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# The effects of inattention on selective attention: How sadness and ruminations alter attention functions evaluated with the Attention Network Test

*Les effets de l'inattention sur l'attention sélective : comment la tristesse et les ruminations altèrent les fonctions attentionnelles évaluées avec l'Attention Network Test*

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## ABSTRACT

In two in-laboratory studies, we investigated the influence of inattention when caused by sadness and ruminations on attention functions. Being sad and ruminating over negative thoughts involves a long-lasting attentional self-focus, altering the ability to process relevant information from the environment. It subsequently leads to inattention, considered as a very specific attention deficit. In a preliminary methodological study, it was demonstrated that the combined imagery vignettes and music procedure was efficient to induce sadness and ruminations, propitious to inattention. Then, in a second experiment, sadness and ruminations were induced with this procedure in order to provoke inattention. The effects of inattention on selective attention processes were assessed using the Attention Network Test, which discriminates between three independent attention functions: alerting, orienting and conflict. Results on reaction times showed that only the orienting function was affected when inattentive, with a significant alteration on spatial information processing. These results were discussed in the light of the literature on emotion and attention.

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## R É S U M É

Dans ces deux études réalisées en laboratoire, nous avons examiné l'impact de l'inattention, causée par la tristesse et les ruminations associées à cet état, sur les fonctions attentionnelles. Être triste et ruminer des pensées négatives implique un repli sur soi attentionnel durable, altérant notre capacité à traiter les informations pertinentes de l'environnement. Ce phénomène génère ainsi de l'inattention, considéré comme un défaut de l'attention très spécifique. Tout d'abord, une étude méthodologique préliminaire a démontré que la procédure combinant la présentation de vignettes et de musique permettait d'induire efficacement de la tristesse et des ruminations, propices à l'inattention. Ensuite, dans une seconde expérience, la tristesse et les ruminations ont été induites à l'aide de cette procédure, dans l'objectif de provoquer une situation propice à l'inattention. Les effets de l'inattention ont ensuite été mesurés grâce à l'Attention Network Test, qui distingue trois fonctions attentionnelles indépendantes : l'alerte, l'orientation et le conflit. Les résultats sur les temps de réactions montrent que seule la fonction d'orientation est détériorée lorsque le sujet est inattentif, montrant des effets délétères lors du traitement des informations spatiales. Ces résultats seront discutés au regard de la littérature sur les émotions et sur l'attention.

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## 1. Introduction

Task efficiency in daily activities depends on the capability to select relevant information and inhibit distractors. Thus, dysfunctions of these two processes are supposed to generate maladjusted attention behaviours such as inattention. According to Lemerrier

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and Cellier (2008), inattention reflects a very specific deficit of selective attention, which has to be drawn up Posner's concept of endogenous orienting of attention (Posner, 1980). Precisely, it is the consequence of a long-lasting orienting of attention to a latent, non-salient, irrelevant and endogenous stimulus. In other words, inattention is a maladaptive orientation of attention on personal thoughts, i.e. attention self-focus, which occurs to the detriment of the processing of other relevant information.

Attentional self-focus is a main component in sadness (Frijda, 1986; Lazarus, 1991) and ruminations, i.e. repetitive negative thoughts that capture attention for a long period of time and preserve the negative emotional state (Joorman and Gotlib, 2008; McLaughlin et al., 2007; Nolen-Hoeksema, 1991, 2000; Nolen-Hoeksema et al., 2008). Specifically, ruminations related to sadness reflect a processing of repetitive negative thoughts that bear on circumstances of one's present sadness and which interfere with problem resolution and imposed goal-oriented tasks (Conway et al., 2000). Indeed, an abundant literature demonstrated an interference of both sadness and ruminations on information processing and particularly on attention processes (e.g., Huffziger and Kuehner, 2009; Watkins and Teadale, 2001). For instance, Philippot and Brutoux (2008) used a traditional Stroop test to measure the effects of dysphoria and ruminations on the inhibition and flexibility functions, in control and dysphoric groups. The two groups were induced in order to ruminate or to be distracted, creating four experimental conditions: control/rumination, control/distraction, dysphoric/rumination and dysphoric/distraction. Results indicated a degradation of the ability to impede irrelevant information when dysphoric and ruminating, compared to the three other conditions. Additionally, the cognitive flexibility was highly deteriorated for this group. Ruminations then alter the ability to inhibit and disengage attention to a different information source (Joorman et al., 2007; Leung et al., 2009). To our point of view, those results also provide evidence that sadness and ruminations provoke a long-lasting attention self-focus, leading to inattention, and affect attention control as defined by Posner (1980).

Indeed, Posner (1980) and later, Fan et al. (2002) characterized attention control as a combination of three attention functions: alerting, orienting and conflict (the executive control). Alerting helps in the performance of continuous and vigilance tasks (activation of different levels of alertness), orienting involves directing attention focus to a located stimulus to select information. Executive control, finally, requires the resolution of conflict among items. The three functions have been tested with the Attention Network Test (ANT), which is a visual-attention task combining a flanker task and a cued reaction time task (Fan et al., 2002). As it is showed in Supplementary data, Fig. 1b, the target is a leftward or rightward arrowhead surrounded by flankers, which can be neutral (no direction), congruent (same direction), or incongruent (opposite direction) with the target. Each target is preceded by a cue of four types: no-cue, double, central and spatial (Supplementary data, Fig. 1a). In their first study, Fan et al. (2002) tested the ANT efficiency and reliability with 40 normal adults. Results showed that alerting, orienting and conflict are not correlated, supporting the independence of the three functions. Precisely, alerting was characterized by a benefit of 47 ms when double cues were presented compared to no cues presentation. Orienting was characterized by a benefit of 51 ms when spatial cues were presented compared to central cues presentation. Finally, conflict was characterized by a benefit of 84 ms when flankers were congruent with the target, compared to incongruent flankers.

The ANT is a reliable and valid tool, which has already been used to test the relationship between attention and working memory capacity (Redick and Engle, 2006) or specific disorders such as schizophrenia or ADHD (Adólfssdóttir et al., 2008; Odludas et al.,

2008; Wang et al., 2005). Consequently, the ANT seems useful to measure the effects of inattention, due to sadness and ruminations on attention functions.

We challenge then the relevance and validity of the ANT to test the impact of inattention on the three independent attention functions. Plus, we examine the real impact of sadness and ruminations, considered here as main causes of inattention on alerting, orienting and conflict. Because inattention is precisely defined as a durable orientation of attention on negative thoughts, we presume that inattention will alter principally the orienting function.

Yet, before testing this hypothesis, we will propose a preliminary methodological study. It was conducted in order to determine the efficiency of two induction procedures, i.e. the autobiographical recall and the imagery procedure, to provoke sadness and ruminations, propitious to inattention.

## 2. Study 1: methodological preliminaries

In this paper, we hypothesized that sadness and ruminations give rise to attention self-focus, leading to inattention and subsequently affect attention functions, when performing the ANT. Before experimenting, a requisite is that sadness and ruminations have to be strong and durable to generate ruminations and then inattention. With regards to the abundant literature on induced sadness and depression (e.g., Clark, 1983; Scherrer and Dobson, 2009; Velten, 1968), induction procedures appear as an interesting experimental alternative to natural emotions. There are a large number of induction procedures including mood self-statements, social feedback, hypnotic suggestion, film, music, etc. (for a detailed review, see Gerrards-Hesse et al., 1994; Juslin et al., 2008; Gilet, 2008; Martin, 1990). According to Martin (1990), procedures which require participants' imagination are one of the most efficient. This category notably includes self-statements (Velten, 1968), autobiographical recall (Brewer et al., 1980) and combined imagery vignettes and music procedure (Mayer et al., 1995).

This first experiment was thus performed to compare the efficiency of the autobiographical recall and the imagery induction procedure, to provoke both sadness and ruminations in normal participants. It is also pointed out that some questionnaires such as the Response Style Questionnaire (RSQ, Nolen-Hoeksema, 1991) or the Beck Depression Inventory (BDI1A, Beck et al., 1996) help in discriminating the presence, the strength and the type of ruminations. Nevertheless, those questionnaires are principally addressed to a clinical depressed population. Because only normal people were recruited in our experiment, we used alternative techniques with standard questionnaires and a post-experimental interview to be sure of the presence of sadness and ruminations.

### 2.1. Method

#### 2.1.1. Participants

Forty-five undergraduate students from the University of Toulouse-2 voluntarily participated in the experiment. The sample consisted of 20 males and 25 females, ranging from 21 to 35 years (mean = 26.33 years, S.D. = 3.45 years). All had normal or corrected-to-normal vision. Participants were randomly assigned to one of the three experimental conditions: neutral induction (control;  $n = 16$ ), sad induction with the autobiographical recall ( $n = 15$ ) and sad induction with the imagery procedure ( $n = 14$ ).

#### 2.1.2. Materials

2.1.2.1. *Experimental inductions.* Neutral induction required the participant to constantly focus on technical characteristics of eight complex classic 1-min music pieces (e.g., prelude in B minor, op.28, No. 6 by Chopin). They had to determine the number and the type of all instruments for each excerpt. At the beginning of each excerpt,

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