Psychology & Neuroscience

Is the Relationship Between Mind Wandering and Attention Culture-Specific?

Óscar F. Gonçalves, Gabriel Rêgo, Patrícia Oliveira-Silva, Jorge Leite, Sandra Carvalho, Julia de Souza-Queiroz, Felipe Fregni, Edson Amaro, Jr., and Paulo S. Boggio

Online First Publication, May 11, 2017. http://dx.doi.org/10.1037/pne0000083

Psychology & Neuroscience

1983-3288/17/$12.00 http://dx.doi.org/10.1037/pne0000083

Is the Relationship Between Mind Wandering and Attention Culture-Specific?

Óscar F. Gonçalves
University of Minho and Harvard Medical School

Gabriel Rêgo
Mackenzie Presbyterian University

Patrícia Oliveira-Silva
Universidade Católica Portuguesa and University of Minho

Jorge Leite and Sandra Carvalho
University of Minho and Harvard Medical School

Julia de Souza-Queiroz
Mackenzie Presbyterian University

Felipe Fregni
Harvard Medical School

Edson Amaro Jr.
University of São Paulo

Paulo S. Boggio
Mackenzie Presbyterian University

There is increasing evidence that both mind wandering (MW) and attention are influenced by culture. However, studies on the interference between MW and attention across cultures are virtually nonexistent. Here we researched how individuals from 2 cultures (Portuguese, Brazilian) differ in terms of type of thoughts and content of MW during the course of the attention network task (ANT). Additionally, we tested the existence of culture-specific associations between type of thoughts and content of mind wandering and each component of the attention network system (alert, orienting, executive). No statistically significant differences were found between Brazilian and Portuguese participants in terms of nature and content of mind-wandering thoughts.

Óscar F. Gonçalves, Neuropsychophysiology Lab–CIPsi, School of Psychology, University of Minho, and Spaulding Neuromodulation Center, Department of Physical Medicine & Rehabilitation, Spaulding Rehabilitation Hospital, and Massachusetts General Hospital, Harvard Medical School; Gabriel Rêgo, Social and Cognitive Neuroscience Laboratory, Center for Health and Biological Sciences, Mackenzie Presbyterian University; Patrícia Oliveira-Silva, Human Neurobehavioral Laboratory, Centre for Studies in Human Development, Faculty of Education and Psychology, Universidade Católica Portuguesa, and Neuropsychophysiology Lab–CIPsi, School of Psychology, University of Minho; Jorge Leite and Sandra Carvalho, Neuropsychophysiology Lab–CIPsi, School of Psychology, University of Minho, and Spaulding Neuromodulation Center, Department of Physical Medicine & Rehabilitation, Spaulding Rehabilitation Hospital, and Massachusetts General Hospital, Harvard Medical School; Julia de Souza-Queiroz, Social and Cognitive Neuroscience Laboratory, Center for Health and Biological Sciences, Mackenzie Presbyterian University; Felipe Fregni, Spaulding Neuromodulation Center, Department of Physical Medicine & Rehabilitation, Spaulding Rehabilitation Hospital, and Massachusetts General Hospital, Harvard Medical School; Edson Amaro Jr., Department of Radiology, Hospital das Clinicas, School of Medicine, University of São Paulo; Paulo S. Boggio, Social and Cognitive Neuroscience Laboratory, Center for Health and Biological Sciences, Mackenzie Presbyterian University.

Óscar F. Gonçalves was funded by the Brazilian National Counsel for Scientific and Technological Development (CNPq) as a special visiting researcher (Grant 401143/2014-7). This study was partially conducted at the Psychology Research Centre (UID/PSI/01662/2013), University of Minho, and supported by the Portuguese Foundation for Science and Technology and cofinanced by FEDER through COMPETE2020 under the PT2020 (Grant POCI-01-0145-FEDER-007653). Paulo S. Boggio is a CNPq researcher fellow (Grant 311641/2015-6). Gabriel Rêgo was supported by Fundação de Amparo à Pesquisa do Estado de São Paulo (PhD Grant FAPESP-2015/18713-9).

Correspondence concerning this article should be addressed to Óscar F. Gonçalves, Neuropsychophysiology Lab, School of Psychology, University of Minho, Campus de Gualtar 4710-057 Braga, Portugal. E-mail: goncalves@psi.uminho.pt

Both groups tended to be predominantly involved in task-related interference thoughts during the attention task. At the end of the task, both groups reported having been predominantly out of focus, dominated mostly by inner language thoughts. Despite the similarities, the type of thoughts and content of MW seemed to affect performance in the attention task differently in each group. First, and regarding ANT overall performance, only Portuguese had a significantly facilitating effect in response time associated with task-interfering thoughts. Second, regarding ANT network effects, Portuguese participants, when compared with Brazilians, seemed to be more sensitive to orientation cues in all thought conditions, benefited more from alerting cues when they reported on-task thoughts, and took better advantage of mind wandering to reduce attentional conflict.

Keywords: mind wandering, attention, attention network task, consciousness, culture

The mind tends to drift away when there is a lack of demands for concentration but also when processing a demanding task. This phenomenon, known as mind wandering (MW), involves a process of decoupling from external attention to internal thought flow (Schooler et al., 2011).

The evidence for an orthogonal relationship between attention and mind wandering is based on studies showing that mind wandering impairs attention by recruiting competing executive resources (Kane & McVay, 2012; Smallwood & Schooler, 2006). Additionally, it has been repeatedly found that MW does not interfere evenly with all types of executive tasks (e.g., Kam & Handy, 2014). Data from neuroimaging studies confirmed that mind wandering recruits both the default mode and the executive networks (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). However, a study by Stawarczyk, Majerus, Maquet, and D'Argembeau (2011)showed that although MW thoughts are responsible for a pick activation in the Default Mode Network (DMN), other interfering thoughts (i.e., external distractions, task appraisal distractors) are also associated with the activation of several midline regions of the DMN.

The evidence just reported highlights the need to approach mind wandering as a multicomponent process. Stawarczyk, Majerus, Maj, Van der Linden, and D'Argembeau (2011) explained that several "out of task" thoughts have traditionally been subsumed under the category of MW: task-related interference (TRI; e.g., thoughts that are associated with side aspects of an external task), external distractions (EDs; e.g., thoughts about environmental stimuli irrelevant to the task), and stimulus-independent and task-unrelated thoughts (SITUTs; e.g., thoughts dissociated from both task and external stimuli). Even though TRI and ED illustrate an already MW state, in both of these situations the individual is still focused on aspects associated with the task (TRI) or the context (ED). Only for SITUT is one in the presence of a truly mind-wandering condition in which the mind enters a space–time-traveling mode (Corballis, 2013).

These different types of thoughts have been reported to affect performance in distinct tasks (Stawarczyk, Majerus, Catale, & D'Argembeau, 2014). For example, Stawarczyk, Majerus, Maj, et al. (2011) observed that all three task thoughts (TRI, ED, SITUT) significantly interfere with an attention performance task: the sustained attention to response task (SART).

Using a different type of attention task (the attention network task [ANT]) and a different mind-wandering assessment method (thought probes and performance indices in the SART), Hu, He, and Xu (2012) found that MW (any type of thoughts unrelated to the task) negatively affected the orienting attention network (ability to select among multiple stimuli). However, a recent study by Gonçalves et al. (2017) looking at interference of different types of thoughts, as measured by on-task (OT), TRI, ED, and SITUT on the ANT, showed that only task-related interference thoughts and external distractions, but not mind wandering (i.e., SITUT), negatively impacted attention.

There has also been some recent evidence that the interference between mind wandering and external distractors in attention tasks is mediated by both individual cognitive abilities (e.g., working memory capacity and fluid intelligence; Unsworth & McMillan, 2014) and en-

vironmental conditions (e.g., noisy vs. silent environment; Robison & Unsworth, 2015).

These different types of thoughts have been reported to affect performance in distinct tasks (Stawarczyk et al., 2014). For example, Stawarczyk, Majerus, Maquet, and D'Argembeau (2011) observed that all three task thoughts (TRI, ED, SITUT) significantly interfere with an attention performance task (SART).

The content of MW thoughts also seems to vary according to the individual or the situation. For example, Delamillieure et al. (2010) advanced a taxonomy to classify the content of thoughts when the mind is dissociated from a task condition. The following categories were suggested: visual mental imagery (IMAG; e.g., seeing something in thought); inner language (LANG; e.g., thinking with one's own voice without overt production), somatosensory awareness (SOMA; e.g., paying attention to body sensations), inner musical experience (MUSI; e.g., thinking in terms of melodies or rhythms), and mental processing of numbers (NUMB; e.g., counting, or time estimation). The authors reported that a significant percentage of individuals could be classified in a dominant MW mode.

Despite its regular occurrence, not all minds wander to the same degree. Individuals exhibit stable differences in their propensity to produce MW thoughts. For example, some individuals are mostly prone to spontaneous MW, whereas others are characterized by deliberate MW (Seli, Risko, & Smilek, 2016); some have reported a MW focus in the past, whereas others focused on the future (Smallwood, Nind, & O'Connor, 2009); and still others have reported being dominated by language thoughts, whereas others reported the prevalence of images (Delamillieure et al., 2010). These differences in mind wandering have been associated with cognitive characteristics (McVay, Unsworth, McMillan, & Kane, 2013), personality traits (Alexander Diaz et al., 2014), or even clinical phenomena (Seli & Purdon, 2017).

Less is known, however, about specific patterns of MW across different cultures. Mind wandering has been studied in participants from both Eastern and Western cultures, suggesting that it is a universal phenomenon. For example, Song and Wang (2012), in studying mind wandering in a Chinese population, found it to be a prevalent phenomenon, mostly associated with prospective mental time travel. However, there has been some initial evidence for MW differences across cultures. In the only study comparing MW in different cultures, Sude (2015) showed that Canadian students from a European heritage tended to have significantly increased MW (task-related and room-related interference thoughts) when compared with students from an Asian heritage while performing an easy and repetitive task.

Similarly, there has been some initial evidence for the effects of culture in different attention networks. For example, Tran, Arredondo, and Yoshida (2015), in longitudinally testing 3-year-old children from the United States, Argentina, and Vietnam in the ANT, found that culture was associated with development of the alerting and executive networks.

A recent study by Amer, Ngo, and Hasher (2017) tested whether Asians of Western and Eastern descent differed on the effect of distractive irrelevant information in attention and working memory tasks. They found that only East Asians were able to maintain implicit memory for distractors without significant task costs. This finding suggests that culture may be associated with the ability to maintain both an internal (e.g., mind wandering) and external (e.g., attention) focus.

In sum, whereas it is known that both mind wandering and attention are influenced by culture, studies on the interference between mind wandering and attention across cultures are virtually nonexistent. It is possible that the survival of specific patterns of mind wandering in different cultures is associated with their potential to coexist and even facilitate specific attention tasks. In fact, there has been increasing evidence that some types of mind wandering may facilitate performance by mechanisms of attention recycling, dishabituation, or mood regulation (Smallwood & Schooler, 2015).

Even though there are no cultural cognition studies comparing Portuguese and Brazilian cohorts, several cross-cultural studies have been reported that certain cultures (e.g., European and North American) are characterized by field-independent and analytic cognition, whereas other cultures (e.g., Asian and Latin American) have exhibited a preference for field-dependent and holistic cognition (cf. Nisbett & Miyamoto, 2005). If this is the case, one may expect from Brazilians a wider attentional scope with less

interference between mind wandering and attention. On the contrary, an eventual narrower attentional scope will render Portuguese individuals more prone to mind-wandering interference. To test this hypothesis, here we researched the differences between Brazilian and Portuguese college students in terms of type of thoughts and MW content during the performance of an attention task. Additionally, we looked at the interference of different types of thoughts and MW content in different attention networks.

Method

Participants

The sample consisted of 243 healthy college students (174 women) with normal or corrected-to-normal vision. Demographic characteristics of the Portuguese and Brazilian samples are presented in Table 1. The two samples were matched in terms of gender and age. No significant differences were found between the samples in terms of gender, $\chi^2(1) = .4$, $p > .05$, and age, $t(241) = -.62$, $p > .05$. All participants provided signed informed consent, and the study was carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki, 2013).

Materials

Attention network task. The ANT is a computerized visual–motor task designed to assess the three attentional networks proposed by Michael Posner (cf. Peterson & Posner, 2012). During the entire procedure, participants are required to focus on a central fixation cross, responding as quickly and accurately as possible as soon as the target—a central arrow—appears either below or above the fixation cross. Participants are asked to identify whether the arrow is pointing right or left by pressing the correspondent side of the mouse button. The targets are preceded by four cue conditions: (a) a spatially informative cue announcing that the target will appear either above or below the fixation cross; (b) a center cue or double cue condition (above and below the fixation cross) alerting that the target will be presented soon but without information about the spatial location; and (c) a no-cue condition. Additionally, (d) the target arrow may be presented alone or accompanied by three types of flankers: surrounding arrows pointing in the same direction as the target (congruent condition) or opposite direction to the target (incongruent condition); or surrounding traces without arrows (neutral condition).

In the current version, the ANT was programed and presented via E-Prime 2.10 (Schneider, Eschman, & Zuccolotto, 2012; Psychology Software Tools, Pittsburgh, PA) in desktop computers according to the following parameters: (a) a fixation cross appeared in the center of the screen all the time; (b) depending on the cue condition, a cue (center, double, or spatial cue or no cue) appeared for 200 ms; (c) after a variable duration (300–1,800 ms), the target (the center arrow) and flankers (congruent, incongruent, or neutral flankers) were presented until the participant responded, but with a time limit of 2,000 ms (participants' responses were provided by pressing either the right or left side of the computer mouse); (d) after the response, the target and flankers were replaced by the central fixation cross (the time lapse between the onset of the target and the start time of the next trial was between 3,000 and 15,000 ms).

A session consisted of five blocks: one full-feedback practice block and four experimental blocks without feedback. Each experimental block consisted of 24 trials (4 cue conditions $\times$ 2 target locations $\times$ 3 flanker conditions). Trials were presented in random order.

The ANT allows for the identification of three attentional systems: alerting, orienting, and executive control. The alerting effect is calculated by subtracting the mean reaction time (RT) of the double cue condition from the no-cue conditions. The orienting effect is calculated by subtracting the mean RT of the spatial cue conditions from the mean RT of the

Table 1
Gender and Age Mean of the Portuguese and Spanish Samples

Country and sex	*n*	Mean age (*SE*)
Portugal		
Women	86	20.3 (.63)
Men	31	21.5 (.93)
Brazil		
Women	88	20.6 (.38)
Men	38	22.0 (.68)

center cue condition. Finally, the executive control (i.e., conflict monitoring) effect is calculated by subtracting the mean RT of all congruent flanking conditions from the mean RT of incongruent flanking conditions.

Thought identification task. After each block of the ANT, participants went through a thought identification task (TIT) requiring the identification of which type of thoughts (derived from Stawarczyk, Majerus, Maj, et al., 2011, classification) were predominant during the block by choosing one among the following four options: (a) on-task (OT) reports of task-related and stimulus-dependent experience, that is, the participant was completely focused on the task (i.e., cues and direction of the arrows); (b) task related interference (TRI), that is, the participant's thoughts were focused on side aspects of the task such as task duration, concerns about overall performance, and rumination over a mistake; (c) external distractions (EDs), that is, the participant was focused on stimuli from the current environment but not related to the experimental task, such as overall exteroceptive conditions (light, temperature) or interoceptive conditions (e.g., physical sensation, hunger, thirsty); (d) stimulus-independent and task-unrelated thoughts (SITUT), that is, the participant wandered through thoughts dissociated from either the task or the current exteroceptive or interoceptive conditions (e.g., past experience, future plans).

Resting State Questionnaire. After completing the ANT, all participants were asked to fill out an adapted version of the Resting State Questionnaire (ReSQ; Delamillieure et al., 2010) in which they were instructed to report the percentage of time spent on the following types of mental activity: focusing on the task (FT); visual mental imagery (IMAG); inner language (LANG); somatosensory awareness (SOMA); inner musical experience (MUSI); and mental processing of numbers (NUMB).

Procedure

After providing signed informed consent and before the experimental trials, participants underwent the following process: (a) received instructions about the overall procedure, (b) received instructions about the TIT (with examples and a quiz on the identification of the four types of thoughts), and (c) performed a practice block of the ANT–TIT procedure with full feedback. Immediately after completing the experimental trials, participants reported the percentage of thoughts experienced during the attention task by filling out the ReSQ.

Statistical Analysis

First, to rule out possible effects related to demographic characteristics, we used a chi-square to test differences for age and gender between Portuguese and Brazilian samples. Second, two-way mixed analyses of variance were used to test the differences between Portuguese and Brazilian samples for (a) type of thoughts (i.e., TIT) and (b) content of mind-wandering thoughts (i.e., ReSQ). In case sphericity was not met, Greenhouse-Geisser corrections were used. Second, to test the interaction between performance on the ANT (accuracy; RT; alert, orienting, and executive effects) type of thoughts (i.e., TIT) and country, we ran a linear mixed model for repeated measures with participants as a random factor, country (Brazil or Portugal) and TIT as fixed effects (analyzing main and interaction effects), and TIT also as a repeated factor (a heterogeneous first-order autoregressive model was used for covariance matrix). ANT network results (alert, orienting, and executive) were calculated based on correct responses after excluding trials with RTs less than 200 ms or higher than 1,200 ms (2.5% of total trials). Data were previously arranged in a stacked format, with one row for each TIT observation for the same participant, with corresponding accuracy, RT, and ANT network scores (alert, orienting, and executive). In the case of repeated TIT across experimental blocks, averaged accuracy, RT, and ANT effects were presented for each TIT. Finally, a Pearson correlation was used to test the relationship between mind-wandering categories (ReSQ) and efficiency in the attention network task for the Brazilian and Portuguese samples. To run the correlation analysis, we averaged ANT networks results across TIT categories to get a single result per participant. For all statistical tests, a confidence level of $\alpha = 5\%$ was adopted.

Results

Differences in the Type of Thoughts (TIT) Between Portuguese and Brazilian Samples

Both groups tended to be predominantly involved in task-related interference (TRI) thoughts during the attention task. Again, no significant differences were observed for the TIT in the two groups of participants, $F(2.82, 679.72) = .76$, $p = .52$; see Figure 1A).

Differences in the Content of Mind-Wandering Thoughts (ReSQ) Between Portuguese and Brazilian Samples

At the end of the task, both groups reported to have been predominantly out of focus ($M = 61.4\%$; against focusing on the task [FT], $M = 48.6\%$), experiencing mostly inner language thoughts (LANG, $M = 23.34\%$), followed by inner musical experience (MUSI, $M = 13.76\%$), somatosensory awareness (SOMA, $M = 11.22\%$), visual mental imagery (IMAG, $M = 11.20\%$), and last, mental processing of numbers (NUMB, $M = 3.31\%$). Again, no significant differences were found between the Portuguese and Brazilian participants for the content of mind-wandering thoughts, $F(3.83, 923.18) = 1.75$, $p = .12$; see Figure 1B).

Attention Network Task: Accuracy and Reaction Time

In terms of ANT accuracy, linear mixing model showed a main effect for TIT, $F(3, 260.05) = 5.92$, $p = .001$. Post hoc with Fisher's least significant difference (LSD) correction showed the following significant differences: OT > TRI ($p < .001$), OT > ED ($p = .002$), SITUT > TRI ($p = .04$), and SITUT > ED ($p = .009$), showing that both being focused on the task (OT) and being in a pure mind-wandering condition (stimulus-independent and task-unrelated thoughts [SITUT]) had a facilitating effect on task accuracy when compared with task-related interference or external distractions (see Table 2 and Figure 1).

Regarding ANT reaction time, there was a significant interaction between TIT and country, $F(3, 244.82) = 2.90$, $p = .04$. Post hoc with Fisher's LSD correction showed significant decreases in RT between TRI and all other TIT conditions for only the Portuguese cohort: TRI < OT ($p = .01$), TRI < ED ($p = .01$), TRI < SITUT ($p = .03$). That is, although the Portuguese and Brazilians seemed to perform similarly (in terms of RT), only the Portuguese had a significantly facilitating effect in reaction

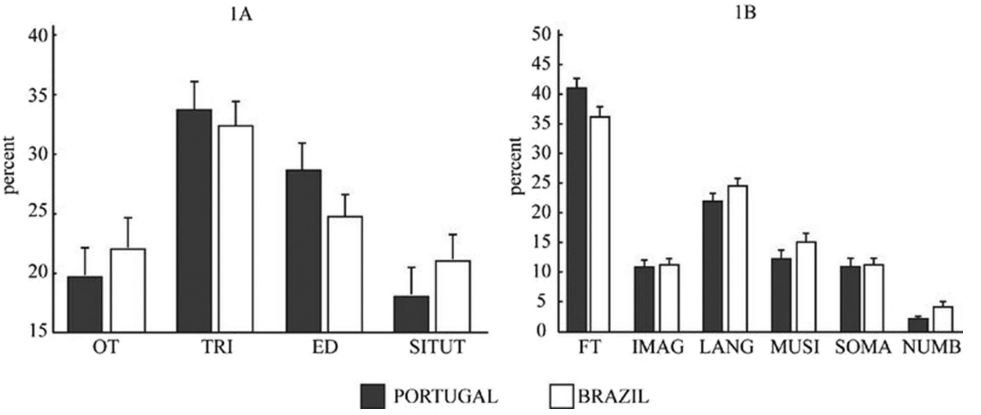

Figure 1. Differences between the Portuguese and Brazilian samples for the thought identification task (Panel 1A) and the Resting State Questionnaire (Panel 1B). Error bars indicate standard error of the means. OT = on-task thoughts; TRI = task-related interference thoughts; ED = external distractors; SITUT = stimulus-independent and task-unrelated thoughts; FT = focusing on task; IMAG = visual imagery; LANG = inner language; SOMA = somatosensory awareness; MUSI: inner musical experience; NUMB = mental processing of numbers.

Table 2
Estimated Accuracy (ACC), Reaction Time (RT), and ANT Networks Associated With TIT in Portuguese and Brazilian Participants

Country and TIT	ACC (%)	RT (ms)	ANT network (ms)		
			Alert	Orient	Exec
Portugal					
OT	96.1 (.7)	662.2 (10.8)	38.3 (7.5)	54.5 (8.5)	155.7 (9.3)
TRI	94.3 (.7)	641.0 (9.6)	23.9 (6.4)	28.7 (7.2)	156.4 (7.7)
ED	94.0 (.8)	660.6 (10.9)	27.2 (7.8)	35.7 (7.3)	152.8 (8.2)
SITUT	95.0 (.8)	668.1 (14.4)	36.4 (8.3)	46.5 (10.4)	115.5 (10.7)
Brazil					
OT	96.48 (.7)	633.6 (10.4)	16.0 (7.3)	36.4 (8.3)	140.9 (8.9)
TRI	94.92 (.7)	642.2 (9.2)	35.6 (6.1)	18.5 (6.8)	140.4 (7.3)
ED	94.87 (.8)	645.7 (10.6)	41.5 (7.7)	24.5 (7.2)	131.7 (8.0)
SITUT	96.41 (.7)	643.3 (12.9)	33.2 (7.0)	21.0 (8.7)	136.8 (9.1)

Note. Data in parentheses are standard errors. TIT = type of thoughts; ANT = attention network task; alert = altering; orient = orienting; exec = executive; OT = on-task thoughts; TRI = task-related interference thoughts; ED = external distractions; SITUT = stimulus-independent and task-unrelated thoughts.

time associated with task-interfering thoughts (see Table 2 and Figure 1).

Attention Network Task: Network Effects

Alerting network. For the alert network there was a significant interaction between country and TIT, $F(3, 228.42) = 2.67$, $p = .05$. Post hoc with Fisher's LSD showed the following significant differences: OT $<$ TRI ($p = .04$) and OT $<$ ED ($p = .02$) but for only the Brazilian sample; the Portuguese cohort had a significant facilitative effect of OT when compared with the Brazilian cohort ($p = .04$; see Table 2 and Figure 1).

Orienting network. For the orienting network there were significant main effects for country, $F(1, 290.68) = 7.52$, $p = .006$, and TIT, $F(3, 203.88) = 2.86$, $p = .04$. Post hoc with Fisher's LSD correction for TIT effect showed a significant difference between the OT $>$ TRI ($p = .004$) and OT $>$ ED ($p = .05$) conditions. Additionally, the Portuguese had a significantly increased score on the orientation network effects, independent of TIT (see Table 2 and Figure 1).

Executive component. Two participants were excluded from the analysis because they missed all the incongruent targets. We found a significant interaction between country and TIT, $F(3, 220.56) = 2.63$, $p = .05$. Fisher's LSD post hoc showed that SITUT is associated with a decreased interference when compared with all other TIT conditions ($p < .1$) but for only the Portuguese sample (see Table 2 and Figure 2).

Correlation Between Mind Wandering (ReSQ) and Attention Networks (ANT) in the Portuguese and Brazilian Samples

As shown in Table 3, we found a significant negative correlation only between the SOMA and alert component for the Portuguese sample, $r(116) = -.20$, $p = .03$.

Discussion

The objective of this study was to look at two population cohorts belonging to different cultures—Brazil (South American culture) and Portugal (southern European culture)—and compare type of thoughts and content of mind wandering during the performance of an attention task. Overall, no statistically significant differences were found between the Brazilian and Portuguese participants in terms of type of thoughts and content of MW. Consistent with a previous study by Gonçalves et al. (2017), both groups reported being mostly involved in task-related interference thoughts during the attention network task. At the end of the task, both groups reported to have been predominantly out of focus, with inner language thoughts.

The finding that our participants were focused on side aspects of the task is partially

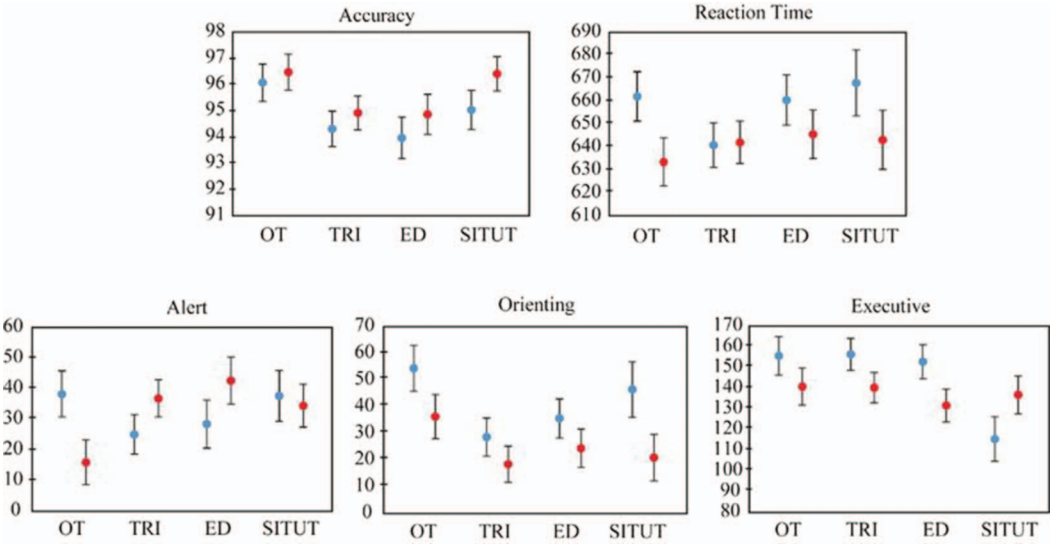

Figure 2. Interactions between country and the thought identification task in the attention network task performance for the Portuguese sample (lighter gray circles; blue in the online figure) and the Brazilian sample (darker gray circles; red in the online figure). Error bars indicate standard error of the means. OT = on-task thoughts; TRI = task-related interference thoughts; ED = external distractors; SITUT = stimulus-independent and task-unrelated thoughts; alert = alerting. See the online article for the color version of this figure.

consistent with Sude's (2015) findings. Sude's study reported that Canadian students from a European heritage showed increased levels of task-interference thoughts. Even though we used different methods to analyze the type of thoughts, one can speculate that the thought profile of our samples seems to be more in line with the findings for European-heritage culture. This seems to make sense given the fact that one of our cohorts was European (i.e., Portugal), whereas the other was mostly from European-heritage individuals.

Table 3
Pearson Correlations Between Content of Mind Wandering (ReSQ) and Attention Networks by Participant Group (Portugal and Brazil)

Content type	Portugal			Brazil		
	Alert	Orient	Exec	Alert	Orient	Exec
FT	.04	.10	.02	−.04	.12	−.08
IMAG	.01	−.07	−.10	.08	−.01	−.03
LANG	.09	.11	.08	.09	.06	.08
MUSI	.02	−.12	.06	−.08	−.14	.08
SOMA	−.20*	−.06	−.16	.12	.07	−.09
NUMB	−.06	−.14	.13	−.01	−.09	−.05

Note. ReSQ = Resting State Questionnaire; alert = alerting; orient = orienting; exec = executive; FT = focused on the task; IMAG = visual mental imagery; LANG = inner language; MUSI = inner musical experience; SOMA = somatosensory awareness; NUMB = mental processing of numbers.
* $p < .05$.

Additionally, the content of MW thoughts was similar in the Portuguese and Brazilian participants, with the predominance of inner language thoughts. In other words, our participants, independent of the culture, seemed to have been involved in "word games" without overt language production. Our data contrast with the findings from Delamillieure et al. (2010) showing that, in a European sample, individuals seem to be mostly involved in mental imagery. However, their study inquired about MW content in a task-free situation (i.e., 8-min resting state task during functional magnetic resonance imaging [fMRI]). Thus, it is possible that these different situational demands (attention task vs. resting task) may have induced a different profile of MW thoughts.

Despite the similarities between the Brazilian and Portuguese participants in the results just discussed, the type and content of MW was

associated with performance in the attention task differently for each group. First, for both cohorts being focused on the task (OT) or being in a pure mind-wandering condition (SITUT) had a facilitating effect on task accuracy when compared with task-related interference or external distractions. This is consistent with the results of other studies showing a significant positive correlation between OT and attention accuracy (e.g., Stawarczyk, Majerus, Maj, et al., 2011). This is also consistent with a previous study by Gonçalves et al. (2017) showing that task-related interference thoughts and external distractors, when compared with mind wandering and on-task thoughts, significantly impaired performance in the attention task. However, and contrary to Stawarczyk, Majerus, Maj, et al. (2011), in our study, SITUT, being in the most pure mind-wandering condition (–i.e., thoughts dissociated from either the task or current exteroceptive or interoceptive stimuli) was found to facilitate performance accuracy in the ANT. Research has shown that mind wandering can have a facilitative effect on certain executive functions but not in others (Kam & Handy, 2014) and that mind wandering can have a facilitative effect in nondemanding tasks for participants with good executive resources (Smallwood & Schooler, 2015). However, one cannot rule out the alternative interpretation that the differences between our findings and those reported by Stawarczyk, Majerus, Maj, et al. (2011) may be due to the different thought-probe strategies. Here we used a strategy introduced in Gonçalves et al. (2017) in which thought probes were presented online during the course of the ANT experiment (real time) but at the end of each ANT block (retrospective probing). This mix of real-time and retrospective strategy thought probe, however, imposes an increased load on episodic memory and may have impacted the reliability of the probe task as well as attention performance in subsequent trials. Future studies should test the same paradigm using pseudorandom probes or, alternatively, experimentally inducing specific types of interfering thoughts.

However, in terms of reaction time, although the Portuguese and Brazilians seemed to perform similarly, only the Portuguese had a significantly facilitating effect in RT associated with task-related interference (TRI) thoughts. This is an intriguing finding because one may expect that thoughts focused on side aspects of the task such as task duration, concerns about overall performance, or rumination over a mistake may have reaction time costs rather than benefits. However, previous studies have shown that the RT costs of TRI are less dramatic than are those expected for ED or SITUT (Stawarczyk et al., 2014; Stawarczyk, Majerus, Maj, et al., 2011). A possible explanation may be that, in participants more prone to worrying, TRI may decrease RT costs. In effect, a study by Pacheco-Unguetti, Acosta, Callejas, and Lupiáñez (2010) showed that the induction of anxiety mood has a facilitative effect on ANT's RT. Additionally, a recent study by Forster, Nunez Elizalde, Castle, and Bishop (2015) suggested that the association between worry and TRI may be responsible for an increased interaction between brain regions associated with executive functioning (e.g., dorsolateral prefrontal cortex) and mind wandering (e.g., default mode network). This may explain the potential RT benefits of TRI in individuals prone to worrying and TRI. It is possible that the Portuguese participants were more prone to increase state anxiety and worry in the ANT task, with the consequent benefit in RT, particularly for tasks with high accuracy performance (RT was computed for only correct responses). To further test this hypothesis, futures studies should control for anxiety and worry levels.

Regarding the interaction effects between country and TIT in the three different attention networks, several results are worth mentioning here. First, in the process of reaching and maintaining a state of response to external stimuli (i.e., alerting effect), the Portuguese participants, when compared with the Brazilians, benefited significantly more from on-task thoughts. Additionally, there was a significant increase in the orientation network effects, independent of TIT, in the Portuguese participants. Finally, also in the Portuguese sample, SITUT was associated with a decrease in attentional conflict when compared with all other TIT conditions. Summing up, although the profile of TIT and overall performance in the ANT seemed to be similar in the Portuguese and Brazilian participants, the Portuguese participants tended to have increased orientation effects independent of the TIT, along with increased alerting effects when their thoughts were focused on the task, and a reduction in attention conflict (i.e., executive

effect) when their thoughts were stimulus-independent and task-unrelated (SITUT). Stated simply, when compared with the Brazilians, the Portuguese participants seemed to be more sensitive to orientation cues in all thought conditions, benefited more from alerting cues when they reported on-task thoughts, and took better advantage of mind wandering to reduce attentional conflict. Despite the facilitative effects of mind wandering in the executive ANT network, when mind wandering was characterized by thoughts of somatosensory awareness, there was a negative impact in the alert ANT network.

As stated before, although several studies have shown that both mind wandering and attention are influenced by culture, we are not aware of any studies on the interference between mind wandering and attention across cultures. We had hypothesized less interference between mind wandering and attention in the Brazilian cohort based on anecdotal reports of a more holistic cognitive style and wider attentional scope. Contrary to our hypothesis, although no significant differences were found in terms of TIT and content of mind wandering, in only the Portuguese sample mind wandering was found to reduce attention conflict effect in the ANT (i.e., executive effect). Only when Portuguese participants focused on a particular sensory aspect of the body (SOMA) was there a negative impact in the individuals' ability to take advantage of alerting cues in the ANT. It is possible that the Portuguese and Brazilian cohorts differed in terms of other cognitive variables that were found to mediate the relationship between mind wandering and attention. There is now evidence suggesting a complex interaction between different types of mind-wandering thoughts (e.g., ED, TRI, SITUT), type of task (e.g., inhibitory control, set-shifting), cognitive abilities (e.g., working memory, fluid intelligence), and contexts (e.g., silent vs. noisy environments; Robison, Gath, & Unsworth, 2017). Future studies should control for some of those cognitive variables while manipulating type of attention task and environmental contexts.

In conclusion, the present study did not find differences between the Brazilian and Portuguese participants in terms of type of thoughts and MW content. Both groups tended to be predominantly involved in task-related interference thoughts during the attention task. At the end of the task, both groups reported having been predominantly out of focus, dominated mostly by inner language thoughts. Despite the similarities, type of thoughts and content of MW seemed to affect performance in the attention task differently in each group. First, and regarding overall ANT performance, only the Portuguese had a significantly facilitating effect in reaction time associated with task-interfering thoughts. Second, in terms of ANT networks, when compared with the Brazilians, the Portuguese participants seemed to be more sensitive to orientation cues in all thought conditions, benefited more from alerting cues when they reported on-task thoughts, and took better advantage of mind wandering to reduce attentional conflict.

As a final note, it is possible that confounders may have influenced the present results. Although our study did not find differences between the Portuguese and Brazilian samples regarding gender, age, and education, other potential influencing variables were left out (e.g., cognitive variables, personality, college major). To tease apart the relative contributions of these variables, we suggest future studies control for variables such as culture, college major, personality traits, working memory, and executive functioning.

References

Alexander Diaz, B., Van Der Sluis, S., Benjamins, J. S., Stoffers, D., Hardstone, R., Mansvelder, H. D., . . . Linkenkaer-Hansen, K. (2014). The ARSQ 2.0 reveals age and personality effects on mind-wandering experiences. *Frontiers in Psychology, 5,* 271. http://dx.doi.org/10.3389/fpsyg.2014.00271

Amer, T., Ngo, K. W. J., & Hasher, L. (2017). Cultural differences in visual attention: Implications for distraction processing. *British Journal of Psychology, 108,* 244–258. http://dx.doi.org/10.1111/bjop.12194

Christoff, K., Gordon, A. M., Smallwood, J., Smith, R., & Schooler, J. W. (2009). Experience sampling during fMRI reveals default network and executive system contributions to mind wandering. *PNAS: Proceedings of the National Academy of Sciences of the United States of America, 106,* 8719–8724. http://dx.doi.org/10.1073/pnas.0900234106

Corballis, M. C. (2013). Wandering tales: Evolutionary origins of mental time travel and language.

Frontiers in Psychology, 4, 485. http://dx.doi.org/10.3389/fpsyg.2013.00485

Declaration of Helsinki. (2013). *Ethical Principles for Medical Research Involving Human Subjects*. Available at http://www.wma.net/en/30publications/10policies/b3/

Delamillieure, P., Doucet, G., Mazoyer, B., Turbelin, M. R., Delcroix, N., Mellet, E., . . . Joliot, M. (2010). The Resting State Questionnaire: An introspective questionnaire for evaluation of inner experience during the conscious resting state. *Brain Research Bulletin, 81,* 565–573. http://dx.doi.org/10.1016/j.brainresbull.2009.11.014

Forster, S., Nunez Elizalde, A. O., Castle, E., & Bishop, S. J. (2015). Unraveling the anxious mind: Anxiety, worry, and frontal engagement in sustained attention versus off-task processing. *Cerebral Cortex, 25,* 609–618. http://dx.doi.org/10.1093/cercor/bht248

Gonçalves, Ó. F., Rêgo, G., Oliveira-Silva, P., Leite, J., Carvalho, S., Fregni, F., . . . Boggio, P. S. (2017). Mind wandering and the attention network system. *Acta Psychologica, 172,* 49–54. http://dx.doi.org/10.1016/j.actpsy.2016.11.008

Hu, N., He, S., & Xu, B. (2012). Different efficiencies of attentional orienting in different wandering minds. *Consciousness and Cognition, 21,* 139–148. http://dx.doi.org/10.1016/j.concog.2011.12.007

Kam, J. W. Y., & Handy, T. C. (2014). Differential recruitment of executive resources during mind wandering. *Consciousness and Cognition, 26,* 51–63. http://dx.doi.org/10.1016/j.concog.2014.03.002

Kane, M. J., & McVay, J. C. (2012). What mind wandering reveals about executive-control abilities and failures. *Current Directions in Psychological Science, 21,* 348–354. http://dx.doi.org/10.1177/0963721412454875

McVay, J. C., Unsworth, N., McMillan, B. D., & Kane, M. J. (2013). Working memory capacity does not always support future-oriented mind-wandering. *Canadian Journal of Experimental Psychology, 67,* 41–50. http://dx.doi.org/10.1037/a0031252

Nisbett, R. E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. *Trends in Cognitive Sciences, 9,* 467–473. http://dx.doi.org/10.1016/j.tics.2005.08.004

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., & Lupiáñez, J. (2010). Attention and anxiety: Different attentional functioning under state and trait anxiety. *Psychological Science, 21,* 298–304. http://dx.doi.org/10.1177/0956797609359624

Peterson, S. E., & Posner, M. I. (2012). The attention system of the human brain: 20 years later. *Annual Review of Neuroscience, 35,* 73–89. http://dx.doi.org/10.1146/annurev-neuro-062111-150525

Robison, M. K., Gath, K. I., & Unsworth, N. (2017). The neurotic wandering mind: An individual differences investigation of neuroticism, mind-wandering, and executive control. *Quarterly Journal of Experimental Psychology, 70,* 649–663. http://dx.doi.org/10.1080/17470218.2016.1145706

Robison, M. K., & Unsworth, N. (2015). Working memory capacity offers resistance to mind-wandering and external distraction in a context-specific manner. *Applied Cognitive Psychology, 29,* 680–690. http://dx.doi.org/10.1002/acp.3150

Schneider, W., Eschman, A., & Zuccolotto, A. (2012). *E-Prime Reference Guide*. Pittsburgh, PA: Psychology Software Tools, Inc.

Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences, 15,* 319–326.

Seli, P., & Purdon, C. L. (2017). Intrusive thoughts: Linking spontaneous mind wandering and OCD symptomatology. *Psychological Research, 81,* 392–398. http://dx.doi.org/10.1007/s00426-016-0756-3

Seli, P., Risko, E. F., & Smilek, D. (2016). Assessing the associations among trait and state levels of deliberate and spontaneous mind wandering. *Consciousness and Cognition, 41,* 50–56. http://dx.doi.org/10.1016/j.concog.2016.02.002

Smallwood, J., Nind, L., & O'Connor, R. C. (2009). When is your head at? An exploration of the factors associated with the temporal focus of the wandering mind. *Consciousness and Cognition, 18,* 118–125. http://dx.doi.org/10.1016/j.concog.2008.11.004

Smallwood, J., & Schooler, J. W. (2006). The restless mind. *Psychological Bulletin, 132,* 946–958. http://dx.doi.org/10.1037/0033-2909.132.6.946

Smallwood, J., & Schooler, J. W. (2015). The science of mind wandering: Empirically navigating the stream of consciousness. *Annual Review of Psychology, 66,* 487–518. http://dx.doi.org/10.1146/annurev-psych-010814-015331

Song, X., & Wang, X. (2012). Mind wandering in Chinese daily lives—An experience sampling study. *PLoS ONE, 7*(9), e44423. http://dx.doi.org/10.1371/journal.pone.0044423

Stawarczyk, D., Majerus, S., Catale, C., & D'Argembeau, A. (2014). Relationships between mind-wandering and attentional control abilities in young adults and adolescents. *Acta Psychologica, 148,* 25–36. http://dx.doi.org/10.1016/j.actpsy.2014.01.007

Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., & D'Argembeau, A. (2011). Mind-wandering: Phenomenology and function as assessed with a novel experience sampling method.

Acta Psychologica, 136, 370–381. http://dx.doi.org/10.1016/j.actpsy.2011.01.002

Stawarczyk, D., Majerus, S., Maquet, P., & D'Argembeau, A. (2011). Neural correlates of ongoing conscious experience: Both task-unrelatedness and stimulus-independence are related to default network activity. *PLoS ONE, 6*(2), e16997. http://dx.doi.org/10.1371/journal.pone.0016997

Sude, D. J. (2015). *Culture influences rates of mind wandering* (Master's thesis). Retrieved from https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0166604

Tran, C. D., Arredondo, M. M., & Yoshida, H. (2015). Differential effects of bilingualism and culture on early attention: A longitudinal study in the U.S., Argentina, and Vietnam. *Frontiers in Psychology, 6,* 795. http://journal.frontiersin.org/article/10.3389/fpsyg.2015.00795

Unsworth, N., & McMillan, B. D. (2014). Similarities and differences between mind-wandering and external distraction: A latent variable analysis of lapses of attention and their relation to cognitive abilities. *Acta Psychologica, 150,* 14–25. http://dx.doi.org/10.1016/j.actpsy.2014.04.001

Received December 19, 2016
Revision received February 22, 2017
Accepted March 29, 2017 ■