3. Proposed experiment

1.1 Introduction

There are still many obscure areas in the field of mind wandering. What we can do is try to better identify to which part of the mind wandering experience the questions we ask in our probes refer. It seems that we can ask about the thoughts themselves: about their **content** (un-/related to the task or the environment, past/future-oriented) and their **features** (modality, vividness). Then when you ask about intention, awareness or agreeability, you inquire about the **feeling** of the phenomenal experience. Finally some questions demand of people to do more introspection on the **process** itself, to retrieve the "route" of the train of thought : that's what happens when you ask " Was your mind moving about freely?" or "Were you aware of your surroundings?"[13,15].

The logic would be that, as you demand more introspection when you go up these dimensions (content, feature, feeling, process), the information gets less accessible, and the results less reliable. Moreover, these dimensions are of course related to each other, as results link for instance content and features: visual and auditory thoughts are less vivid in on-task then off-task, but it is not the case for verbal thoughts[15].

Christoff's model provides a good account of the observations we have on spontaneous thoughts[7]. The main idea is that you have both automatic and deliberate constraints. For instance, ruminations or obsessive thoughts are highly constrained, but not deliberately. Moreover, the same deliberate involvement can be accompanied by different levels of constraints on variability and content: imagining a story would be little constrained, whereas problem solving a lot more. The deliberate component only modulates the automatic component that regulates the train of thought. Here, we believe that the only real determiners of the spontaneous thought experience are those two types of executive constraints; and that the perceptual decoupling and self-generation components classically proposed[1,34] refer more to feelings than to the process itself (Figure 2).

One can already explain a range of results and intuitions with this distinction. In the obsessive example before, you could predict that one would feel particularly aware and find their thoughts rather vivid and clear – without being deliberate. And vividness has indeed been shown to increase awareness[15]. Furthermore, in this framework, the involvement of deliberate constraints at the onset of the mind wandering episode would be what brings the feeling of intention in Seli's manipulations, and that would bring a feeling of awareness. So, it seems that both automatic and deliberate constraints bring awareness.

One feeling that hasn't really been discussed in the mind-wandering and spontaneous thought literature is **agency**. Here we propose that it is similar to the deliberateness feeling, but refer to intention at the time of the current thought (or just before probe) rather than at the onset of mind wandering episode. If Smallwood described this as awareness[32], we rather believe that the feeling of awareness derives from deliberate involvement, i.e. from the feeling of agency. As vividness is also correlated with awareness, we could have a case of collinearity with agency. However, we predict those two are independent, as compulsive thought are vivid and aware without being deliberate. We could hypothesize that if you inquire about these three aspects on Likert scales, agency and vividness are going to predict awareness. This can be tested with a paradigm similar to Seli's above described, with different probes (Figure 3).

1.2 Methods

We would first need to test the validity of our probes by seeing if we reproduce previous results. Studies didn't contrast awareness with similar conditions before, but we can look for an increase in RTs before unaware episodes (1-4) in the hard condition[14] with a t-test. Vividness is similar to what certain papers refer to as "intensity of focus"[12], and those found that RTV was modulated by an interaction of relatedness and intensity (more RTV for more intense unrelated thoughts, less for more intense related

ones). An ANOVA would tell us if we reproduced those results. Agency is a newly proposed probe, but we can expect it behaves similarly to intentionality in Seli's paper: we think a mixed ANOVA will yield a similar interaction of difficulty and type (agency 1-4 vs 6-9) of unrelated thoughts. However we believe the means of these results differ in both experiments – as agency and intention don't refer to the same feeling. That can be verified with t-tests as our set-ups are almost identical. We should also control that vividness and agency are indeed independent by looking for a linear relationship between them.

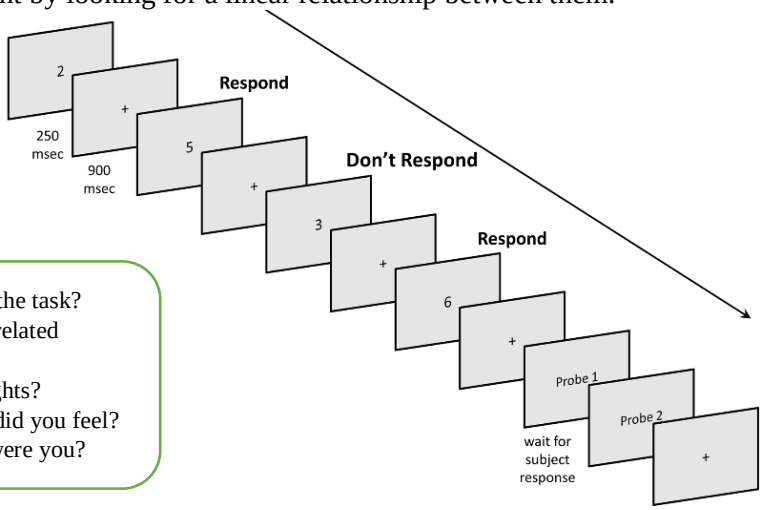

***Figure 3**: Sustained-attention-to-response task (SART), adapted from Jha, et al.[46]. The probes inquire respectively: relatedness, vividness, agency and awareness. We need the first probe to compare our results to studies that only inquired about unrelated thoughts (restrictive definition of mind wandering).*

Probe 0: How were your thoughts related to the task?
Totally unrelated 1 2 3 4 5 6 7 8 9 Totally related

Probe 1: How vivid were your last thoughts?
Probe 2: How in control of you train of thought did you feel?
Probe 3: How aware were of your thoughts were you?

Our main hypothesis is that agency and awareness are both positively correlated to awareness, because they respectively reflect the allocation of deliberate and automatic resources. And the more resources are involved, the more the feeling of awareness is going to grow. We expect that to be true, independently of relatedness (i.e. for both mind wandering and on task-thought), and we can explore all this with linear regressions.

Another hypothesis would be an interaction of difficulty and relatedness to predict vividness: the less the thoughts are related to the task, the more vivid they are going to be in the easy condition, and vice versa in the hard one. As you don't need resources to complete the easy task successfully, on task thoughts reflect an unfocused state – maybe similar to day dreaming or mind-blanking. On the other hand, on tasks thoughts in the hard condition would reflect a focus on the task, and consequently more vividness. The same parameters could also predict agency and awareness in linear regressions. Consequently, (less) awareness and (more) relatedness could predict (greater) RTV in the easy condition, and the opposite in the hard one.

1.3 Perspectives

We could test the relationship between different components defining our train of thought, without a restrictive definition that can make us loose some effects. Here we investigate thought generally, but could still compare our data to previous results by binning it into several categories. We hope this can test the proposed distinction of thought components, and validate this methodology, allowing more reproducibility.

A way to account for greater RTV in mind-wandering has been the perceptual decoupling. But one can go farther by looking at working memory and consciousness models. Research on executive functions tells us that the only way we can do two things at the same time (here the task and mind wandering), is to switch between those things[47]. As little resources are needed in those tasks, one can think of something else and switch without "loosing" its train of thought. But the difference might be, do you switch when a stimulus appears (low RTV), or when you "finish" your thought? Recent research (notably on retro-perception[42,48–50]) has shown us that the conscious access to an external stimulus' representation isn't necessarily time-locked to the stimulus apparition, but that the process is rather flexible. We can explain the results this way: if we dedicate more attentional resources to our inner processes, we won't be more variable in our response time, and maybe accuracy.