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Manipulating cues in mind wandering:

Verbal cues affect the frequency and the temporal focus of mind wandering

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Abstract

Our understanding of mind wandering (MW) has dramatically increased over the past decade. A key challenge still facing research is the identification of the processes and events that directly cause and control its occurrence. In the present study we sought to shed light on this question, by investigating the effects of verbal cues on the frequency and temporal focus of MW. To this aim, we experimentally manipulated the presence of irrelevant verbal cues during a vigilance task, in two independent groups (Verbal-cues group *vs.* No-cues group).

We found that compared to the No-cues group, the Verbal-cues group reported a higher amount of MW, mostly triggered by the irrelevant cue-words, and a higher proportion of past-oriented MW compared to the other temporal orientations. These results demonstrate that task-irrelevant verbal stimulation increases the frequency of MW and steers its temporal orientation toward the past. Implications for the research on MW are discussed.

Keywords: mind wandering; task-unrelated thoughts; involuntary autobiographical memories; verbal cues; temporal orientation; retrospective bias

1. Introduction

While reading a book, driving the car, or attending a class, there may be moments when our attention drifts away from an ongoing task toward internal thoughts whose content is unrelated to the task, like memories or prospective thoughts. We refer to this "shift of attention away from a primary task toward internal information" (Smallwood & Schooler, 2006, p. 946) as mind wandering (MW).

Converging evidence suggests that MW is a ubiquitous and pervasive mental activity, common across different cultures and groups (see for a review, Smallwood & Schooler, 2015). Experience sampling studies have indeed shown that people spend between 25% and 50% of their daytime engaged in MW (Kane et al., 2007; Killingsworth & Gilbert, 2010), and the frequency of MW might even increase during well-practiced tasks (e.g., driving, reading) (Mason et al., 2007).

First studied by a handful of researchers almost fifty years ago (Antrobus, Singer, & Greenberg, 1966; Klinger, 1971; Singer, 1966), in the past decade MW has received a widespread scientific attention in both psychology and neuroscience (Christoff, Irving, Fox, Spreng, & Andrews-Hanna, 2016). In particular, research on MW greatly benefited from the adoption of the "strategy of triangulation" (Smallwood & Schooler, 2015), whereby self-reports, behavioral measures, and physiological measures are combined together, to make inferences about covert mental experiences.

What still remains unclear, though, is the neurocognitive mechanism by which MW arises and unfolds over time, that is *why* and *how* the mind wanders. As argued by Smallwood (2013), any comprehensive account of MW is expected to address and explain the process of the *initial occurrence* of MW as well as its *maintenance-continuity* over time (i.e., the process-occurrence framework; Smallwood, 2013). One of the reasons for the inability to determine the onset of MW is the difficulty in causally linking MW to a preceding event that triggers the onset of MW (i.e., imperative stimulus; Smallwood, 2013). In the MW literature MW episodes have been mainly described as self-generated (e.g., Smallwood, 2013) and stimulus-independent (Antrobus, 1968), terms that emphasize their independence from external stimuli and ongoing actions.

However, during the last few years, empirical evidence has been reported suggesting for a role of external stimuli in MW (McVay & Kane, 2013; Plimpton, Patel, & Kvavilashvili, 2015; Song & Wang, 2012). For example, in the experience sampling study by Song and Wang (2012), in most MW samples (88%) participants could report the trigger for the MW and nearly a half was reported to be associated with internal (49%) and half with external (51%) cues.

An important contribution to addressing the question of the onset of MW and its cue-dependent nature has been recently provided by the related research field on involuntary autobiographical memories (IAMs). IAMs are memories of personal events that come to mind spontaneously, without any deliberate attempt to retrieve them (Berntsen, 1996, 1998, 2009; Kvavilashvili & Mandler, 2004; Mace, 2004, 2005). Crucially, IAMs share similar features with MW (Johannessen & Berntsen, 2010; Marchetti, Koster, Klinger, & Alloy, 2016), as studies have highlighted that these memories are more likely when one is engaged in undemanding activities that require little attention and concentration (Berntsen & Hall, 2004; Kvavilashvili & Mandler, 2004). It is also noteworthy that IAMs are largely elicited by easily identifiable external cues (e.g., Berntsen, 1996; Berntsen & Hall, 2004; Mace, 2004), generally related to prominent aspects of the remembered experiences (e.g., Berntsen, 1996; Berntsen & Hall, 2004). Direct comparisons between IAMs and involuntary future thoughts revealed for both kinds of involuntary cognitions clearly identifiable triggers but IAMs were more likely to be triggered by environmental cues compared to the future thoughts (e.g., Berntsen & Jacobsen, 2008).

In one of the most successful paradigms, developed by Schlagman and Kvavilashvili (2008) to assess IAMs in a laboratory setting, participants are exposed to a long sequence of trials of mostly horizontal lines and have to detect an occasional target (i.e., vertical lines), while being simultaneously exposed to irrelevant cue-words, presented in the center of each slide (i.e., 'relaxing on a beach' or 'crossing the street'). To assess the frequency of IAMs, both self-caught (Schlagman & Kvavilashvili, 2008) or probe-caught (Vannucci, Batool, Pelagatti, & Mazzoni, 2014) procedures have been used in the studies. This paradigm elicits a fair amount of IAMs, the majority of which (85% in the original study) are reported as being triggered by the word-cues on the screen.

Recently, Plimpton et al. (2015) used a modified version of this paradigm, originally developed for studying IAMs, to investigate the association between external cues and the frequency and temporal orientation of task-unrelated thoughts (TUTs). In the study, participants were stopped 11 times during the vigilance task and recorded their thoughts at that moment. The results revealed that the majority of reported TUTs (86%) had an identifiable external trigger, and, in most cases (85%), the trigger was one of the verbal cues appearing on the screen. As for the temporal orientation of TUTs, the frequency of past-focused thoughts was significantly higher than future and current thoughts. The cue emotional valence interacted with the temporality of the thoughts, with negative cues being more likely to elicit past thoughts, while positive cues being more likely to elicit future thoughts.

These findings suggest that both the frequency and the temporal focus of TUTs may be function of the external context, rather than being completely self-generated. Nevertheless, a few caveats are warranted. First, given the absence of a direct experimental manipulation of the presence of verbal cues, it is not possible to conclude that the presence of verbal cues was the direct *cause* of the occurrence of TUTs and the steering of their temporal focus toward the past. Moreover, in the study by Plimpton et al. (2015), the authors primarily referred to TUTs as a category comprising both mind wandering and external distractions (EDs), while previous taxonomies (i.e., Robison & Unsworth, 2015; Stawarczyk, Majerus, Maj, Van der Linden, & D'Argembeau, 2011; Unsworth & Robison, 2016) and empirical evidence (i.e., Unsworth & McMillan, 2014) suggested differential effects for these two phenomena.

In the present study, we aimed to capitalize on these recent promising findings, by experimentally investigating the *causal* role of verbal cues in triggering and shaping MW. We did so, by addressing two major questions: First, does exposure to task-irrelevant verbal information directly trigger MW during a vigilance task? If so, we should find a higher frequency of MW during a vigilance task with verbal cues compared to an identical vigilance task with no verbal cues. This question mirrors the current research agenda on spontaneous thought that underlines the crucial importance of tracking the onset of each single MW episode (i.e., "*why*"), rather than simply ascertaining its presence or absence (Smallwood, 2013).

Second, does the exposure to verbal information influence the temporal orientation of MW and, specifically, increase past-oriented MW? The indirect evidence we reviewed above would suggest that the exposure to verbal information stimulate the mind to wander toward the past, compared to an identical condition with no verbal information presented. However, so far, no studies investigated whether the exposure to verbal information might systematically affect the temporal orientation of MW.

To address these two questions, in the context of a *between-subject* design, we experimentally manipulated the presence of verbal cues during the vigilance task in two independent groups, “Verbal-cues” group and “No-cues” group respectively. Since evidence has been reported for negative verbal cues being more likely to trigger past memories and positive verbal cues to trigger thoughts about the future (Plimpton et al., 2015), to avoid any bias in favour of a specific temporal focus of MW, all the verbal cues employed in the present study had been previously evaluated as emotionally neutral and a-temporal (see Methods).

In the study, a self-catching procedure was used, thereby instructing participants to report the occurrence of any spontaneous mental content not directly related to the task at hand. In line with the taxonomy proposed by Stawarczyk and colleagues (2011), we distinguished TUTs in external distractions (ED) and mind wandering (MW) episodes, as these two phenomena were shown to have partially distinct associations with attentional control and working memory (Unsworth & McMillan, 2014). To our knowledge, it is still unknown whether task-irrelevant verbal cues might have differential effects on the frequency of MW and ED. Given the association reported in the literature between past-oriented MW and negative mood (e.g., Poerio, Totterdell, & Miles, 2013; Smallwood & O’Connor, 2011), positive and negative affect were measured (through the Positive and Negative Affect Schedule, PANAS) at the beginning of the experimental session. Finally, phenomenological information on each reported thought was acquired.

2. **Method**

2.1.Participants

Sixty-two undergraduate students from the University of Florence (48 females, age range 18–29, *M* = 21.76 years) volunteered to participate in our study. All participants were Italian native speakers and they had normal or corrected-to-normal vision. Half were randomly assigned to the Verbal-cues condition (n = 31) and the other half to the No-cues condition (n = 31). Groups did not significantly differ in age, gender, and depressive symptoms (assessed by the Beck Depression Inventory-II; Beck, Steer, & Brown, 1996; Italian adaptation in Ghisi, Flebus, Montano, Sanavio, & Sica, 2006)

2.2.Materials

Vigilance task. Participants completed a modified version of the computer-based vigilance task developed by Schlagman and Kvavilashvili (2008) and already used in previous studies (Barzykowski & Niedźwieńska, 2016; Vannucci et al., 2014; Vannucci, Pelagatti, Hanczakowski, Mazzoni, & Rossi Paccani, 2015). The task consisted of 600 trials, presented in a fixed order, each remaining on the screen for 1.5 sec. In each trial an image (approximately 21.5 cm x 12.5 cm in size) was shown depicting either a pattern of black horizontal (non-target stimuli) or black vertical lines (target stimuli). Target stimuli appeared on 12 trials, with a minimum of 42 and a maximum of 59 trials between each target. In the Verbal-cues condition, cue words (e.g., “stainless steel”, “long hair”, “paper bag”) in 18-CPI Arial font were shown in the middle of the image on 108 (18%) trials. The words that served as cues were selected from the pool of 800 word-phrases developed by Schlagman and Kvavilashvili (2008) and adapted to the Italian sample (for more details on the Italian adaptation, see Vannucci et al., 2015). Temporally-oriented word-phrases (e.g., “old family photos”, “forgotten appointment”) were not included in the sample and, when necessary, the words were slightly modified to make them emotionally neutral (e.g., “jealous behaviour“ was replaced by “behaviour”). Moreover, to verify that the selected cues were actually neutral and a-temporal we asked eight independent judges to evaluate for each word the emotional valence (positive, negative or neutral) and the temporal focus, that is whether the word was commonly used in daily life and linked to a specific temporal orientation (i.e., past, present, future), more than one (i.e., mixed), or to no specific temporal orientation (i.e., a-temporal). Only the words evaluated as neutral and a-temporal by at least 6 out of 8 judges (i.e., 75%) were selected for the study.

Thought questionnaire: After completing the vigilance task, participants provided details of their mental contents on a questionnaire. First, they were asked to indicate the temporal orientation of each mental content, distinguishing among “past”, “present”, “future”, and “a-temporal”. Participants were told that an “a-temporal” mental content refers to every thought with no specific temporal orientation (i.e., *I am a very anxious person; I like very much eating pizza*) whereas a “present” mental content refers to every thought related either to something occurring here and now (i.e., *I miss my dog, that is now with my boyfriend*) or to something occurring in the current period of life (i.e., *I don’t get along with my mother in this period*). Moreover, they were asked to specify for each event (i) whether it was general or specific and (ii) whether it was self-related or not. At the end of this short questionnaire they were also asked to rate on a 5-point scale their overall level of concentration (1 = not at all concentrated; 5 = fully concentrated) and boredom (1 = not at all; 5 = very bored) experienced during the task.

Mood questionnaires: At the beginning of the experimental session, participants were asked to complete the Positive and Negative Affect Schedule - State (PANAS; Watson, Clark, & Tellegen, 1988; Italian adaptation in Terracciano, McCrae, & Costa, 2003). The Positive and Negative Affect Schedule consists of two 10-item self-report scales, one measuring positive affect (i.e., excited, inspired) and the other one measuring negative affect (i.e., upset, irritable). Each item is rated on a 5-point Likert scale (ranging from 1 = very slightly or not at all, to 5 = extremely), and it measures the extent to which each mood state has been experienced during a specified time frame. In the study participants filled out the PANAS form with “the present moment” instructions.

2.3.Procedure

Participants were tested individually. After being welcomed into the laboratory, participants were briefly introduced to the research project, presented as a study examining concentration and its correlates, and they were asked to complete the PANAS. Once this was completed, they received the instructions for the vigilance task. In this task they were asked to detect target stimuli (vertical lines) among a large number of non-target stimuli (horizontal lines), by saying “yes” out loud each time they detected a target stimulus. Participants in the Verbal-cues condition were also told that they would see words in some of the trials. They were told that they were not supposed to do anything with these words. It was explained that the condition they were taking part in was looking at how people could keep their concentration on the patterns and that in another condition participants would have to concentrate on the words. Participants were informed that the task was quite monotonous and that task-unrelated mental contents (e.g., thoughts, plans, considerations, past events, images, etc.) could pop into their mind spontaneously during the task. If something came to their mind during the vigilance task, they should click the mouse to interrupt the presentation and write a brief description of the mental content and to indicate whether it was triggered by internal thoughts, an element in the environment, a word on the screen (for the Verbal-cues group only; participants were asked to specify the word) or no cue. This initial description should be sufficient for them to identify the mental content at a later point in time, if necessary. After the instructions, participants were given a short practice of the vigilance task. As in the experimental session, they were allowed to stop the presentation if they had any task-unrelated thoughts. When the vigilance task was over, they were presented with the brief descriptions of their mental contents and asked to complete a brief questionnaire (thought questionnaire). The total session lasted from approximately 60 to 75 min.

3. Results

3.1. Performance on vigilance task

All 62 participants successfully completed the vigilance task. Only one participant (in the No-cues group) reported a mistake (omission). There were no significant differences between the two groups with respect to the level of concentration experienced during the task (p = .64, d = 0.12), but the No-cues group reported higher levels of boredom compared to the Verbal-cues group (p = .008, d = 0.70) (see Table 1).

3.2. Mood

All participants completed the Positive and Negative Affect Schedule (PANAS) at the beginning of the experimental session. The two groups did not significantly differ in either Positive (p = .96, d = 0.01) or Negative Affect Schedule (p = .48, d = 0.18) (see Table 1).

3.3. The role of verbal cues in mind-wandering

Before conducting the data analyses on the mental contents, all thoughts recorded by participants were independently coded by the authors as either task-related or task-unrelated. Task-related contents consisted of any reference to some task features or to the participant's overall performance (i.e., thoughts about the experiment's duration or the number of target stimuli successfully detected), whereas task-unrelated mental contents did not include references to the task at hand (see Plimpton et al., 2015) and included "external distraction" (ED) and "mind wandering" (MW) (see Stawarczyk et al., 2011; Stawarczyk, Majerus, Catale, & D' Argembeau, 2014).

Task-unrelated mental contents were coded as ED, when the participant's attention was focused on stimuli that were present in the current environment but unrelated to the task at hand. This category comprised all thoughts whose content was focused on current sensory perceptions unrelated to the task, with the origin of these perceptions being either external or internal (i.e., bodily sensations). Task-unrelated mental contents were coded as MW when participants had their attention decoupled from the current environment and they were experiencing thoughts unrelated to the task at hand. The MW episodes may have been triggered by external or internal cues. For both categorizations, inter-rater reliability between the coders was very good (categorization of task-related *vs*. task-unrelated contents, *Kappa* = .93, *SE* = .02; categorization of MW *vs*. ED reports, *Kappa* = .91, *SE* = .03) and minor disagreements were solved by discussion. Of the 62 participants, one outlier (in the Verbal-cues group) was excluded from the analyses because of the very high frequency with which reported MW episodes.

Sixty-one participants reported a total of 444 mental contents, 77 were classed as task-related (*M* = 1.26, *SD* = 1.40 per participant) and 367 as task-unrelated mental contents (*M* = 6.02, *SD* = 4.79). Out of 367 task-unrelated contents, 324 were classed as MW reports (*M* = 5.31, *SD* = 4.70, range 0-20) and 43 as ED reports (*M* = 0.70, *SD* = 1.05, range = 0-4). Since we were interested in task-unrelated thoughts, task-related thoughts were not further considered in our analyses.

To assess the effects of the experimental manipulation of cues on the two types of task-unrelated mental contents (i.e., MW and ED), we calculated the average number of MW and ED reports per person and entered them into a 2 (Group: No-cues *vs*. Verbal-cues) x 2 (Type of task-unrelated mental contents: MW vs. ED) mixed ANCOVA, with boredom as covariate. Descriptive data (means and standard deviations) as a function of group are reported in Table 2.

Results showed a significant main effect of Group F (1, 58) = 8.73, p = .005, η^2= 0.07, with the Verbal-cues group reporting a higher amount of task-unrelated mental contents (*M* = 3.94) compared to the No-cues group (*M* = 2.11), and a significant main effect of the Type of task-unrelated thoughts, F (1, 58) = 8.35, p = .005, η^2= 0.06, as MW reports

(*M* = 5.35) outnumbered ED (*M* = 0.70) reports. However, the main effects were qualified by a significant Group by Type of task-unrelated mental contents interaction, F (1, 58) = 14.70, $p < .0005$, $\eta^2 = 0.11$: the Verbal-cues group reported a higher amount of MW (*M* = 7.40) compared to No-cues group (*M* = 3.30, $p < .005$, *d* = 0.91). The difference between the two groups in the amount of ED was not significant (Verbal-cues: *M* = 0.49 *vs.* No-cues: *M* = 0.92, *p* = .09, *d* = 0.45).

Globally, these results suggest that the incorporation of verbal cues into the vigilance task increases the amount of MW experienced during the task. To further investigate the contribution of the verbal cues in triggering MW, in the Verbal-cues group we examined the number of MW episodes reported to be triggered by word-phrases (cues), internal thoughts, environmental stimuli, and no trigger.

A one-way repeated measures ANOVA with Type of trigger as independent variable was performed on these values. Results showed a significant effect of Type of trigger, F (1.4, 41.3) = 23.92, $p < .000005$, $\eta^2 = 0.33$. Pairwise comparisons with Bonferroni adjustment showed that the mean number of MW reports triggered by word-phrases (*M* = 4.37) was significantly higher than those triggered by internal thoughts (*M* = 1.57, $p < .0005$, *d* = 1.09), environmental stimuli (*M* = 0.33, $p < .00005$, *d* = 1.21) and by no trigger (*M* = 1.00, $p < .0005$, *d* = 1.03). Moreover, the mean number of MW reports triggered by environmental stimuli was significantly lower than those triggered by internal thoughts ($p < .005$, *d* = 0.82) and by no trigger ($p < .05$, *d* = 0.63).

3.4. *Temporal focus of mind wandering and verbal cues*

At the end of the vigilance task, participants coded each of their recorded thoughts as past memories, future thoughts, thoughts about a current situation or a-temporal thoughts. Out of the 324 MW reports, 127 (39.2%) were classified as past memories, 81 (25%) as future thoughts, 38 as present thoughts (11.7%) and 78 (24.1%) as a-temporal thoughts. In the Verbal-cues group, out of 218 MW episodes, 97 (44.5%) were classed as past memories, 40 (18.3%) as future thoughts, 23 (10.6%) as present thoughts and 58 (26.6%) as a-temporal thoughts. In the No-cues group, out of 106 MW episodes, 30 (28.3%) were classed as memories, 41 (38.7%) as future thoughts, 15 (14.1%) as present thoughts and 20 (18.9%) as a-temporal thoughts.

To assess the effects of the experimental manipulation on the temporal focus of MW, the mean proportion of each type of thought (past, present, future and a-temporal) was calculated per person and entered into a 2 (Group: Verbal-cues *vs.* No-cues) x 4 (Temporal focus: past, present, future, and a-temporal) mixed ANOVA.

The analysis was carried out on participants who reported at least 3 thoughts, and the epsilon correction for the degrees of freedom suggested by Greer and Dunlap (1997) was used to take into account that, for each participant, the sum of the values (proportion) across the conditions of the temporal focus factor is constant, namely 1.

The analysis revealed a significant main effect of Temporal focus, F (2.6, 99.2) = 8.08, $p < .0005$, $\eta^2 = 0.18$. Pairwise comparisons with Bonferroni adjustment indicated that the proportion of present ($M = .12$) was significantly lower than past ($M = .35$, $p < .0001$, $d = 0.94$) and future ($M = .30$, $p < .005$, $d = 0.69$). The Group x Type of temporal focus interaction was also significant, F (2.6, 99.2) = 5.53, $p < .005$, $\eta^2 = 0.13$. The Verbal-cues group reported a higher proportion of past events compared to No-cues group ($M = .45$ *vs.* $M = .26$, $p < .01$, $d = 0.53$) and a lower proportion of future events ($M = .20$ *vs.* $M = .40$, $p < .01$, $d = 0.52$). In the Verbal-cues group the proportion of past events ($M = .45$) was significantly higher than present thoughts ($M = .09$, $p < .000005$, $d = 1.10$), future thoughts ($M = .20$, $p < .05$, $d = 0.56$) and a-temporal thoughts ($M = .26$, $p < .05$, $d = 0.54$), and the proportion of a-temporal thoughts was significantly higher than present thought ($p < .05$, *d* = 0.61). In the No-cues group the proportion of future thoughts (*M* = .40) was significantly higher than present thoughts (*M* = .15, *p* < .05, *d* = 0.62) (Figure 1).

These data suggest that the exposure to verbal cues affected the temporal orientation of MW. To further investigate this aspect, we ran a secondary analysis limited to the MW episodes that participants reported as being triggered by the verbal cues and examined the mean proportion of each type of temporal focus (past, present, future and a-temporal) calculated over the total amount of MW triggered by the verbal cues.

The analysis was carried out on participants who reported at least 3 episodes of MW, and the epsilon correction for the degrees of freedom suggested by Greer and Dunlap (1997) was used to take into account that, for each participant, the sum of the values (proportion) across the conditions of the temporal focus factor is constant (i.e., 1).The analysis revealed a significant main effect of Temporal focus, F (1.71, 36.1) = 15.35, $p < .00005$, $\eta^2 = 0.42$. Pairwise comparisons with Bonferroni adjustment indicated that the proportion of past (*M* = .50) was significantly higher than the proportion of present (*M* = .08, *p* < .000005, *d* = 1.75) and future (*M* = .09, *p* <.00005, *d* = 1.56). The proportion of a-temporal (*M* = .32) was significantly higher than the proportion of present (*p* < .05, *d* = 0.83) and future (*p* < .05, *d* = 0.75) and it did not significantly differ from the proportion of past (*p* = 0.65, *d* = 0.42).

3.5. Phenomenological properties of mind wandering

At the end of the vigilance task, participants were asked to specify for each event whether it was general or specific, and whether it was self-related or not. Out of 324 MW reports, 182 (56.2%) were classed as specific and 248 (76.5%) were classed as self-related. In the Verbal-cues group, out of 218 MW reports, 118 (54.1%) were classed as specific and 167 (76.6%) as self-related. In the No-cues groups, out of 106 MW reports, 64 (60.4%) were classed as specific and 81 (76.4%) were classed as self-related.

To assess whether the presence of verbal cues affected these two phenomenological qualities of MW, we calculated for each participant the proportion of specific MW episodes and the proportion of self-related MW episodes. Descriptive data (means and standard deviations) as a function of group are reported in Table 2.

Two independent sample *t*-tests were performed to compare specific MW episodes and self-related MW episodes between No-cues and Verbal-Cues groups.

T-tests did not reveal any significant difference between the two groups in the mean proportion of specific MW episodes (p = .78, d = 0.07) or in the mean proportion of self-related mental contents (p = .80, d = 0.07).

4.Discussion

The present study aimed at investigating the *causal* role of the exposure to verbal cues, in triggering and shaping MW. To this aim, we used a vigilance task already successfully used to induce and assess MW in the laboratory (Plimpton et al., 2015) and we investigated, in a between-subject design, the effects of the exposure to task-irrelevant word-phrases on the rate of MW and its temporal orientation. The results of the study showed that the exposure to verbal cues positively affects the rate of reported MW, with a significantly higher number of MW episodes reported by the Verbal-cues group compared to the No-cues group. Moreover, the Verbal-cues group reported a higher proportion of past-oriented MW compared to the other temporal orientations.

Globally, these results provide an important contribution to identifying the conditions of naturally occurring episodes of MW. One of the crucial findings emerging from the MW literature is that the frequency of MW depends heavily on the attentional demands of the ongoing task. The rate of MW is reduced whenever *attentional load* is increased, such as in tasks requiring a substantial involvement of the attentional processes operating within the working memory system (Levinson, Smallwood, & Davidson, 2012; Teasdale et al., 1995) or focused attention (e.g., manipulation of perceptual load, Forster & Lavie, 2009).

Our results demonstrate that both the frequency of MW and its temporal focus can be also manipulated by systematically modifying the external context. Moreover, by assessing separately MW and ED, we could show that only MW increased under the exposure to verbal cues. This pattern of results confirms previous studies showing that MW and ED are two partially distinct processes, that can be differentiated at the behavioural (Stawarczyk et al., 2014; Unsworth & McMillan, 2014) and physiological level (e.g. pupillary correlates in Unsworth & Robison, 2016).

Our findings also give an important contribution to our understanding of the mechanisms underlying MW and they have implications at both theoretical and methodological level. First, the higher amount of MW shown by the Verbal-cues group demonstrates that MW is a cue-dependent phenomenon and that the external context can stimulate the so-called "process of ignition" of MW (Smallwood, 2013). So far, most of the research on MW has not considered the potential contribution of the external stimuli as trigger for the MW. In fact, MW episodes are often described as "stimulus-independent thoughts" (Antrobus et al., 1966) or "self-generated thoughts" (Smallwood, 2013), despite the fact that early studies acknowledged the triggering role of external cues (Varendock, 1921). Alternatively, it is possible to speculate that in a vigilance task the presence of distractors may reduce participants' attention and make them more susceptible to MW. Although this explanation appears to be in line with previous evidence showing that people with worse performance on attentional tasks are more prone to experience MW (Hu, He, & Xu, 2012), our results do not seem to support such a scenario. The Verbal-cues and the No-cues groups did not differ with respect to their level of concentration and the amount of external distraction, whereas the amount of MW was markedly greater in the Verbal-cues group than in the control group.

Second, the majority of the experimental paradigms and sampling procedures currently used to investigate MW allow for detecting whether MW is taking place but they do not enable researchers to identify the events that lead to the initiation of MW and to distinguish between its onset and maintenance over time. For example, in many studies on MW, a go/no go task involving very simple stimuli (i.e., digits, meaningless letter strings) has been used, without any other meaningful external stimuli, therefore reducing the possibility of any context-triggered experience of MW. Moreover, the experience sampling procedures that are often used (i.e., self-caught and probe-caught; Smallwood & Schooler, 2006) do not include any assessment of the potential triggers of the MW episodes thereby overshadowing the relative contribution of the external environment and internal processes (e.g., thoughts, emotions) to MW. Only recently, a few studies have started addressing the question of the cue-dependent nature of MW, by assessing the triggers of MW episodes (Song & Wang, 2012) and incorporating meaningful cues into a monotonous vigilance task (McVay & Kane, 2013; Plimpton et al., 2015).

Third, the incorporation of verbal cues into the vigilance task increases the frequency of MW experienced during the task and affects its temporal orientation, specifically facilitating past-oriented MW. Previous studies on the temporal orientation of MW have shown that, although robust evidence indicates a prospective bias in MW (Baird, Smallwood, & Schooler, 2011; Song & Wang, 2012; Stawarczyk, et al., 2011), specific factors, such as negative mood, cognitive load, and familiarity may affect the temporal orientation of MW (Baird et al., 2011; Poerio et al., 2013; Smallwood et al., 2011; Smallwood, Nind, & O'Connor, 2009; Smallwood & O'Connor, 2011). The retrospective bias reported in the present study by the Verbal-cues group is consistent with the evidence coming from direct comparisons between involuntary memories and involuntary future thoughts (Berntsen & Jacobsen, 2008): although both involuntary memories and involuntary future events were found to be mainly triggered by clearly identifiable cues, external cues were more frequent for involuntary memories than for involuntary future events (52% *vs.* 34% in Berntsen & Jacobsen, 2008). In a similar vein, in a very recent study on MW in elderly and young adults, Maillet and Schacter (2016b) found that environmental stimuli (cues) primarily triggered past-oriented thoughts. These results are consistent with the fact that, compared to memories, involuntary future thinking is related to and triggered primarily by current concerns, being less dependent from external stimulation (Cole & Berntsen, 2015; Klinger, 2013). In sum, there is increasing evidence suggesting the "[…] *possibility that autobiographical associations with the current task environment have a potential to cue the disinterested mind*" (Smallwood et al., 2009, p.118).

In keeping with this, involuntary memories are also more sensitive to the type of the task-irrelevant external cues (i.e., verbal *vs.* pictorial) compared to other spontaneous task-unrelated thoughts (Mazzoni, Vannucci, & Batool, 2014). Specifically, in the study by Mazzoni et al. (2014) more IAMs were elicited when verbal cues were presented during the task, rather than pictorial cues, whereas there was no significant difference between the effects of verbal and pictorial cues on the non-memory contents. As recently suggested by Maillet and Schacter (2016b), the strong association between environmental cues and past-events might be a very important adaptive mechanism that helps people relate the current environment to similar situations experienced in the past and this might support appropriate behavior (Preston & Eichenbaum, 2013).

Some limitations of the present study as well as suggestions for future developments should be also considered. Our data makes a compelling case for the role of external cues in MW. However, the exact mechanism by which the exposure to cues of verbal nature facilitates MW and steers it toward the past, still remains to be established. Such an effect in fact could possibly be due to either the mere presence of distractors, or the exposure to semantically meaningful cues. Interestingly, previous literature suggests that not all the distractors are the same in facilitating task-unrelated mental activity, with verbal cues being more effective in inducing IAMs than pictorial cues (Mazzoni et al., 2014). Hence, future investigations should systematically manipulate the nature of the distractors in vigilance tasks and clarify their influence on the frequency and phenomenology of MW.

Moreover, in our study MW was assessed by using a self-catching procedure, in which participants were asked to interrupt the task whenever they became aware of any task-unrelated mental contents and to report them. With this procedure, people necessarily report only task-unrelated thoughts of which they are aware, therefore focusing the investigation on mental contents that are sufficiently activated to pass the awareness threshold. Besides, by adopting a self-catching procedure, we cannot rule out that the presence of verbal cues broke up the flow of thought inducing participants to be aware that their mind was wandering off, and, in turn, to report more MW episodes. Future studies might use a probe-catching method instead of the self-catching method employed here and assess whether and how the presence of external cues might affect the level of awareness of the mental state of MW (e.g., aware *vs.* unaware mind-wandering, in Christoff, Gordon, Smallwood, Smith, & Schooler, 2009). However, although legitimate, this concern is mitigated by the fact that our findings are consistent with the ones reported by Plimpton et al. (2015), regardless the methodological differences between the two studies, such as the assessment method (self-catching *vs.* probe-catching), cue valence (only neutral *vs.* neutral, positive and negative) and cue rate (few cues *vs.* many cues).

Future studies should further examine the association between mind wandering and boredom. In our study, the No-cues group retrospectively reported a higher level of boredom experienced during the task compared to the Verbal-cues group, but no significant differences in the level of concentration. Whereas empirical work on the association between attention and boredom has largely focused on boredom proneness or *trait* boredom (e.g., Carriere, Cheyne, & Smilek, 2008; Cheyne, Carriere, & Smilek, 2006; Hunter & Eastwood, 2016; Isacescu, Struk, & Danckert, 2016), the few studies which investigated *state* boredom reported a positive association with poor sustained attention and mind wandering (Carriere et al., 2008; Hunter & Eastwood, 2016). However, the precise nature of this association has yet to be clarified and specifically the connection between state boredom and mind wandering both assessed "on-line" (during the task) deserves future investigation.

The identification of the events that directly cause and control the occurrence of MW provide an important contribution to addressing the question of "*when*" the mind starts wandering and "*why*" it starts at that moment in time. However, MW does not occur upon each encounter with a stimulus. One might argue for the existence of a gating mechanism which regulates the onset of a MW episode triggered by an external event, like a word-phrase presented on the screen (see for a similar discussion on IAMs, Kompus, 2011). Future studies are needed to examine whether the onset of a spontaneous MW episode is foreshadowed in the neural activity up to a few seconds before the presentation of the external cue which is, subjectively, reported to have triggered the MW.

Finally, we investigated the effects of verbal cues on the experience of MW in a sample of young adults. Future studies should investigate these effects in other populations of special interest for research on MW, such as elderly people. Studies on aging have shown a reduction in MW in healthy older adults compared to young adults (see for a discussion, Maillet & Schacter, 2016a), and an age-related increase in reliance on the environment (Craik, 1986; Maillet & Schacter, 2016b). Future studies should examine the effects of the exposure to task-irrelevant verbal cues on the frequency and temporal orientation of MW in elderly people and verify whether the presence of external cues might increase the frequency of engagement in MW in elderly people, to a stronger extent than in young adults.

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Captions

Fig.1 Mean proportion of past-focused, present-focused, future-focused, and a-temporal mind wandering in the Verbal-cues and No-cues groups

Table 1

Means, standard deviations, results of significance tests, and effect sizes of the comparison of Verbal cues (n = 31) and No-cues (n = 31) on concentration rating, boredom rating, and Positive and Negative Affect Schedule (PANAS) scores.

Variable	Verbal cues		No-cues		*t*	*df*	*p*	*d*
	M	SD	M	SD				
Vigilance task								
Concentration rating	3.55	0.81	3.45	0.81	0.47	60	.64	0.12
Boredom rating	2.84	1.16	3.65	1.14	2.76	60	.01	0.70
Mood								
PANAS-Positive score	30.97	5.27	30.90	5.48	0.05	60	.96	0.01
PANAS-Negative score	13.16	4.20	12.52	2.73	0.72	60	.48	0.18

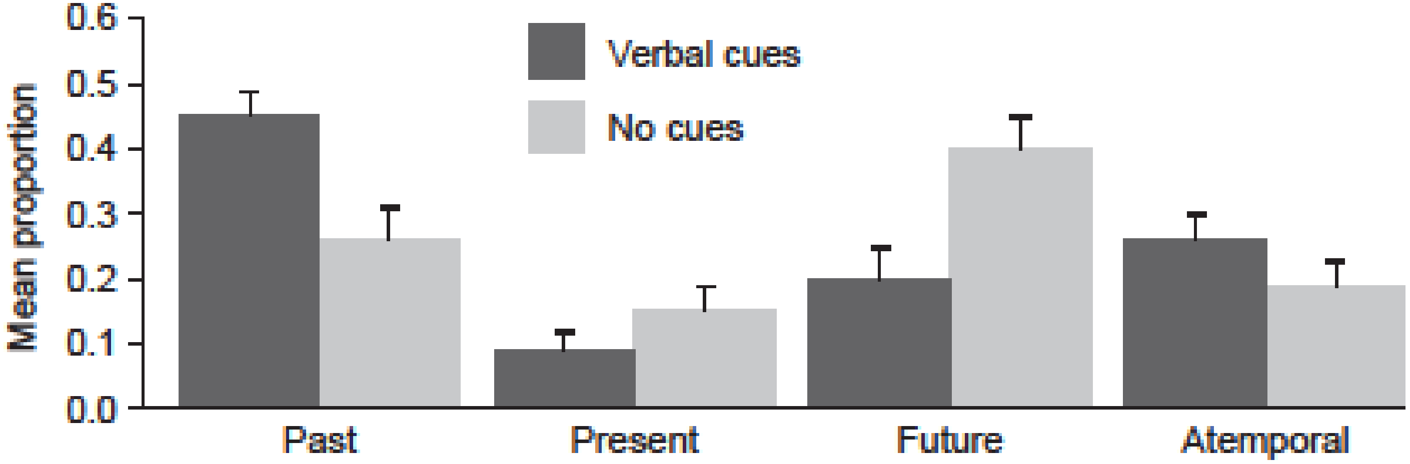
Note: M = mean: SD = standard deviation; *t* and *df* = t-value and degrees of freedom, respectively, from the independent sample t-test; *p* = p-value; *d* = Cohen's effect size for independent-sample mean comparisons.

Table 2

Means and standard deviations of task-unrelated thoughts reported (mind wandering and external distractions) and phenomenological properties of MW episodes (specificity and self-relatedness) as a function of group (Verbal cues and No-cues).

Variable	Verbal cues		No-cues	
	M	SD	M	SD
Task-unrelated thoughts				
Mind-wandering (MW)	7.27	5.51	3.42	2.69
External distractions (EDs)	0.33	0.61	1.06	1.26
Phenomenological properties of MW				
Specificity (proportion)	.62	.23	.65	.34
Self-relatedness (proportion)	.78	.18	.79	.22

Figure 1


0.6
0.5
0.4
0.3
0.2
0.1
0.0
Mean proportion
Verbal cues
No cues
Past
Present
Future
Atemporal