Mind Wandering as Diffuse Attention

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Abstract

This paper reconciles an inconsistency between the benefits of mind wandering and a prominent conception of attention in philosophy and cognitive psychology, namely, the prioritization view. Since we prioritize the information in a task less if we are doing it while mind wandering compared to solely concentrating on it, why does our performance in the task sometimes improve when we are mind wandering? To explain this, we offer a conception of diffuse attention that generalizes from external to internal forms of attention and captures deep commonalities between the two (Chun et al. 2011). We conceptualize mind wandering as an instance of internal diffuse attention that also induces diffuse attention in other concurrent tasks. Moreover, *pace* the prioritization view, certain tasks are in fact better performed with diffuse attention, which prioritizes information less than focused attention. Our account of mind wandering as an instance of the more general category of diffuse attention improves upon current leading philosophical views of mind wandering (such as Irving 2016) by better explaining the interaction between mind wandering and other tasks. (175w)

Keywords: Mind wandering, attention, diffuse attention, internal attention

1. Introduction

In this paper, we solve a puzzle about mind wandering and attention. Often, mind wandering is thought of as detrimental to our performance in another task. Recall the last time your mind started wandering as you were reading a difficult academic article, or trying to follow a talk at a conference. As your mind starts wandering, your attention is diverted from the task, leading to impaired processing of the information in the article or the talk. You start to lose track of the arguments in the article, or the research that the speaker is presenting (Smallwood and Schooler 2006). Indeed, many studies show that mind wandering hinders performance in a variety of tasks that require attending to external targets, such as reading, learning a sequence, or performing a go-no go perceptual task (Brosowsky et al. 2021, Christoff et al. 2009, Smallwood and Schooler 2006).

Intuitively, you are prioritizing the task you are working on less if your mind is wandering, compared to when you are focusing solely on the task. This idea is articulated in a standard characterization of attention in cognitive psychology, according to which paying attention to some target consists in *selecting* this target and *prioritizing* its processing with respect to other, competing processing (Carrasco 2011, Fiebelkorn & Kastner 2020). Moreover, selecting and prioritizing information are often linked to how attention performs what is often taken to be its crucial function: improving processing of the information that is attended to (Wu, 2014). For example, attention makes perceptual representation less noisy and can be more quickly processed (Anderson & Drucker, 2013), and it is often assumed that attention has these processing benefits thanks to the fact that it selects and prioritizes certain information over others.

In philosophy, a version of this view that attention improves processing by prioritizing information is expressed by Sebastian Watzl's (2017, 2023). Watzl takes attention to play the role of introducing a priority structure to mental representations by organizing them into an ordered set: attention structures our stream of consciousness by prioritizing some mental representations over others. This enables attention to facilitate processing of prioritized information. Watzl argues that priority of a certain information is closely tied to its usability by other mental processes downstream (Watzl, 2023).

We interpret this view, which we will refer to as "the prioritization view of attention", as making the following two commitments: (1) Attending to information *P* requires selecting and prioritizing *P*, and (2) more prioritization of information *P* improves processing of *P* and also improves the related task-performance. In accordance with this view, if during mind wandering one is prioritizing the perceptual input needed for a task at hand less, we would only expect that performance will suffer, compared to conditions where subjects are solely focused on the task. However, mind wandering is not always detrimental for task-performance (Brosowsky et al. 2021, Baird et al. 2012). Surprisingly, in some cases, mind wandering even correlates with performance *improvements*. A notable example involves rapid serial visual presentation tasks (RSVP), where participants must detect targets within a string of rapidly succeeding distractors. Mind wandering participants do better on these tasks, compared to fully attending participants (Olivers & Nieuwenhuis, 2005; see also Thomson et al., 2015). [1] As we discuss in detail below, performance improvement was

[1] Thomson et al. (2015) found a correlation between a *disposition* towards mind wandering and performance in RSVP tasks: participants who tended to engage more in mind wandering in everyday life did better than those with lesser tendencies towards mind wandering. This supports the robustness of the connection between mind

measured by the reduction of the effect known as attentional blink (Raymond et al. 1992), in which participants tend to miss the second of two rapidly succeeding targets. In this way, we have three seemingly inconsistent claims:

1. When your mind is wandering while performing an unrelated task *T* that requires information *P*, you are not prioritizing *P* as much as you would if you were solely concentrating on the task T.
2. More prioritization of information *P* improves processing of *P* and also improves performance in task *T*.
3. For some tasks, performance is better during mind wandering than when you solely concentrate on the task.

Since claim 3 is clearly in tension with claims 1 and 2, a revision of at least one of these is needed. We propose to solve this puzzle by rejecting 2, which is part of the commitments of the prioritization view of attention. Against the prioritization view, we argue that certain information is better processed with *diffuse* rather than focused attention, even though diffuse attention does not prioritize information as much as focused attention does (Prettyman 2022, 2014; Gopnik 2009). More importantly, we propose an account of diffuse attention that expands beyond previous discussions of diffuse attention that focus on perception. Our more expansive conception of diffuse attention includes mind wandering as an instance of internally directed diffuse attention (Chun et al. 2011; Fortney 2018, 2020).

We propose that by unifying mind wandering with other mental processes all under the category of diffuse attention, we can better understand their interactions. Thus, an advantage of our view is that it provides new insights into the effect of mind wandering on other tasks, i.e., the kind of tasks that mind wandering impairs, improves, or neither impairs nor improves. Our account is thus an improvement on leading philosophical views of mind wandering, such as Irving's (2016) unguided attention view. A further advantage is that our view also provides new insight on the nature of attention: *pace* the prioritization view, certain contents, whether internal or external, are better processed when they are less prioritized.

The paper is structured as follows. We start by introducing the literature on diffuse attention in perception (§2) and use it to motivate the view that there is an internal analogue to external diffuse attention (§3). Then, we suggest that mind wandering has the signature

wandering as a distinctive way of using attention and the resulting distinctive way of processing perceptual information.

characteristics of internal diffuse attention and show how this view can explain the effect of mind wandering on other tasks (§4). Finally (§5), we explain how our view improves our understanding of mind wandering, specifically, beyond the unguided attention view (Irving 2016, 2021) and of attention more generally by revising the standard prioritization view. We conclude (§6) by laying down some questions that our account poses for future empirical research.

2. Diffuse Attention, Internal and External

In the last two decades, psychologists have been proposing that at least in perceptual attention, there is a *distributed* mode of attention besides focused attention (Treisman 2006, Gopnik 2009, Srinivasan et al. 2009; Demeyere & Humphreys 2007; Chong & Evans 2011). This attentional mode has a broader scope, kicks in more quickly, and targets different information than focused attention, even though it sometimes can be used alongside focused attention. In the words of Gopnik (2009), attention can be either a focused "spotlight", or a less focused "lantern". With "lantern" attention, the scope of attention is larger and enables the processing of a larger scope of content. The properties that are better processed with this distributed, "lantern" attention include the gist of a scene (Li et al. 2002; Oliva & Torralba 2006) and statistical properties like mean sizes or colors of groups of objects (Chong & Treisman 2005; Treisman 2006; Srinivasan et al. 2009; Demeyere & Humphreys 2007; Chong & Evans 2011). Li et al. (2002) also show that subjects can perform two perceptual tasks (a demanding letter discrimination task in their focal attention and a natural scenery categorization task in their peripheral vision) simultaneously just as well as they can perform the two separately. Other studies also suggest that a spatially broader focus of attention increases sensitivity to lower spatial frequencies, while narrowing the focus of attention increases sensitivity to higher frequencies (Oliva & Torralba, 2006). For example, in gist perception, subjects can categorize whether a low-resolution image shows a kitchen or a street based on configurational properties of the image without processing the local properties in the specific items in the image. Finally, a broader focus of attention is associated with increases in temporal resolution: when subjects are attending to a broader portion of space, they are better able to process the temporal details of a perceived event, such as the order of appearance of two rapidly succeeding targets (Yeshurun & Levy 2003, Mudumba & Srinivasan 2021).

Some theories conceptualize this more distributed type of perceptual attention as *diffuse attention*. The first (and, to our knowledge, only) systematic account in philosophy is due to Adrienne Prettyman (2022). Her Global Selection view characterizes diffuse attention by the kind of targets it selects, namely, global objects and properties. For instance, a whole scene is a global object, and the set of spatial relations amongst the elements of the scene is a global property. Prettyman uses the example of contemplating a large painting (think, for instance, of Rubens' *The Great Last Judgment* or Siqueiros' *La Marcha de la Humanidad*). Appreciating these artworks requires spreading your attention widely, to pick out the whole painting as a global object, without fixating on any of the local elements it depicts. You also need to direct your attention to global properties, like the composition of shapes and colors.[2]

Like the psychologists who are interested in the distributed mode of attention in perception, Prettyman's account focuses on external attention in perception as well. For our purpose, however, we are interested in providing an account of diffuse attention that captures distributed attention towards both internal and external contents, and Prettyman's account cannot serve this purpose. Following the prior literature in psychology and philosophy, we believe that attention in general has both external and internal forms (Fortney 2018, 2020, Chun et al. 2011). In addition to attending to objects represented in our perception of the external world, we can also direct our attention to stimulus-independent contents, including thoughts, memories, and mental imagery.[3] The Global Selection view does seem to capture distributed visuospatial attention in perception, since statistical and configurational properties plausibly fall under the category of global properties. However, we are interested in capturing the distributed mode of attention towards internal contents as well, and the Global Selection view only captures some instances of it. It is true that in some stimulus-independent processes such as visual memory and imagination, one can attend to contents diffusely in a way that can be captured by the Global Selection view (e.g. attending to a street scene as a whole in one's visual working memory, or imagining a street scene as a whole). However, consider the case of open-monitoring meditation, which is difficult for the Global Selection view to capture. During open-monitoring meditation, agents monitor, but do not react to, their thoughts and feelings as they come and go (Lutz et al. 2008; Fujino et al. 2018). In this case,

[2] Nanay (2016) holds a similar view. He focuses on aesthetic attention, and proposes that this way of directing attention is focused on one object (the painting), but distributed over lots of the object's properties (shapes, colors, etc.).

[3] We follow Fortney (2018, 2020) in using "stimulus-independent" in the sense that the stimulus-independent contents do not have direct causal relation with external stimuli. Thus, both visual memory and imagination count as stimulus-independent, despite them having causal dependencies on external stimuli in a very attenuated sense.

throughout a period of time, the agent attends to various contents in a distributed manner, but there is no global content that the agent attends to.[4]

While characterizing diffuse attention as selecting global objects and properties does not generalize well to internal attention, there are certain features shared by paradigm cases of external diffuse attention that do generalize well to internal attention. One is having a broad scope of focus, which we understand in a general sense to encompass attending to non-pictorial contents. In addition to attending to a broad scope of content in space and time, one could also attend to a broad scope of content in the conceptual space, as is often the case in internal diffuse attention. Conceptual space refers to a representation of contents on the conceptual level where the similarity relation between contents is modeled as the distance between points in a geometric space (Bellmund et al., 2018; Tenenbaum & Griffiths, 2001; Gärdenfors 2000). Contents that are less similar are therefore represented as more distant from each other in the geometric space. This feature is different from how the Global Selection View characterizes diffuse attention. A broad focus does not require that there are global objects or properties that are attended to. It only requires that attention is distributed over a wide range of information, but the information need not be unified into a single global object or global properties.

One example of attending to a broad scope of internal contents is creative thinking. During creative thinking, attention is often directed inwards towards disparate contents in memory that could serve to solve an open-ended problem (Benedek et al. 2017). Think, for instance, about what you do in brainstorming to try and come up with a good sofa design. You would attend to a wide variety of sofas of different styles for inspiration (Carruthers 2020). The focus of your attention is much broader than, say, when you are trying to recall a specific sofa design to see if it will fit with the style of your other living room furniture.[5]

Another feature shared by paradigm cases of external diffuse attention is reduced inhibition of information. For example, in the perceptual dual-task experiment from Li et al. (2002), instead of inhibiting all the information except the targets in one's focal attention, subjects are still attending to information in their peripheral vision (albeit with less prioritization) to complete the secondary task. This feature of exhibiting reduced inhibition of information is also shared by creative thinking. During the brainstorming process, you would often refrain from inhibiting any information that is of some faint relevance to the problem,

[4] There is a possibility that contents that are in sentential, instead of pictorial, format are difficult for Prettyman's view, because it is difficult to make sense of a global object when contents have a sentential format, but we will not explore this issue here.

[5] See Wang (Manuscript) for a detailed discussion of diffuse attention in creative thinking.

especially if you are trying to come up with a novel idea that is not typically associated with the problem.

Open-monitoring meditation is another case that shares both of these two features, i.e. having a broad focus and exhibiting reduced inhibition of information (Lutz et al. 2008; Fujino et al. 2018). Meditators must maintain awareness of whatever contents pop out in their minds at any given moment, from bodily feelings and sensations to thoughts and emotions, without further engaging with any of these contents.[6] Meditators therefore attend to a broad scope of contents spread out in the conceptual space. Importantly, these contents are not regarded as distractors, but instead as contents for observation pertaining to the present moment (Fujino et al. 2018). Therefore, meditators refrain from inhibiting any of the contents that they observe. This is different from, say, when you try to focus your attention on a conference talk, in which case you need to actively suppress irrelevant or interfering information (e.g., the color of the speaker's shirt or the notifications on your phone).

We now propose a general conception of diffuse attention characterized by these two features: (1) having a broad focus, and (ii) exhibit relaxed inhibition, or no inhibition of information. This conception of diffuse attention encompasses both internal and external attention. External diffuse attention, which psychologists and philosophers have been focused mostly on so far, is only one species of this more general notion of diffuse attention. We thus offer the following taxonomy of attention:

1 Focused and external Watching a specific soccer player's performance in a match Tasting the fruity flavor in the wine	**2 Focused and internal** Calculating tips in your mind Recalling an argument from a specific paper
3 Diffuse and external Attending to busy street scene as a whole Watching a meteor shower in the wild	**4 Diffuse and internal** Brainstorming about a sofa design Contemplating your feelings as they come and go

Table 1. A taxonomy of attention

[6] Though in open-monitoring meditation attention is not *exclusively* directed at internal content, it very plausibly involves internal attention in addition to external attention as one of its components.

We propose that mind wandering fits in the fourth box of this taxonomy, as we will now argue.

3. Mind Wandering as Internal Diffuse Attention

The two core features of diffuse attention, i.e. attending to a wide range of content, and reduced or absence of inhibition of information, aptly characterize mind wandering. When your mind starts wandering, for example, during a conference talk, your thoughts drift towards a wide range of content, from what to have for dinner, to when to do laundry, or to your next vacation. Compare such a condition with calculating tips in your mind, or recalling a detail of your last meeting with your collaborator . There is a sense in which your internal attention has a narrower and more constrained focus in the latter cases, compared to how this focus is in mind wandering.

Moreover, in support of the idea that mind wandering is accompanied by relaxed or even absent inhibition, some psychologists interpret mind wandering as a result of omission in exercising top-down control over what internal content to attend to (McVay and Kane, 2009). Psychology studies show that subjects with lower working memory capacity tend to engage more in mind wandering. This is likely because they are less capable of exercising top-down controlled attention to sustain contents in the working memory, which lends support to understanding mind wandering as having relatively less inhibition of information.

One might worry that our view cannot capture the dynamic nature of mind wandering suggested in Irving (2016) and Christoff et al. (2016). Both Irving and Christoff et al. emphasize that the content of mental states in mind wandering changes dynamically over time, such that one's thoughts move "hither and thither without fixed course or certain aim". A similar idea was proposed in Sripada (2018), who proposes that mind wandering can be captured as an exploratory train of thought that jumps from one topic to another. All of these accounts allow that in mind wandering, one might be paying focused attention to some thought at any given time. Thus, the distinctive feature of mind wandering is not that it does not involve a narrow focus of attention, but rather that the focus of attention meanders through different contents across time. One might worry that our theory of mind wandering as diffuse attention does not capture this feature.

To address this worry, we suggest that attentional states can be diffuse along two dimensions: synchronically and diachronically. The former refers to breadth of focus and range of contents at a time, while the latter refers to the same things but over time. Internal

synchronically diffuse attention can occur when you try to remember a scene of a busy crossroad that you glanced through very quickly through the window, as you try to bring up a wide range of information in the scene. It can also occur when you try to attend to many thoughts at the same time in your mind. Internal diachronically diffuse attention can occur in creative thinking. For example, when you are trying to come up with a new sofa design, your attention is distributed over a wide range of content through a stretch of time as you explore various ideas (Carruthers 2020). We propose that this diachronic dimension of diffuse attention captures the dynamic nature of mind wandering, as it is manifested in the drifting of attention among a wide range of content during a time stretch.[7] In section 5, we will return to a discussion of Irving's account and Christoff's account, where we argue that not only does our account capture the dynamic nature of mind wandering that these accounts also capture, but our account also improves upon these accounts by better explaining the interaction between mind wandering and other mental processes.

Another potential worry is that there are certain cases of mind wandering where one's mind in fact wanders about *closely related* topics instead of meandering among different ones. *Prima facie*, in such cases the subject seems to pay focused attention both synchronically and diachronically, because the range of attended content is not too wide neither at a time nor over time. However, our model would still characterize such cases as diffuse attention. In these cases, even though the mind is wandering about closely related topics, the pattern of thoughts are importantly different from rumination or goal-directed thought, insofar as there is no inhibition. It is a mere coincidence that in some cases the mind wanders about closely related topics. But if attention were then to shift to other less related content, there would be no inhibition of such content.[8] In this sense, attention is still diffuse.

With this account in hand, and having addressed some initial worries, we can now explain the kind of tasks that mind wandering improves, impairs, or neither improves nor impairs.

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[7] Of course, an important difference between creative thinking and mind wandering is that the former is guided, however loosely, towards a goal, while the latter is not. This might suggest that creative thinking sometimes requires a smaller temporal focus than mind wandering, as one would need to suppress ideas completely unrelated to the creative problem. To account for this, we think that the distinction between diffuse and focused attention might come in degrees, and more constrained forms of creative thinking are closer to focused attention than mind wandering is.

[8] According to Irving (2016), the mark of mind wandering is that attention is then unguided: there is no felt need to keep attention "in track" and/or "pulling it back" if we note that our mind has drifted off. Though this counts as absent inhibition in our view, we do not think that inhibition must be characterized by a *felt* need to redirect attention. Inhibition can also be unconscious, as the literature on unconscious attention demonstrates (Kentridge 2011, Norman et al. 2013).

4. Interaction between Mind Wandering and Other Tasks

Several studies have shown that mind wandering improves performance in rapid serial visual presentation (RSVP) tasks. In RSVP tasks, a string of numbers or letters are presented for a tiny fraction of a second at the spot where participants are fixating their eyes (see Figure 1). Often, participants must give reports about the letters or numbers ("did you see a '5'?"). Studies find a limitation in this task: if participants are asked to detect and identify two targets (T1 and T2) presented within one such string (e.g., two letters amongst a string of digits), they are unable to do this when T1 and T2 appear too closely together. More specifically, if participants successfully detect T1, and if T2 appears within 200-400 ms after T1, participants will miss T2. This effect is known as the attentional blink (Raymond et al. 1992).[9]

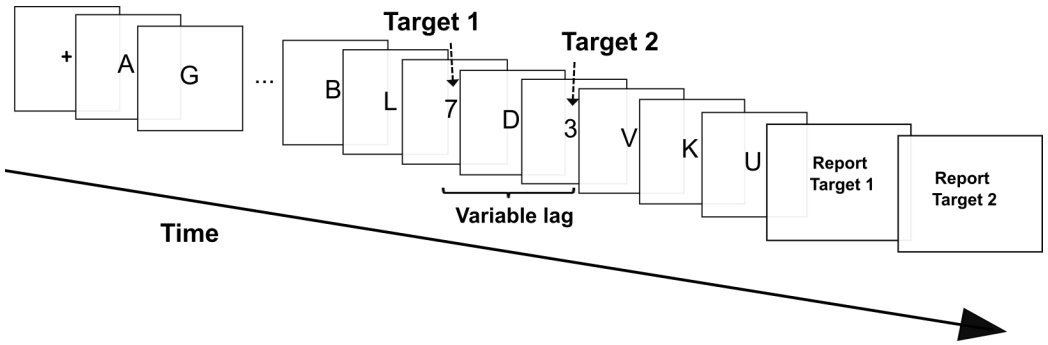

Figure 1. RSVP task from Olivers and Nieuwenhuis (2005). Copyright © 2022 Author, Creative Commons Attribution 4.0 International License.

Interestingly, a study from Olivers and Nieuwenhuis (2005) shows that mind wandering participants, who are seemingly prioritizing the stream of images less, show reduced attentional blink, i.e. they show an improved accuracy in detecting T2 while maintaining the same level of accuracy in detecting T1 as participants who only focus on the RSVP task. Olivers and Nieuwenhuis (2005) asked participants to detect two target digits presented amongst a string of letters, under one of three conditions: focusing solely on this detection task, listening to music, or mind wandering (free association starting off from thinking about their holidays or dinner plans). The experimenters found that in the second and third

[9] The specific mechanisms underlying the attentional blink are still unclear. See Chun et al. (2011) for discussion.

conditions where attention was not solely focused on the detection task, subjects are just as accurate in detecting the first target as when they focus solely on the detection task, but their detection accuracy of the second target significantly improves.

While Olivers and Nieuwenhuis (2005) instructed participants to let their mind wander, another study on the effect of mind wandering on RSVP tasks investigates the effect of the general disposition for mind wandering outside the lab on attentional blink in the RSVP task. They also found a link between mind wandering and improved RSVP performance. Participants who are more disposed to mind wandering in their everyday lives also exhibit a lesser attentional blink compared to participants who are less disposed to mind wandering (Thomson et al. 2015). Though here we focus on the results from Olivers and Nieuwenhuis (2005), the offered considerations can be applied to the results from Thomson et al. (2015) as well.

Olivers and Nieuwenhuis attribute the improved performance in the second and third conditions to a diffusion of attention. They suggest that this diffusion might consist in a "widening of attention", so as to "include" both the perceptual task and the concurrent task. They then add that attention could have also "widened temporally", so that the second target in the perceptual task was also "included."

We think that this proposal is on the right track, but it requires some further articulation. It remains unclear how mind wandering induces diffuse attention in the perceptual task. For say that mind wandering involves a "diffusion of attention". If our considerations from sections 2 and 3 are on the right track, this diffusion of attention is primarily internal. It remains to be explained how *internal* diffuse attention influences *external* information processing. Specifically, more needs to be said about how mind wandering interacts with attention in the perceptual task.

Here, we provide more evidence that the improvement in performance in the RSVP task is in fact due to diffuse attention. Moreover, we argue that mind wandering subjects switch to diffuse attention in the perceptual task because mind wandering is itself a form of diffuse attention. As we will now argue, internal and external attention interact in such a way that when one of them switches to diffuse mode, the other one plausibly does so as well.

Our argument has two parts. First, we show how performance improvements in RSVP tasks can be attributed to diffuse *external* attention. Then, we show how mind wandering, as diffuse *internal* attention, can bring about diffuse external attention in RSVP tasks.

4.1. A Broad Focus of Spatial Attention Improves Temporal Resolution

One plausible explanation for why subjects with reduced attentional blink in the RSVP task can detect the second target shortly after the first one is that their visual processing has higher temporal resolution. Thus, provided that our conceptualisation of broadly distributed spatial attention as diffuse external attention is on the right track, studies linking increased temporal resolution to broader distributions of spatial attention provide evidence for our claim that diffuse external attention is responsible for the reduced attentional blink. We will now discuss two such studies.

Yeshurun and Levy (2003) studied the effects of spatial attention on temporal resolution. They presented participants with either one disk in their visual periphery, staying there for several milliseconds, or two successive disks separated by a varying interval (see Figure 2). Participants had to report whether they saw one or two disks. This was harder when the interval between the disks was shorter, for it required participants to detect smaller temporal gaps. The crucial finding was that directing participants' attention to the location of the disks impaired their discrimination performance, compared to a baseline condition where attention was not directed to any specific location in the display. This suggests that *focused* attention impairs temporal resolution.

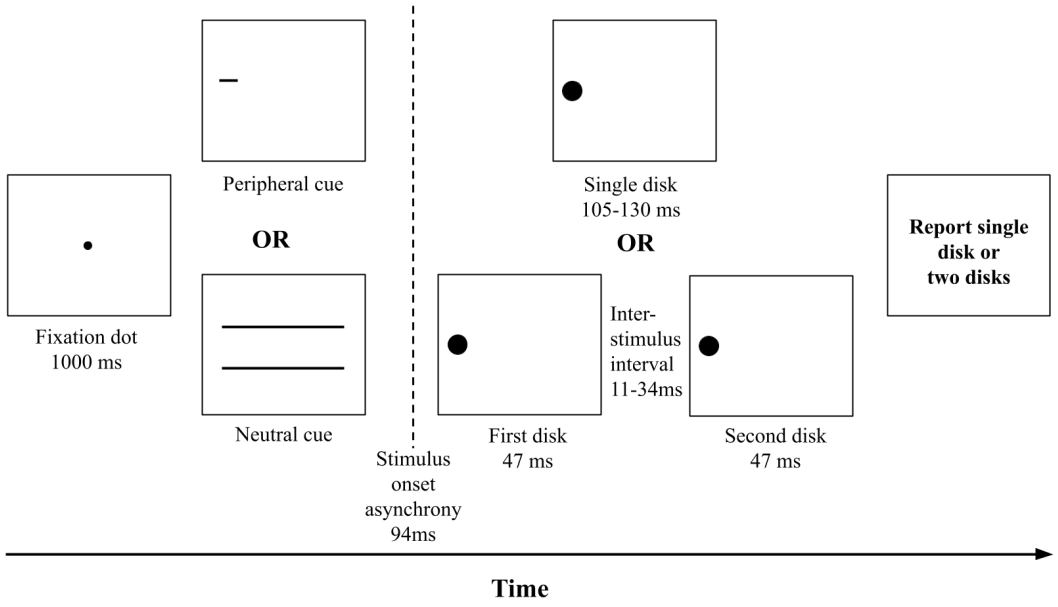

Figure 2. Temporal resolution task from Y. Yeshurun and L. Levy (2003). Original figure by Author.

As Yeshurun and Levy note, these results fit well with other findings revealing that focusing attention on a spatial location increases the apparent duration of stimuli presented at that location. They also note that temporal resolution plausibly trades off with spatial resolution, so that increases in the former correlate with decreases in the latter, and vice versa. For instance, while spatial resolution is best at the fovea and worse at the visual periphery, the opposite occurs with temporal resolution, which is better at the visual periphery. Furthermore, better temporal resolution is associated with larger neuronal receptive fields, as opposed to spatial resolution which requires smaller receptive fields.

For our present purposes, these findings are significant because they suggest a trade-off between focused and diffuse attention, insofar as these two modes of attention typically improve perceptual processing in distinctive *and opposing* ways. It is well known that focused spatial attention increases spatial resolution throughout the entire visual field (Anton-Erxleben & Carrasco 2013), and that it also shrinks down receptive fields (Moran & Desimone 1985). If temporal resolution requires less spatial resolution and/or large receptive fields, it is not surprising that it gets worse with focused attention. But if there was a mode of attention that enlarged rather than shrunk receptive fields, then, even if it also decreased spatial resolution, that mode of attention could well improve the ability to detect the gaps between two stimuli that appear very closely together in time.

We propose that diffuse external attention, in the form of broadly distributed spatial attention, effectively does this job. Participants in Yeshurun and Levy's task must maintain their gaze fixated on the center of the display, but they also know that the stimuli for their task will appear at a random location in their visual periphery. Because they know this, it is plausible that they use a strategy of distributing their attention evenly throughout the display. Thus, their performance in the baseline condition could be attributed to diffuse external attention.

More direct evidence for a connection between improved temporal resolution and diffuse external attention as broadly distributed spatial attention comes from a recent study by Mudumba and Srinivasan (2021). In this study, participants saw arrangements of "local" letters, which together composed a "global" letter; for example, many small H's arranged to form a big 'E' (see Figure 3). At the start of each trial, participants were given the instruction of reporting either the local or the global letter. Alongside with the letter display, two discs appeared briefly, one after another, with varying intervals between the two of them. One disc appeared in the upper portion of the display and the other in the lower portion. Participants

then pressed the “up” and “down” arrows on the keyboard, to indicate the order in which they saw the discs. Finally, participants reported the target letter by pressing the corresponding key.

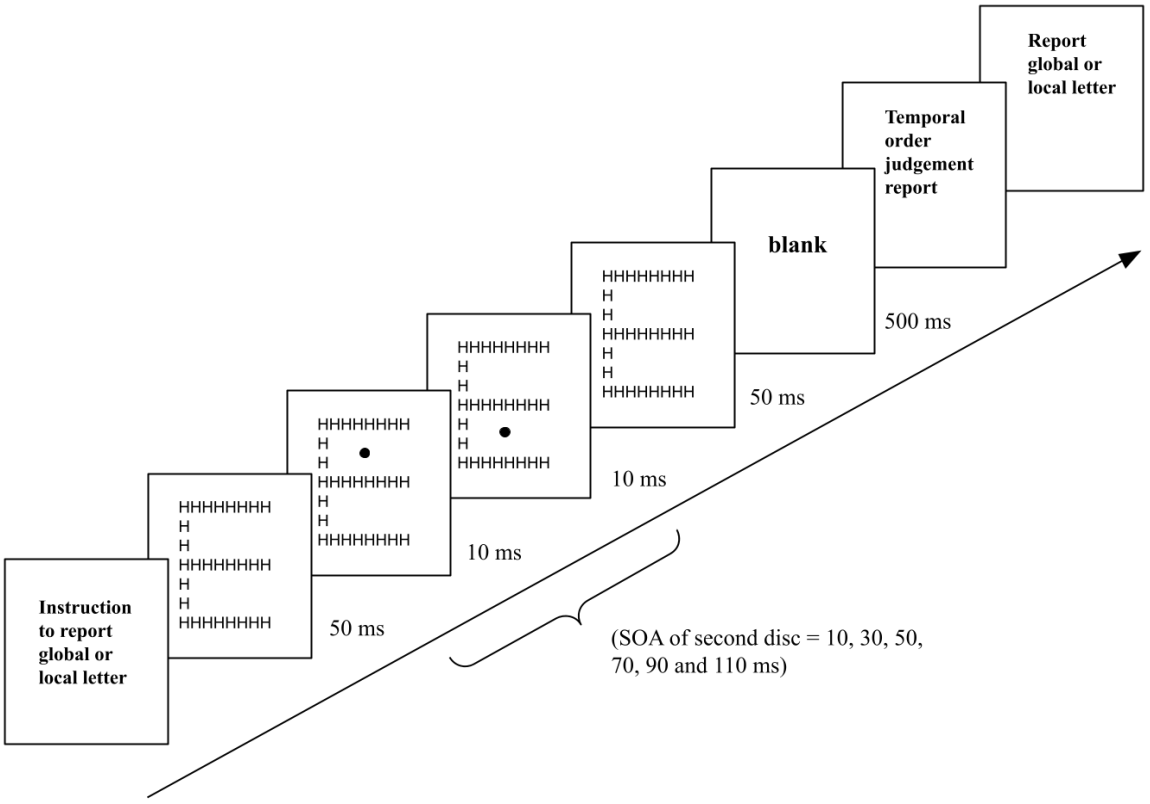

Figure 3. Task from Mudumba and Srinivasan (2021).
Original figure by Author.

Mudumba and Srinivasan treated the global letter condition as requiring a broader scope of attention, since reporting the big letter composed of smaller letters requires attention to be spread out over a larger spatial region. They hypothesized that if a broad focus of attention improves temporal resolution, participants would report the order of appearance of the two discs more accurately in the global than in the local letter condition, where attention was more narrowly focused on smaller portions of the display. This is just what they found. So they concluded that broadening the spatial scope of attention effectively improves temporal resolution.

By showing how a widely distributed focus of spatial attention can improve temporal resolution, these studies provide evidence that diffuse external attention can improve our ability to discriminate objects appearing in rapid succession. Hence, these studies support our

proposed explanation of the improved performance of mind wandering participants in a RSVP task, as attributable to a diffuse mode of external attention.[10] It remains to be seen why one should take these participants to deploy diffuse external attention.

4.2. Interactions between Mind Wandering and Attention in the Primary Task

So how does mind wandering induce diffuse attention in the primary task? In other words, why should internal diffuse attention induce external diffuse attention?

Several studies suggest that there is interaction between internal and external diffuse attention as we have characterized them in at least one direction, i.e. from external diffuse attention to internal diffuse attention. In a study by Friedman et al. (2003), participants are asked to first focus on certain perceptual targets, and then perform a creativity task of either generating original uses of a brick within limited time, or generating unusual category exemplars. In one experiment, participants were asked to repeatedly search for the number "3" among several digits either scattered throughout a big area on the screen or displayed close to each other in a small area. According to our proposed taxonomy, these two conditions correspond to conditions of diffuse and focused external attention, respectively. Then, participants were given a minute to write down the most creative use for a brick that is "neither typical nor virtually impossible". Their answers are then rated for creativity.[11] Participants who repeatedly searched through the bigger area provided the most original answers. In another experiment, participants were presented with a selected map of an American state, and asked to either attend to the entire state, or attend to a red star in the center of the map. Again, we respectively take these as conditions of diffuse and focused external attention. Then, participants were asked to type as quickly as possible the name of the most unusual exemplar they can think of of a given category (birds, fruits, furniture, etc). Participants that attended to the broader perceptual target, i.e. the entire map, provided exemplars that were ranked as more original than those that attended to the star. Friedman

[10] It is very likely, however, that improvement in temporal resolution does not give the complete explanation for the effect that mind wandering has on the RSVP task. When T2 appears immediately after T1 within 100ms, non-mind wandering subjects in RSVP tasks can usually capture T2 with a much higher accuracy than when T2 appears between 200-500ms (Chun and Potter 1995). This effect is called "Lag-1 sparing". This effect would not occur if the attentional blink occurs solely because of a limitation in temporal resolution. However, we note that the accuracy of capturing T2 within 100ms after T1 is still lower than when T2 occurs after more than 600ms when attentional blink no longer occurs. Therefore, it is plausible that limitation in temporal resolution still accounts for the attentional blink to some extent.

[11] An answer such as "throw it out the window" is ranked as not creative, and "to grind [it] up and use [it] as makeup" is ranked as relatively creative.

and collaborators interpret the result as broad perceptual attention inducing internal attention that is broad in the conceptual space. Given our characterization of diffuse attention, we interpret this result to provide evidence that diffuse external attention induces diffuse internal attention.

In another study by Wegbreit et al. (2012), participants are asked to first perform a visual perceptual task, and then solve Compound Remote Associate (CRA) problems. In each CRA problem, participants are presented with three words (e.g. carbon, cat, right), and must think of one word that forms a compound word or common two-word phrase with each of the three words (e.g. "copy" forms "carbon copy", "copycat", and "copyright"). For the visual perceptual task, one group is asked to perform a center-focused flanker task, where they need to focus on the target letter in the center, and ignore the distracting letters or numbers that surround it. Another group is asked to perform a rapid object identification task of identifying a series of visually degraded pictures of animals flashed by quickly. These are conditions of more focused versus more diffuse external attention, according to our taxonomy.

Results show that those who performed the center-focused flanker task showed higher tendency to solve the CRA problems through an analytic method, i.e. by generating words that can form compounds with one of the three given words, and then test out, one by one, whether these words can form compounds with the other two. Meanwhile, those who performed the rapid object identification task tended to use insight instead: they suddenly arrived at the right answer by attending to weak associations among all three words all at the same time. This suggests that diffuse external attention can make internal attention more diffuse, in that the subjects can attend to weak semantic associations among multiple lexicons at the same time.

Given that diffuse external attention seems to induce diffuse internal attention, it is reasonable to think that the interaction goes the other way as well, i.e. that diffuse internal attention also induces diffuse external attention. This proposal is further supported by studies suggesting that internal and external attention share the same underlying mechanism. Prominently, visual working memory studies suggest that sustaining attention to contents in the "mind's eye" and to objects in the external world might recruit the same top-down control mechanism, differing only in whether attended contents are internal representations or external objects (Chun et al. 2011). While this interaction concerns *focused* internal and external attention, we suggest that something similar might happen for *diffuse* attention. Particularly, we think that the lack or relaxation of inhibition in internal attention plausibly elicits a relaxation of inhibition in external attention as well. This idea sits well with some

psychological views attributing mind wandering to an omission of top-down control over what content to attend to. Studies show that subjects with lower working memory capacity tend to engage more in mind wandering (McVay and Kane 2009). This is likely because they are less capable of exercising top-down controlled attention to sustain contents in working memory.[12] [13]

So far we have offered reason for thinking that diffuse internal attention can induce diffuse external attention, and that diffuse external attention is a plausible explanation of why mind wandering participants are better able to detect two targets within an RSVP string, compared to fully attending participants. To strengthen our case for these views, we will now review evidence that mind wandering's improvement of RSVP performance is not an isolated case. We will briefly discuss some other tasks that are either facilitated by mind wandering, or at least compatible with mind wandering, and we will explain how our account of mind wandering as diffuse attention can readily apply to these other cases.[14]

4.3. What Kind of Tasks are Better Performed while Mind Wandering?

Besides the RSVP task, what other tasks are better performed while mind wandering? Clearly, not all tasks are better performed while mind wandering. Abundant studies show that mind wandering in fact impairs task performance in many cases, such as when the primary task is a go-no go perceptual task (Christoff et al. 2009), or a reading comprehension task

[12] Dixon et al. (2014) suggests another way to think about the interaction between internal and external attention, according to which internal and external attention interfere with each other when both forms of attention require high inhibitory control. Since diffuse attention only requires relaxed inhibition, our theory is compatible with Dixon's theory and might also complement it by explaining how low inhibition internal and external attention interact with each other.

[13] One might worry that our proposal stands in tension with findings on visual information sampling during mind wandering. In a recent experiment, Krasich et al. (2018) found that mind wandering subjects make fewer and longer fixations on a visual scene they are asked to memorize, compared to attentive subjects. This suggests that their spatial attention might not be as broadly spread out as we propose. In response, we emphasize that attention and gaze behavior can be dissociated, as evinced by a large body of empirical research (see Carrasco 2011 for a review). Thus, a fixed gaze is compatible with different attentional states, and in this specific case, subjects might be simply "zooming out" while blankly staring at a target. Later studies show that different mechanisms underlie the longer fixation durations observed in mind wandering subjects and in subjects paying attention under high processing demands (O'Neil et al. 2022), which lends further support for the "blank stare" interpretation.

[14] While we won't discuss in length here, our model also fits well with extant psychological theories of attentional blink. In general, psychological models explain the attentional blink either as a result of overexerting cognitive control (Taatgen et al., 2009), or as a result of the first target taking up all of the attentional resources (Chun and Potter, 1995). In both models, detecting the first target triggers a protection rule to ensure its processing and prohibit processing of any new target in the meantime. Our explanation in terms of diffuse attention would imply disabling the protection rule to allow processing of the second target while the first one is still being processed. This explanation is also suggested by Taatgen et al (2009), though their model only considers the effect of a secondary perceptual task, and not an internal attention task.

(Smallwood and Schooler, 2006). This makes it seem as a rather curious accident that mind wandering participants do better in one very specific kind of task. However, we think that there is support for a more general claim. There is a more general class of tasks, including the RSVP task, that are better performed (or at least not impaired) while mind wandering. We suggest that this class of tasks are tasks that are better performed with diffuse instead of focused attention.

One notable example are tasks that require creativity. A study by Baird et al. (2012) shows that mind wandering during the incubation stage of creative thinking improves performance in these tasks, even when the contents that subjects entertain during mind wandering are not explicitly related to the task. Participants were first given a creative thinking problem ("generate as many unusual uses as possible for a common object"), and then some were asked to work on a non-demanding task which causes increased mind wandering, while others worked on a demanding task that did not cause mind wandering. When both groups returned to the creative thinking task, the mind wandering group performed much better than the other group. Assuming, as we have suggested above, that the creativity task requires some level of internal diffuse attention (e.g., to spread the focus of attention widely, to activate distant or unusual nodes in semantic association networks), this study provides evidence that mind wandering facilitates better performance in some concurrent tasks that require diffuse attention.

We think that one commonality between the RSVP task and creative thinking task is that they are tasks that are better performed with diffuse attention. While we will not commit to arguing that *all* tasks of this category can be performed better while mind wandering, we think that these studies at least suggest that mind wandering tends to have a positive effect on performance in these tasks.[15]

[15] We also do not claim that the mode of attention employed in the other task is the only factor that affects how it interacts with mind wandering. A study by Brosowsky et al. (2021) shows that mind wandering impairs explicit but not implicit sequential learning. In their experiment, subjects are asked to follow a sequence displayed on the screen by hitting the corresponding buttons on a keyboard, but only the explicit learning group is informed that they will be asked to reproduce the sequence later. We think that in this case, the difference maker between the implicit and explicit learning group in terms of their interaction with mind wandering is more likely how information is encoded in working memory, instead of the modes of attention involved in learning. The encoding of information for explicit learning might be more demanding on working memory capacity, and so more affected by mind wandering. This result suggests that factors other than mode of attention employed also affect how tasks interact with mind wandering.

5. Diffuse Attention and the Prioritization View

To close our discussion, we will now explain how our proposal improves on existing views of mind wandering. We will also return to our initial puzzle and explain how our views motivate some important qualifications on the prioritization view of attention.

We have mentioned before that our theory accounts for the dynamic nature of mind wandering identified in recent theories of mind wandering as unguided attention (Irving, 2016), spontaneous thought with mild constraints (Christoff et al., 2016) or exploratory thinking (Sripada, 2018). In addition to capturing the same feature of mind wandering as these previous theories, our account of mind wandering as (internal) diffuse attention also has a distinctive advantage over these alternatives. The advantage is that our account can easily explain why mind wandering is beneficial for some tasks that depend on external information, including but not necessarily limited to RSVP. This is thanks to the fact that our account understands mind wandering as a form of internal attention, and draws on the interaction between internal and external attention. Previous views of mind wandering, on the other hand, cannot readily explain the interaction between mind wandering and tasks that rely on external contents represented in perception.

For example, neither Sripada's account nor Christoff et al.'s account gives much consideration to the role of attention in mind wandering. As a result, it is not obvious how an exploratory mode of *thinking* (Sripada 2018) or the lack of constraints in *thought* (Christoff et al. 2016) shall facilitate the processing of incoming visual information, as in the RSVP task. Conceptualizing mind wandering as an attentional phenomenon helps bridging this gap, as attention spans internal and external processing. In this respect, Irving's (2016) unguided attention view is already a step in the right direction. However, Irving's account does not consider the interaction between internal and external attention, and therefore cannot explain the beneficial effects that mind wandering has for certain perceptual tasks, such as RSVP. In comparison, by situating mind wandering in the taxonomy of internal and external attention, our proposal provides a more integrative view where the processes underlying mind wandering are understood as interacting with other processes in the mind.

In addition, our characterization of mind wandering as internal diffuse attention, along with the proposed two-dimensional taxonomy of attention (as external or internal and focused or diffuse) has more general implications beyond explaining mind wandering. In particular, our taxonomy has the additional benefit of furthering our understanding of the nature of

attention. Though diffuse attention has been previously discussed in philosophy and psychology, previous theories focus mostly on diffuse attention in visual perception. We provide a more general account, in which diffuse attention can be both internal and external. Since this more general account casts a wider range of psychological phenomena as attentional, it pushes us to hone in into what the defining characteristics of attention are.

For example, one important point of clarification concerns the function of attention. Specifically, our theory puts pressure on the prioritization view. Recall that this view has two commitments: (1) attending to information *P* requires selecting and prioritizing *P*, and (2) more prioritization of information *P* improves processing of *P* and also improves the related task-performance. Our view rejects the second commitment. In our view, more prioritization does not always improve processing and performance. When we attend to things with diffuse attention, no single piece of information is as prioritized as it would be if we were to attend to it with focused attention, since we are giving as much priority to it as we do to many other contents at the same time. To phrase it in Watzl's terminology of "priority structure", the corresponding priority structure of diffuse attention is flat, rather than s*piky*, which would be the case with focused attention.[16]

However, as we have demonstrated with empirical evidence, for some specific internal or external contents, paying diffuse attention to them, which involves less prioritization, leads to improved (or at least comparably good) processing compared to when we pay focused attention to them.[17] This suggests that the function of attention might in fact be something more general than how it is characterized by the prioritization view. More specifically, while it might be true that attention functions to improve processing of the attended information (Marchi 2020), this does not necessarily have to be achieved through selection and prioritization. At least, *pace* the prioritization view, it is not necessarily the case that for all kinds of content, the more we prioritize it, the better we can process it.

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[16] Watzl (2017, p. 73).

[17] Notably, recent accounts of skilled action and choking phenomena reach similar results. Choking occurs when a skilled performer reflects on their ongoing behavior, thus hindering their performance. Since the standard view of skilled behaviors is that they are automatized and no longer require attention, one could think of these as examples where attention does not improve and in fact impairs performance. However, Bermudez (2017) has recently argued that skilled behavior still depends on an amount of attentional control. In his view, choking and related phenomena occur when attention is misdirected from its proper target, the basic action, to focus on the automated action components or factors external to the action (e.g., audience pressure). A skillful soccer player must maintain her "head in the game", but to do so she does not need to keep track of the angle of her feet. While a novice player must highly prioritize this information, the expert player must deprioritize it to perform at her best. Importantly, deprioritizing information of these action components is compatible with her playing attentively. In our view, her attentive playing is explained in terms of the appropriate breadth of her attentional focus, which "zooms out" from already automatized details.

Finally, we would like to consider a possible objection: someone who interprets selection and prioritization in a very strict way might think that our account rejects (1) as well, and object to our account on that ground. The thought goes as follows: not only are selection and prioritization part of the definition of attention, but that a very specific type of selection and prioritization is required for attention, i.e. the type required for, in Watzl's terms, "spiky" attention. According to this view, attention requires focusing on a narrow scope of contents, and strictly prioritizing it over other contents. This objector might go on to argue that what we call "diffuse attention" on our view is better characterized as inattention. They might think that the mind wandering subject is not attending to any thoughts at all, because no single thought is strictly prioritized over others.

In response, we would like to note that it would be somewhat controversial to understand the notion of selection and prioritization in attention so narrowly. Watzl, for example, understands prioritization in a general sense, and takes "flat" attention to be a type of attention as well. According to his view, attention merely requires taking one thing to be *at least as* prioritized as another, instead of being prioritized *over* another. Different things can "have a tie" in the priority structure, which is the case when one's attention is distributed among a wide scope of contents (Watzl, 2017, Ch. 5). We agree with Watzl in understanding prioritization in a more general sense, such that the mind wandering agent is still prioritizing the thoughts that they entertain as their mind wanders, even though they are prioritizing a wide range of thoughts, and none of them is prioritized *over* each other, and the same reason applies to why the agent performing the RSVP task while mind wandering is attending to the targets in the RSVP task, instead of processing them without paying attention to them at all.

While we agree with Watzl in terms of how to understand the scope of attention, there is a crucial difference between our account and current accounts like Watzl's that already adopt a broad conception attention that includes "flat" attention: since we reject (2) of the prioritization view, we do not think of diffuse attention as a "lesser" version of focused attention in terms of its processing benefits. Instead, we show that diffuse attention has its own distinctive processing benefits, and that *pace* the prioritization view, different kinds of attention achieve their own distinctive processing benefits through different kinds of prioritization, be it spiky or flat.

6. Conclusion

We have proposed that by understanding mind wandering as a state of internal diffuse attention, we can explain the interaction between mind wandering and other tasks, and especially the benefits of mind wandering for other tasks that are best performed with diffuse attention. With this, we have provided a solution to a puzzle about mind wandering and attention, which has the further advantages of deepening our understanding of both attention and mind wandering.

Admittedly, our proposal has limitations. To more thoroughly investigate whether mind wandering has the tendency to improve tasks that are better performed with diffuse attention, we will need more evidence about how mind wandering interacts with other tasks that fall into this category beyond the ones we discussed. Some of these other tasks include magnitude estimation (Chong & Evans 2011) and temporal resolution tasks (Yeshurun & Levi 2003; Mudumba & Srinivasan 2021). We will also need to investigate what other specific tasks (besides RSVP) can benefit from mind wandering, and whether these tasks can be conceptualized as recruiting diffuse attention, as we suggested for RSVP and creative thinking. Answering these questions will require more empirical investigations as well as philosophical interpretations of the results.

Finally, while we have made a case against the prioritization view of attention, more theoretical work is needed for establishing either an alternative to the prioritization view, or a revised version of it. In either case, the new theory will need to avoid the bias of taking focused attention to be the paradigm case of attention, which likely underlies the prioritization view. Instead, the new account of attention will need to take seriously the fact that at least certain contents are better processed with internal or external diffuse attention, and understand the function of attention in light of this fact.

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