -.163]) and current state of being (.141 [.042, .241]). All of these correlations are weak to modest. Note that, for the same composite variable (i.e., TRI), the correlation with one factor was negative and the correlation with the other was positive. This suggests that at least some thought content reports were reflective of the relationship between working memory capacity and attention restraint failures (that is, high performers had a greater proportion of their off-task thoughts dedicated to their evaluation of their task performance).

Current state of being was the only composite to significantly correlate with all the others in the OFF model. These correlations were all negative, ranging from weak to modest (-.142 to -.442). What this means is, if a participant’s off-task thought reports included reports of thoughts about current state of being, they were less likely to include any other type of report. The TRI composite was also significantly correlated with all the other composites, except for external environment. Although it was non-significant, the correlation between TRIs and external environment was also negative and approached significance ($p = .094$). The only other significant correlation was between everyday thoughts and daydreams, but it was weak (-.074) and very close to the threshold of significance ($p = .043$). Finally, the correlation between thoughts about current state and external environment (-.174 [-.240, -.108) was both negative and significant. This seems to be exactly opposite of the expectation for a positive correlation, given the Stawarczyk et al. model.

Discussion

Recall that the overarching purpose of this study was to test the empirical distinction between external distractions and mind wandering found in a model forwarded by Stawarczyk et al. (2011a, b; 2014). Specifically, this line of research treats mind wandering as being constituted of stimulus-independent and task-unrelated thoughts (SITUTs). That is, mind wandering is dissociated from both the outside world and the task at hand. By contrast, external distractions

(EDs) are considered to be unrelated to the task, but instead focused on stimuli in the environment. These stimuli might be exteroceptive (related to the world outside of the person's body) or interoceptive (related to internal bodily sensations like hunger). Additionally, the model accounts for task-related interferences (TRIs) and being fully on-task in terms of stimulus-dependency and task-relatedness. TRIs are said to be stimulus-independent and task related, while on-task thoughts are both stimulus-dependent and task-related.

The results of my study do not quite match up with the picture provided by the above model. The model places exteroceptive perceptions and interoceptive sensations both into the category of external distractions. Exteroceptive perceptions quite obviously match up with response 7 (external environment), while interoceptive sensations match up with response 4 (current state of being). Given this, if the model is correct, it seems that we should expect to see naturally occurring positive correlations between reports of thoughts about the external environment and reports of thoughts about current state of being. In short, this does not pan out.

In the ALL model, there was no significant correlation between current state of being and external environment. In fact, if it were significant, the correlation found between the two (-.055) would seem to run counter to the notion that they should be grouped together. Turning to the OFF model, recall that current state of being was the only composite variable to correlate significantly with all the other composites, and that all of those correlations were negative. That is, if participants reported thoughts about their current state, they were somewhat less likely to have reported any other types of off-task thoughts. Of course, this includes thoughts about the external environment. This result definitely seems to run counter to the notion that thoughts about external environment and current state should be grouped together as they are in the four-way model.

Looking at the external environment composite, it was not significantly correlated with most other composites. Interestingly, when it was, the correlation was negative. If not for the negative correlation between external environment and current state in the OFF model, this might be interpreted as making the two more alike than different. That is, these correlations might be indirectly capturing something that makes both of them different from mind wandering, and thus similar to each other. However, the significant negative correlation between the two in the OFF model muddies this interpretation. In other words, they both might be different from mind wandering, but it is not clear that they are different for the same reason.

Turning to the full confirmatory factor analyses, the first important fact about them is that there were very few significant correlations between the predictor factors (WMC and attention restraint) and the composite variables. Additionally, the correlations which were significant were different between the ALL and OFF models. At first glance, they do not systematically show much at all. However, notice that the significant correlations between WMC and responses considered mind wandering were negative, while those between attention restraint failures and mind wandering responses were positive. Crucially, this includes current state thoughts in the OFF model. In other words, thoughts about current state of being seem to be more like some types of mind wandering, in that they fit this pattern of correlation. As well, although they were non-significant, the correlations between the external environment composite and the two factors invert this pattern. Unfortunately, because they are non-significant, it is as yet impossible to say exactly what this means.

Recall that Unsworth and McMillan (2014) found that latent variables of mind wandering and external distraction fit best in a model that treated them as distinct, but correlated. On the surface, this would seem to show some support for the four-way model. However, Unsworth and

McMillan seem to have used a different definition of external distractions from Stawarczyk et al. Whereas Stawarczyk et al. included interoceptive and exteroceptive stimuli in the definition given to participants, Unsworth and McMillan use this probe response to signify EDs: “I am distracted by information present in the room (sights and sounds).” This very clearly leaves out interoceptive stimuli, making it closer to the external environment response in the current study. It is unclear how this correlation might have changed if interoceptive stimuli had been included in the definition. Given the negative correlation between the current state and external environment composites in this study, it might be reasonable to think that it would be positive, but weaker. However, if current state thoughts are more like mind wandering – as the CFAs seem to suggest, to some extent – it might have been stronger.

Although the evidence from this study is beginning to suggest that the four-way model makes an incorrect distinction, there is still one important question. Why does it work? Particularly, why did thought content reports seem to fall out for Stawarczyk et al. in the way they would predict from their model? Most likely, it seems to be because they predisposed their participants to give one type of answer whether they experienced thoughts interoceptive or exteroceptive stimuli. After all, they took great care to distinguish for their participants what type of thought each response was for. By doing this, they did much to ensure that participants would choose the right response – according to their model – for any given type of thought. In a manner of speaking, they labeled four different boxes, and then asked their participants to sort their thoughts into those boxes.

To be clear, the inclusion of interoceptive stimuli in the ED category was not entirely wrongheaded. On the contrary, it follows perfectly from the logic that thoughts can be categorized along dimensions of stimulus-dependence and task-relatedness. Stimulus-dependence should pretty much act the same whether it is dependence on an internal or an external stimulus. To some extent, the present study did the same thing as Stawarczyk et al., but with more boxes. The major difference between the two is that the present study was not designed to test any particular theory about the structure of conscious thoughts, whereas those carried out by Stawarczyk and colleagues were. The interesting fact is, people were not more likely to place their thoughts into the external environment box if they had already placed some of them into the current state box, and vice versa. In fact, when we looked at just the off-task boxes, they seemed to be less likely to do so. The fact that such an association did not arise naturally suggests that it may not make sense to impose it by way of thought probe choices.

In the future, it would be wise to address the concerns raised by the present study more directly. Specifically, replication of the present findings would be a strong first step toward suggesting revisions to the four-way model proposed by Stawarczyk and colleagues. After all, just one contradictory study is not enough to make a complete case against the model. A second step toward revising the four-way model will be to test its assumptions – particularly about external distractions – against models which do not share them. Again, the current study was not based on any particular theoretical model of mind wandering, and does not make claims about which alternative model is correct. Therefore, to determine which model is correct, further testing of models against one another is needed.

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Figures and Tables

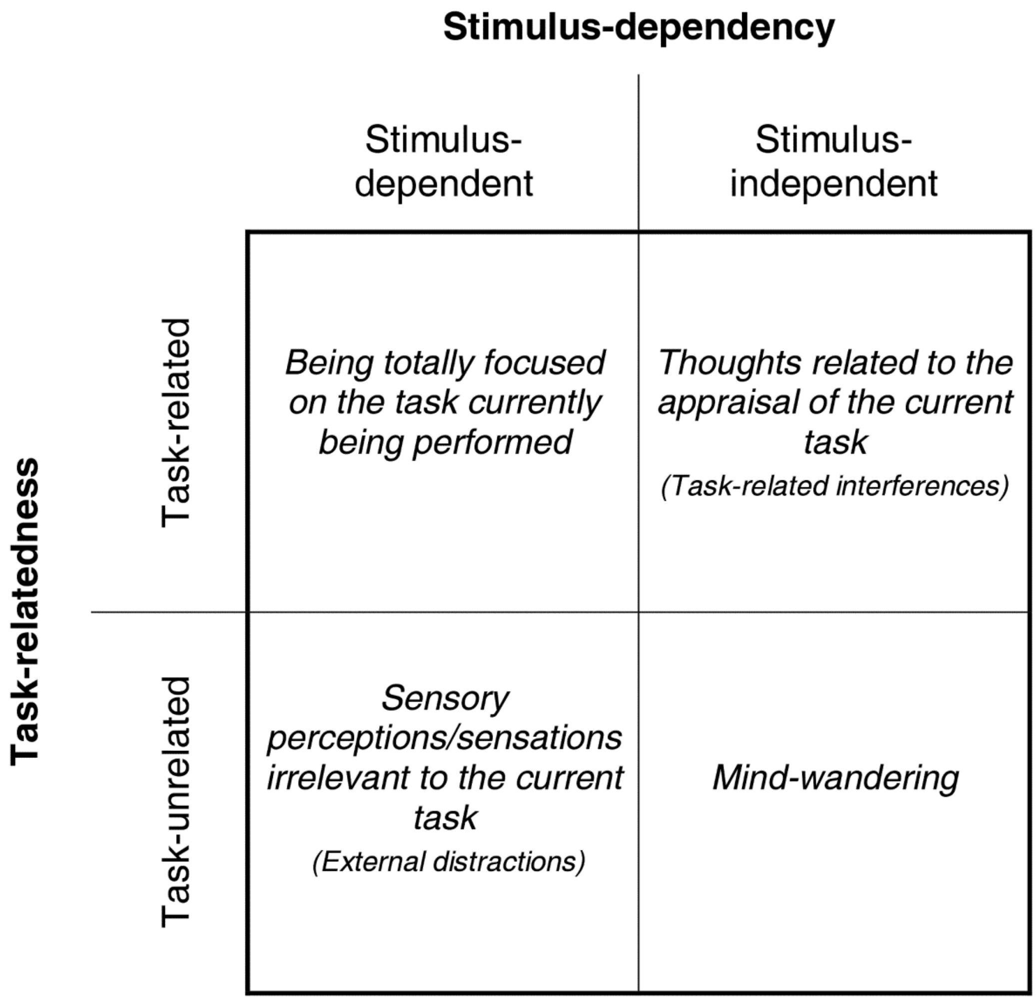

Figure 1. This is a model of conscious thoughts using the dimensions of stimulus-dependency and task-relatedness. Reprinted from "Neural Correlates of Ongoing Conscious Experience: Both Task-Unrelatedness and Stimulus-Independence are Related to Default Network Activity," by D. Stawarczyk, S. Majerus, P. Maquet, & A. D'Argembeau, 2011, *PLoS ONE, 6*(2), e16997. Reprinted with permission.

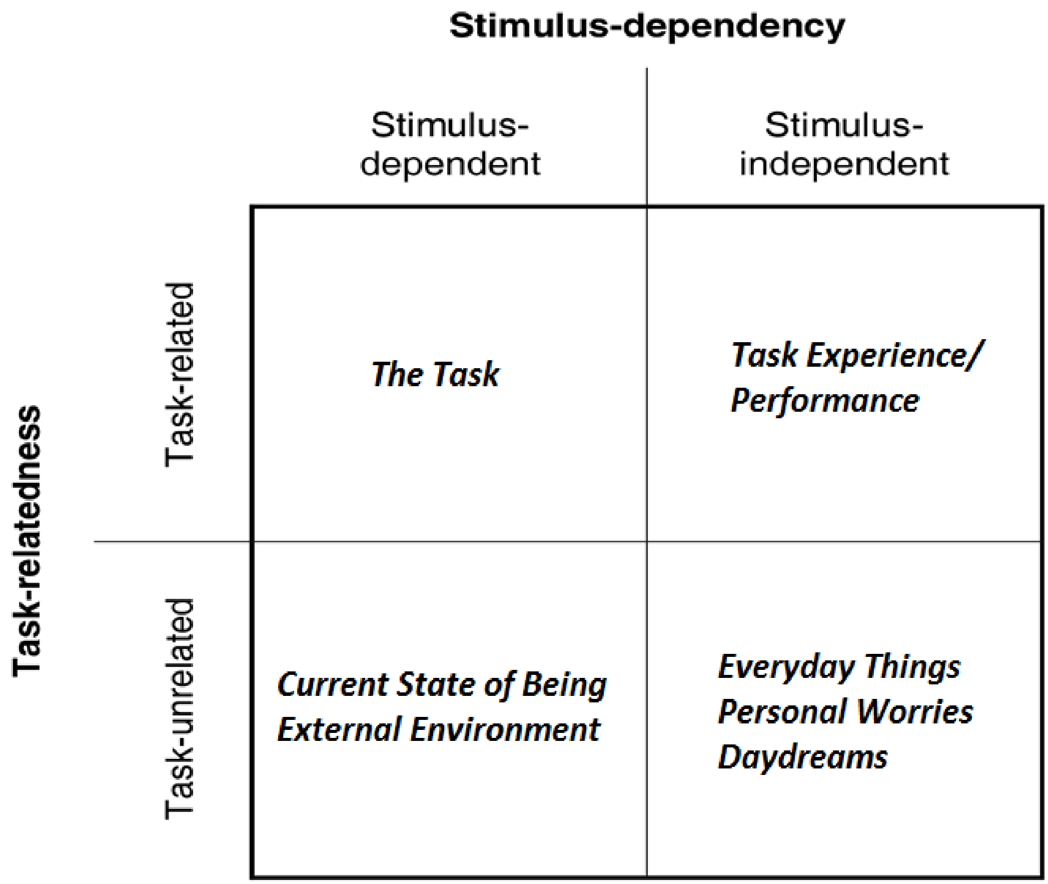

Figure 2. This is a version of the 2 × 2 model introduced by Stawarczyk et al. (2011a, 2011b) with the current study's thought probe responses mapped onto the quadrants of the original model.

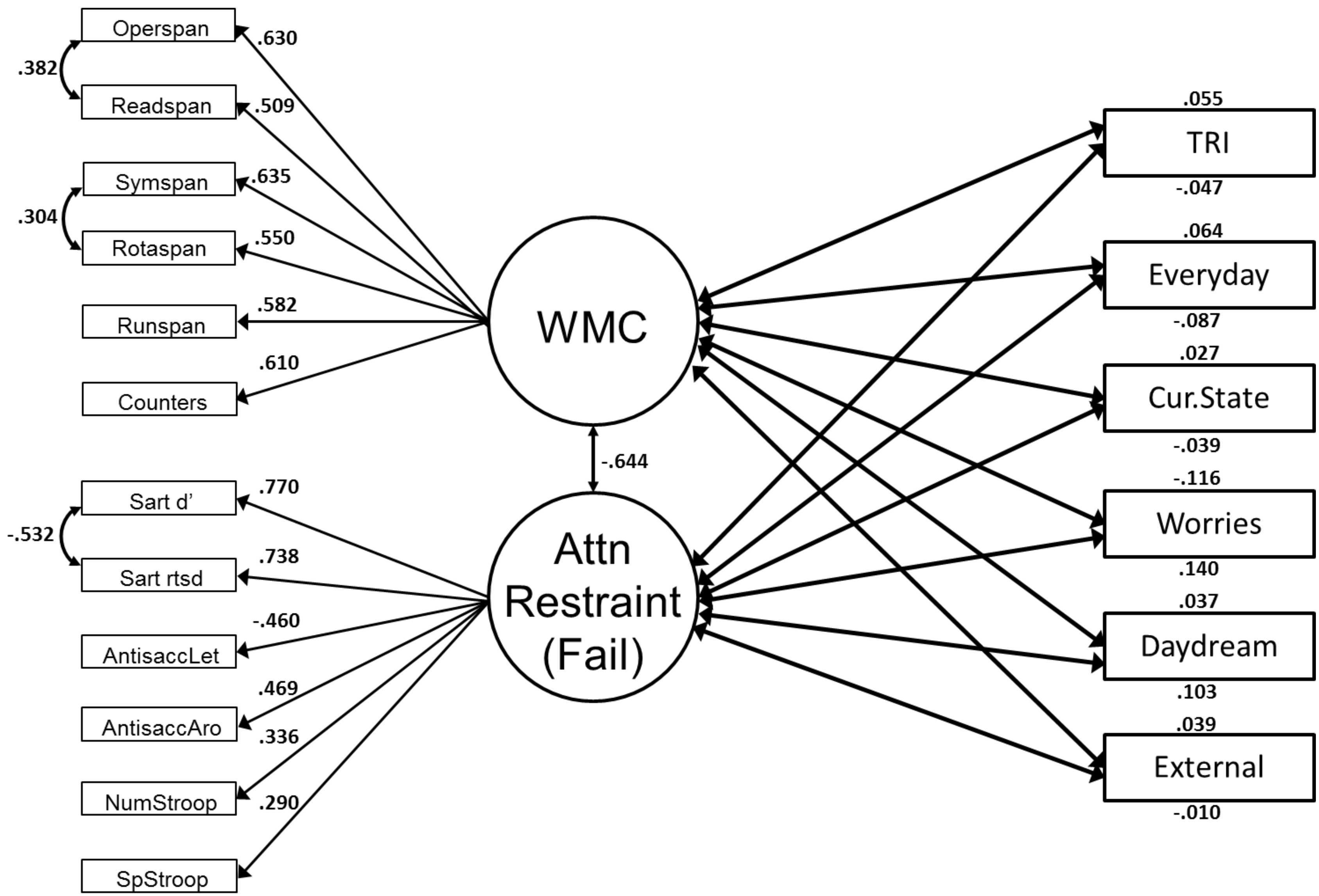

Figure 3. Model of the confirmatory factor analysis for the ALL proportions. Note: correlations above the composite variables are for WMC and those below are for attention restraint failures.

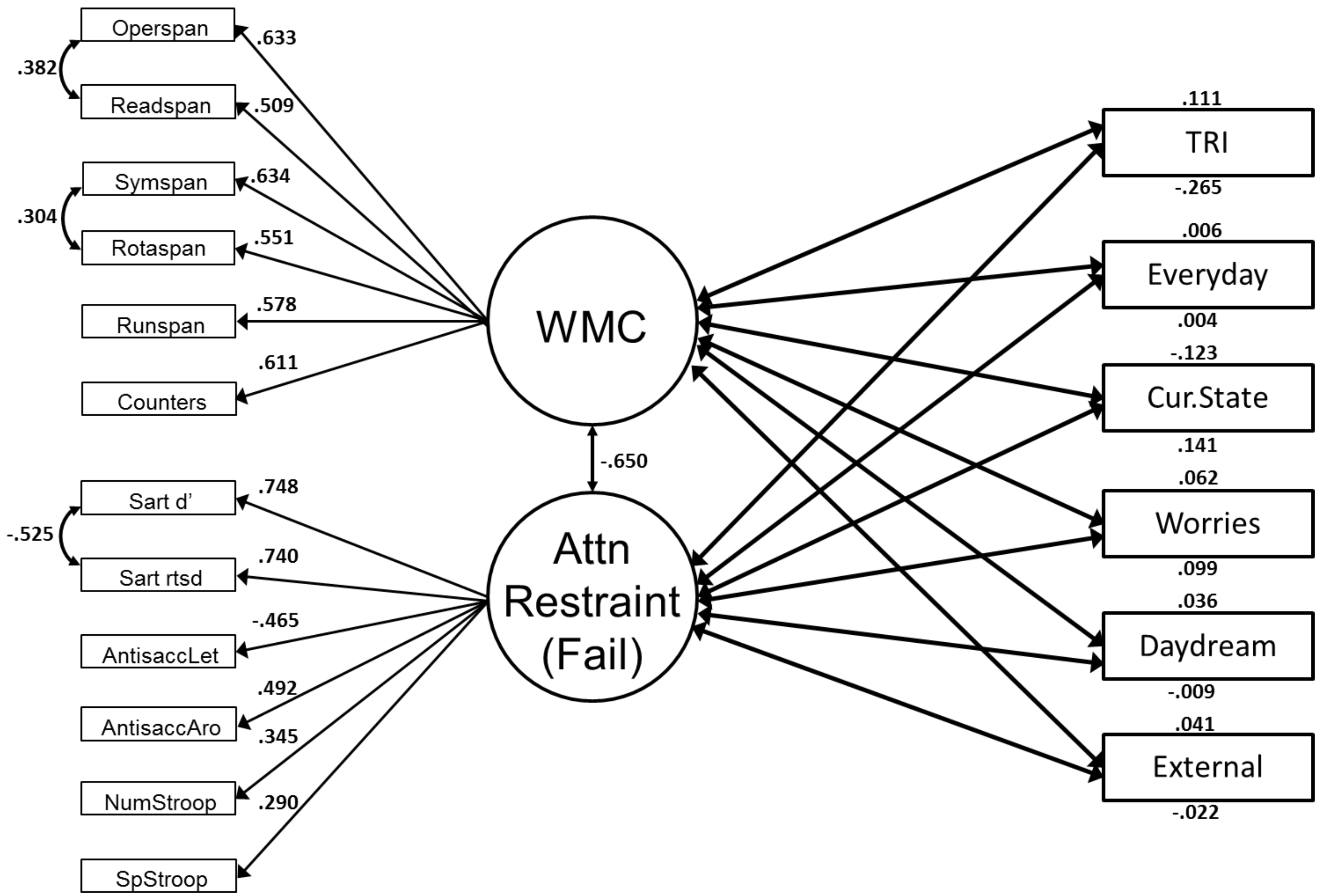

Figure 4. Model of the CFA for OFF. Note: correlations above the composites are for WMC and those below are for attention restraint failures.

Measure	Mean [95% CI]	SD	Min	Max	Skew	Kurtosis	N
OPERSPAN	50.667 [49.377, 51.958]	14.313	0.000	75.000	-0.743	0.293	475
READSPAN	33.820 [32.758, 34.882]	11.114	3.000	59.000	-0.225	-0.451	423
SYMMSPAN	26.657 [25.962, 27.353]	7.651	2.000	42.000	-0.390	-0.164	467
ROTASPAN	25.336 [24.543, 26.129]	7.934	0.000	42.000	-0.552	0.018	387
RUNNSPAN	35.444 [34.523, 36.365]	10.074	8.000	64.000	0.231	-0.103	462
COUNTERS	0.398 [0.384, 0.413]	0.161	0.070	0.920	0.552	0.146	480
ANTI-LET	0.475 [0.462, 0.488]	0.146	0.080	0.800	-0.401	-0.535	470
ANTI-ARO	0.363 [0.345, 0.381]	0.185	0.010	0.790	0.399	-0.695	405
SEM-SART d'	1.644 [1.559, 1.728]	0.987	-0.170	4.540	0.398	-0.508	526
SEM-SART rtsd	214.99 [207.15, 222.83]	91.516	87.600	570.460	1.255	1.301	526
N-STROOP	666.86 [658.13, 675.60]	95.632	422.05	1045.450	0.702	1.348	463
S-STROOP	-0.008 [-0.015, -0.002]	0.073	-0.140	0.300	1.650	2.812	444

Table 1. Descriptive statistics for all tasks measuring working memory capacity and attention restraint. Adapted from Kane et al. (under revision).

	1	2	3	4	5	6	7	8	9	10	11	12
1 OPERSPAN	(.81)											
2 READSPAN	.576	(.76)										
3 SYMMSPAN	.396	.380	(.68)									
4 ROTASPAN	.445	.324	.543	(.76)								
5 RUNNSPAN	.453	.373	.274	.196	(.54)							
6 COUNTERS	.364	.227	.374	.288	.387	(.85)						
7 ANTI-LET	-.208	-.175	-.336	-.212	-.253	-.346	(.89)					
8 ANTI-ARO	-.246	-.185	-.304	-.362	-.267	-.330	.593	(.92)				
9 SEM-SART d'	.149	.202	.194	.136	.214	.170	-.360	-.273	(.96)			
10SEM-SART rtsd	-.145	-.193	-.213	-.110	-.227	-.212	.358	.277	-.633	(.98)		
11 N-STROOP	-.171	-.029	-.191	-.184	-.098	-.208	.255	.261	-.126	.209	(.93)	
12 S-STROOP	-.025	-.021	-.108	-.126	-.054	-.118	.192	.209	-.253	.244	.031	(.81)

Table 2. A correlation matrix for all measures of working memory capacity and attention restraint. Adapted from Kane et al. (under revision).

	N	Minimum	Maximum	Median	Mean	95% CI Upper	95% CI Lower	Std. Error	Std. Dev	Skewness	Kurtosis
LETTFLNK2	460	0.000	1.000	0.083	0.131	0.146	0.116	0.008	0.163	2.242	6.958
LETTFLNK3	460	0.000	0.750	0.000	0.076	0.086	0.066	0.005	0.108	2.160	6.801
LETTFLNK4	460	0.000	1.000	0.167	0.266	0.289	0.244	0.011	0.243	0.952	0.217
LETTFLNK5	460	0.000	0.833	0.000	0.064	0.074	0.054	0.005	0.106	2.510	8.978
LETTFLNK6	460	0.000	0.750	0.083	0.095	0.108	0.083	0.006	0.137	2.122	5.296
LETTFLNK7	460	0.000	0.750	0.000	0.045	0.053	0.037	0.004	0.087	3.325	16.890
SART2	526	0.000	0.978	0.244	0.274	0.293	0.256	0.009	0.216	0.871	0.318
SART3	526	0.000	0.467	0.022	0.051	0.058	0.045	0.003	0.074	2.491	7.689
SART4	526	0.000	0.978	0.178	0.232	0.250	0.215	0.009	0.203	1.151	1.099
SART5	526	0.000	0.600	0.022	0.047	0.054	0.040	0.003	0.080	3.150	13.325
SART6	526	0.000	0.889	0.044	0.096	0.108	0.085	0.006	0.136	2.308	6.685
SART7	526	0.000	0.556	0.022	0.036	0.042	0.031	0.003	0.063	3.662	20.151
N-STROOP2	463	0.000	1.000	0.150	0.220	0.240	0.200	0.010	0.219	1.350	1.715
N-STROOP3	463	0.000	1.000	0.000	0.064	0.073	0.054	0.005	0.106	3.123	16.052
N-STROOP4	463	0.000	1.000	0.100	0.210	0.233	0.186	0.012	0.256	1.441	1.218
N-STROOP5	463	0.000	1.000	0.000	0.052	0.063	0.042	0.005	0.112	4.051	22.003
N-STROOP6	463	0.000	1.000	0.000	0.069	0.083	0.056	0.007	0.151	3.522	14.256
N-STROOP7	463	0.000	1.000	0.000	0.023	0.029	0.016	0.003	0.068	8.128	98.985
ARROFLNK2	424	0.000	1.000	0.100	0.175	0.194	0.156	0.010	0.202	1.693	3.032
ARROFLNK3	424	0.000	1.000	0.050	0.071	0.082	0.059	0.006	0.122	3.746	20.099
ARROFLNK4	424	0.000	1.000	0.100	0.197	0.219	0.175	0.011	0.230	1.633	2.382
ARROFLNK5	424	0.000	0.750	0.000	0.064	0.076	0.053	0.006	0.118	2.696	8.860
ARROFLNK6	424	0.000	1.000	0.000	0.100	0.117	0.082	0.009	0.184	2.686	7.594
ARROFLNK7	424	0.000	0.450	0.000	0.023	0.028	0.018	0.002	0.051	3.509	17.261
N-BACK2	461	0.000	1.000	0.133	0.207	0.228	0.187	0.010	0.223	1.406	1.669
N-BACK3	461	0.000	1.000	0.000	0.045	0.054	0.036	0.005	0.099	5.074	36.845
N-BACK4	461	0.000	1.000	0.133	0.200	0.222	0.179	0.011	0.234	1.432	1.668
N-BACK5	461	0.000	0.800	0.000	0.054	0.065	0.043	0.006	0.121	3.629	15.691
N-BACK6	461	0.000	1.000	0.000	0.084	0.099	0.069	0.008	0.163	2.944	9.737
N-BACK7	461	0.000	0.867	0.000	0.019	0.024	0.014	0.003	0.058	7.879	101.568

Table 3. Descriptive statistics for the ALL proportions.

	N	Minimum	Maximum	Median	Mean	95% CI Upper	95% CI Lower	Std. Error	Std. Dev	Skewness	Kurtosis
LETTFLNK2	449	0.000	1.000	0.125	0.189	0.209	0.168	0.010	0.219	1.677	3.046
LETTFLNK3	449	0.000	1.000	0.000	0.107	0.121	0.093	0.007	0.149	2.084	6.359
LETTFLNK4	449	0.000	1.000	0.333	0.363	0.390	0.336	0.014	0.291	0.518	-0.744
LETTFLNK5	449	0.000	0.833	0.000	0.089	0.103	0.076	0.007	0.145	2.287	6.285
LETTFLNK6	449	0.000	1.000	0.083	0.131	0.147	0.114	0.008	0.177	1.786	3.405
LETTFLNK7	449	0.000	1.000	0.000	0.066	0.078	0.054	0.006	0.129	3.078	12.837
SART2	524	0.000	1.000	0.316	0.347	0.369	0.325	0.011	0.251	0.574	-0.411
SART3	524	0.000	0.870	0.030	0.070	0.080	0.061	0.005	0.110	3.505	17.616
SART4	524	0.000	1.000	0.244	0.290	0.310	0.271	0.010	0.231	0.864	0.248
SART5	524	0.000	0.765	0.024	0.061	0.069	0.052	0.004	0.101	3.045	12.369
SART6	524	0.000	1.000	0.055	0.122	0.137	0.108	0.007	0.167	2.136	5.479
SART7	524	0.000	0.556	0.023	0.047	0.053	0.040	0.003	0.077	2.953	11.952
N-STROOP2	454	0.000	1.000	0.325	0.368	0.397	0.339	0.015	0.310	0.554	-0.764
N-STROOP3	454	0.000	1.000	0.000	0.097	0.110	0.083	0.007	0.148	2.146	5.661
N-STROOP4	454	0.000	1.000	0.182	0.291	0.319	0.263	0.014	0.302	0.894	-0.373
N-STROOP5	454	0.000	1.000	0.000	0.073	0.085	0.060	0.006	0.135	2.886	11.102
N-STROOP6	454	0.000	1.000	0.000	0.096	0.113	0.079	0.009	0.187	2.858	8.732
N-STROOP7	454	0.000	1.000	0.000	0.034	0.042	0.025	0.004	0.091	5.111	37.507
ARROFLNK2	414	0.000	1.000	0.218	0.283	0.310	0.256	0.014	0.279	0.930	-0.035
ARROFLNK3	414	0.000	1.000	0.053	0.108	0.124	0.092	0.008	0.164	2.395	7.092
ARROFLNK4	414	0.000	1.000	0.214	0.289	0.317	0.262	0.014	0.283	0.959	0.035
ARROFLNK5	414	0.000	0.833	0.000	0.090	0.105	0.075	0.008	0.153	2.202	5.173
ARROFLNK6	414	0.000	1.000	0.000	0.146	0.169	0.123	0.012	0.237	2.013	3.561
ARROFLNK7	414	0.000	1.000	0.000	0.036	0.045	0.028	0.004	0.087	5.015	40.249
N-BACK2	443	0.000	1.000	0.267	0.360	0.391	0.329	0.016	0.331	0.640	-0.838
N-BACK3	443	0.000	1.000	0.000	0.075	0.089	0.061	0.007	0.150	3.383	14.431
N-BACK4	443	0.000	1.000	0.231	0.300	0.328	0.272	0.014	0.297	0.805	-0.342
N-BACK5	443	0.000	1.000	0.000	0.079	0.095	0.064	0.008	0.167	3.086	10.637
N-BACK6	443	0.000	1.000	0.000	0.121	0.140	0.101	0.010	0.209	2.214	4.694
N-BACK7	443	0.000	0.867	0.000	0.028	0.035	0.021	0.004	0.075	4.734	37.625

Table 4. Descriptive statistics for the OFF proportions.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. LETTFLNK2															
2. LETTFLNK3	-0.019														
3. LETTFLNK4	-0.257	-0.193													
4. LETTFLNK5	-0.078	-0.057	-0.161												
5. LETTFLNK6	-0.182	0.020	-0.160	0.017											
6. LETTFLNK7	0.034	-0.071	-0.173	-0.028	-0.026										
7. SART2	0.365	0.026	-0.135	-0.008	-0.106	0.081									
8. SART3	-0.002	0.497	-0.103	-0.042	0.008	-0.052	-0.098								
9. SART4	-0.113	-0.083	0.587	-0.086	-0.079	-0.111	-0.302	-0.084							
10. SART5	-0.067	0.054	-0.086	0.445	0.052	-0.036	-0.158	-0.045	-0.066						
11. SART6	-0.056	0.008	-0.085	0.018	0.425	0.024	-0.248	-0.071	-0.203	0.051					
12. SART7	-0.012	0.039	-0.085	0.097	0.042	0.352	-0.145	-0.008	-0.087	0.066	0.078				
13. N-STROOP2	0.352	0.055	-0.056	-0.006	-0.148	0.070	0.446	-0.003	-0.102	-0.064	-0.112	-0.012			
14. N-STROOP3	-0.029	0.211	0.020	0.02	-0.017	-0.003	-0.059	0.286	0.083	0.062	0.038	0.073	-0.027		
15. N-STROOP4	-0.059	0.022	0.231	-0.038	0.021	-0.043	-0.081	-0.075	0.317	-0.019	0.005	-0.005	-0.360	-0.139	
16. N-STROOP5	0.105	0.023	0.027	0.189	0.030	0.030	-0.128	-0.009	0.088	0.197	0.168	0.119	-0.139	-0.011	-0.037
17. N-STROOP6	-0.103	-0.053	-0.009	0.088	0.444	-0.017	-0.081	-0.024	-0.045	0.069	0.365	-0.028	-0.225	-0.012	-0.110
18. N-STROOP7	0.032	0.105	-0.046	0.006	0.005	0.128	0.039	-0.030	-0.048	0.046	-0.028	0.121	0.013	-0.042	-0.094
19. ARROFLNK2	0.314	0.097	-0.012	0.034	-0.107	0.022	0.415	0.032	-0.035	-0.026	-0.139	-0.065	0.598	0.008	-0.239
20. ARROFLNK3	-0.042	0.190	0.045	0.08	-0.035	-0.066	0.005	0.293	0.050	0.036	0.027	-0.020	-0.052	0.514	0.022
21. ARROFLNK4	0.080	0.010	0.211	-0.039	-0.127	-0.003	-0.037	-0.069	0.302	0.016	-0.085	0.030	-0.130	-0.019	0.498
22. ARROFLNK5	-0.046	0.006	0.029	0.296	0.013	0.113	-0.026	-0.093	0.079	0.213	0.065	0.059	-0.022	-0.007	0.063
23. ARROFLNK6	-0.068	0.013	-0.085	0.032	0.457	-0.022	-0.026	-0.042	-0.109	0.025	0.424	0.109	-0.170	-0.022	0.020
24. ARROFLNK7	-0.077	0.005	-0.034	0.135	0.157	0.133	-0.019	-0.003	-0.089	0.088	0.120	0.233	0.020	-0.027	-0.074
25. N-BACK2	0.276	-0.091	-0.022	-0.005	-0.061	0.033	0.372	-0.007	-0.009	-0.064	-0.147	-0.010	0.431	-0.022	-0.169
26. N-BACK3	-0.015	0.363	-0.056	-0.045	-0.032	-0.031	-0.088	0.223	0.016	0.044	-0.021	0.082	-0.035	0.211	-0.001
27. N-BACK4	-0.098	-0.009	0.248	-0.017	-0.072	0.017	-0.113	-0.034	0.338	-0.027	-0.022	-0.020	-0.150	0.013	0.361
28. N-BACK5	0.048	0.012	0.058	0.059	0.072	-0.034	-0.076	-0.035	0.038	0.145	0.131	0.028	-0.102	0.104	0.061
29. N-BACK6	-0.144	-0.021	-0.011	0.037	0.370	0.058	-0.149	0.017	-0.105	0.135	0.345	-0.010	-0.149	0.033	-0.073
30. N-BACK7	-0.009	0.047	-0.073	0.064	0.148	0.087	-0.026	0.019	-0.103	-0.011	0.120	0.389	0.038	-0.044	0.038

Table 5. Correlation matrix for ALL proportions.

	16	17	18	19	20	21	22	23	24	25	26	27	28	29
16. N-STROOP5														
17. N-STROOP6	0.036													
18. N-STROOP7	-0.031	-0.035												
19. ARROFLNK2	-0.066	-0.157	-0.012											
20. ARROFLNK3	-0.018	-0.022	-0.018	-0.016										
21. ARROFLNK4	0.146	-0.154	-0.039	-0.202	-0.077									
22. ARROFLNK5	0.380	0.034	0.065	-0.091	-0.029	-0.106								
23. ARROFLNK6	0.022	0.633	0.078	-0.225	-0.125	-0.211	0.025							
24. ARROFLNK7	-0.012	0.087	0.382	-0.105	-0.041	-0.046	-0.014	0.117						
25. N-BACK2	-0.059	-0.103	-0.019	0.427	-0.011	-0.094	-0.038	-0.079	-0.032					
26. N-BACK3	0.023	-0.041	0.305	-0.012	0.207	-0.024	0.070	0.002	0.064	-0.077				
27. N-BACK4	0.002	-0.060	0.017	-0.064	0.031	0.305	0.017	-0.108	0.011	-0.244	-0.081			
28. N-BACK5	0.250	0.111	-0.036	-0.118	0.041	0.088	0.192	0.107	-0.066	-0.166	0.005	-0.072		
29. N-BACK6	0.086	0.368	-0.054	-0.069	-0.037	-0.065	0.030	0.365	-0.004	-0.215	-0.036	-0.126	0.070	
30. N-BACK7	0.002	0.024	0.066	-0.051	-0.051	0.029	-0.018	0.077	0.392	-0.090	0.003	-0.022	0.018	0.034

Table 5 cont.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. LETTFLNK2															
2. LETTFLNK3	-0.070														
3. LETTFLNK4	-0.427	-0.306													
4. LETTFLNK5	-0.128	-0.129	-0.240												
5. LETTFLNK6	-0.249	0.010	-0.299	-0.066											
6. LETTFLNK7	0.002	-0.116	-0.251	-0.075	-0.097										
7. SART2	0.356	0.008	-0.162	-0.052	-0.122	0.122									
8. SART3	0.002	0.494	-0.153	-0.061	-0.005	-0.070	-0.158								
9. SART4	-0.194	-0.153	0.512	-0.137	-0.170	-0.161	-0.476	-0.140							
10. SART5	-0.134	0.014	-0.114	0.459	0.048	-0.058	-0.225	-0.057	-0.126						
11. SART6	-0.117	-0.002	-0.164	0.006	0.458	0.017	-0.320	-0.086	-0.295	-0.007					
12. SART7	-0.035	-0.016	-0.127	0.072	-0.020	0.295	-0.200	-0.048	-0.153	0.060	0.059				
13. N-STROOP2	0.325	-0.054	-0.117	-0.037	-0.152	0.051	0.409	0.003	-0.226	-0.094	-0.193	-0.041			
14. N-STROOP3	-0.070	0.202	-0.007	0.006	-0.028	-0.037	-0.128	0.254	0.029	0.042	0.008	0.019	-0.140		
15. N-STROOP4	-0.166	-0.025	0.254	-0.081	-0.053	-0.048	-0.138	-0.109	0.300	-0.060	-0.059	-0.028	-0.564	-0.225	
16. N-STROOP5	-0.010	-0.004	-0.059	0.183	0.002	0.043	-0.154	-0.013	-0.006	0.184	0.110	0.111	-0.233	-0.080	-0.141
17. N-STROOP6	-0.143	-0.037	-0.119	0.056	0.422	-0.041	-0.137	-0.010	-0.120	0.028	0.402	-0.045	-0.317	-0.065	-0.215
18. N-STROOP7	-0.005	0.045	-0.081	0.068	-0.023	0.123	0.036	-0.036	-0.088	0.136	-0.033	0.152	-0.072	-0.060	-0.146
19. ARROFLNK2	0.296	0.013	-0.108	-0.058	-0.137	0.059	0.374	-0.011	-0.169	-0.100	-0.177	-0.076	0.530	-0.042	-0.245
20. ARROFLNK3	-0.115	0.235	-0.006	0.050	-0.016	-0.098	-0.122	0.283	-0.005	0.031	0.003	-0.009	-0.091	0.433	-0.033
21. ARROFLNK4	-0.017	-0.071	0.291	-0.122	-0.214	-0.011	-0.127	-0.055	0.320	-0.052	-0.148	-0.030	-0.178	-0.075	0.429
22. ARROFLNK5	-0.102	-0.028	-0.041	0.273	-0.015	0.089	-0.073	-0.103	0.035	0.182	0.022	0.037	-0.102	-0.078	-0.009
23. ARROFLNK6	-0.092	-0.041	-0.166	-0.013	0.433	-0.059	-0.093	-0.043	-0.179	-0.025	0.397	0.059	-0.213	-0.049	-0.099
24. ARROFLNK7	-0.096	-0.043	0.012	0.118	0.082	0.034	-0.056	-0.004	-0.062	0.130	0.052	0.149	-0.014	-0.058	-0.132
25. N-BACK2	0.321	-0.077	-0.115	0.019	-0.110	0.046	0.324	0.013	-0.109	-0.071	-0.186	-0.032	0.463	-0.035	-0.265
26. N-BACK3	-0.022	0.256	-0.058	-0.050	-0.047	-0.028	-0.102	0.195	-0.022	0.039	-0.012	0.079	-0.031	0.152	-0.052
27. N-BACK4	-0.166	-0.010	0.289	-0.038	-0.152	-0.017	-0.150	-0.083	0.323	-0.036	-0.079	-0.020	-0.292	-0.005	0.417
28. N-BACK5	-0.049	-0.013	0.001	0.078	0.029	-0.025	-0.091	-0.037	0.006	0.092	0.083	-0.037	-0.134	-0.016	0.028
29. N-BACK6	-0.156	-0.012	-0.084	-0.001	0.395	-0.014	-0.110	0.033	-0.173	0.096	0.350	-0.040	-0.152	0.009	-0.112
30. N-BACK7	-0.011	-0.002	-0.113	0.035	0.046	0.080	-0.011	-0.021	-0.151	-0.046	0.060	0.302	0.029	-0.083	-0.013

Table 6. Correlation matrix for OFF proportions.

	16	17	18	19	20	21	22	23	24	25	26	27	28	29
16. N-STROOP5														
17. N-STROOP6	0.008													
18. N-STROOP7	0.010	-0.073												
19. ARROFLNK2	-0.133	-0.204	-0.085											
20. ARROFLNK3	-0.068	-0.082	0.005	-0.133										
21. ARROFLNK4	0.030	-0.227	-0.067	-0.398	-0.168									
22. ARROFLNK5	0.332	-0.009	0.044	-0.198	-0.085	-0.211								
23. ARROFLNK6	-0.020	0.591	0.035	-0.327	-0.201	-0.319	-0.050							
24. ARROFLNK7	-0.035	0.016	0.285	-0.144	-0.053	-0.116	-0.063	-0.001						
25. N-BACK2	-0.129	-0.150	-0.029	0.338	-0.061	-0.101	-0.049	-0.147	-0.039					
26. N-BACK3	-0.016	-0.054	0.140	-0.037	0.224	-0.104	0.027	0.003	0.055	-0.184				
27. N-BACK4	-0.013	-0.144	-0.011	-0.162	-0.006	0.294	-0.008	-0.146	0.010	-0.480	-0.173			
28. N-BACK5	0.201	0.035	-0.032	-0.156	0.015	-0.006	0.143	0.077	-0.066	-0.306	-0.058	-0.166		
29. N-BACK6	0.070	0.413	-0.076	-0.092	-0.059	-0.130	-0.031	0.370	-0.043	-0.337	-0.086	-0.266	-0.017	
30. N-BACK7	0.018	-0.014	0.062	-0.076	-0.067	0.029	-0.024	0.014	0.234	-0.158	-0.050	-0.079	0.006	0.001

Table 6 cont.

	1	2	3	4	5
1. TRI					
2. Everyday	0.086				
3. Cur. State	-0.048	-0.093			
4. Worries	-0.113	-0.294	-0.079		
5. Daydreams	-0.030	-0.161	-0.043	-0.060	
6. External	0.030	-0.252	-0.055	-0.198	0.072

Table 7. Correlation matrix for ALL composite variables.

	1	2	3	4	5
1. TRI					
2. Everyday	-0.145				
3. Cur. State	-0.442	-0.206			
4. Worries	-0.259	-0.039	-0.142		
5. Daydreams	-0.320	-0.074	-0.329	0.015	
6. External	-0.066	-0.051	-0.174	0.026	-0.016

Table 8. Correlation matrix for OFF composite variables.