Research in Developmental Disabilities 36 (2015) 384–395

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Is the impairment in temporal allocation of visual attention in children with ADHD related to a developmental delay or a structural cognitive deficit?

Sophie Donnadieu [a,b,*], Carole Berger [a,b], Marie Lallier [c], Christian Marendaz [a,d], Annie Laurent [e]

[a] Laboratoire de Psychologie et Neurocognition, CNRS UMR-5105, Grenoble, France
[b] Université de Savoie, BP 1104, 73011 Chambéry Cedex, France
[c] Basque Center on Cognition Brain and Language, Donostia-San Sebastian, Spain
[d] Université Pierre Mendès France, BP 47, 38040 Grenoble Cedex 9, France
[e] CHU de Grenoble, Département de Psychiatrie, 38000 Grenoble, France

ARTICLE INFO

Article history:
Received 20 June 2014
Received in revised form 3 October 2014
Accepted 10 October 2014
Available online 8 November 2014

Keywords:
ADHD
Development
Selective visual attention
Attentional blink
Inhibitory process

ABSTRACT

We investigated the temporal allocation of visual attention in 11-year-old children with attention-deficit/hyperactivity disorder (ADHD) by comparing their attentional blink (AB) parameters (duration, amplitude and minimum performance) with those observed in three groups of healthy control participants (8-year-olds, 11-year-olds and adults). The AB is a marker of impaired ability to detect a second target following the identification of a first target when both appear randomly within a rapid sequence of distractor items. Our results showed developmental effects; with age, the AB duration decreased and the AB minimum moved to shorter lag times. Importantly, 11-year old children with ADHD presented much the same similar AB patterns (in terms of duration and minimum position) as the healthy 8-year-old controls. Our results support the hypothesis whereby impaired allocation of temporal selective attention in children with ADHD is due to a developmental delay and not a specific cognitive deficit.

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) affects between 3 and 7% of school-age children (Barkley, 1990; Szatmari, 1992), with boys being over-represented. The disorder is not usually detected before school age. It persists into adolescence in 50–80% of cases clinically diagnosed in childhood and even persists into adulthood in 30–50% of cases (Barkley, Fischer, Edelbrock, & Smallish, 1990; Klein & Mannuzza, 1991; Weiss & Hechtman, 1993). According to the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5; American Psychiatric Association, 2013), ADHD is characterized by the presence of six or more symptoms of inattention and/or six or more symptoms of hyperactivity–impulsivity before the age of 7 in two or more contexts. On the basis of these three symptom dimensions, the DSM-5 defines three subtypes: ADHD-I (predominantly inattentive type), ADHD-H (predominantly hyperactive-impulsive

* Corresponding author at: Université de Savoie (Chambéry), Laboratoire de Psychologie et Neurocognition (UMR 5105), U.F.R. Lettres, Langues et Sciences de l'Homme, Département de Psychologie, Route du Sergent Revel, Jacob-Bellecombette, BP 1104, F-73011 Chambery Cedex, France.
Tel.: +33 479 758 582.
E-mail address: sophie.donnadieu@univ-savoie.fr (S. Donnadieu).

http://dx.doi.org/10.1016/j.ridd.2014.10.014
0891-4222/

type) or ADHD-C (combined type). Studies of the academic achievements of children with ADHD imply that they are more likely to obtain lower grades in standard measures (reading and maths, for example; see Barkley et al., 1990) than control children of equivalent intelligence. Aggression and conduct problems and depressive or anxiety disorders are often associated with a diagnosis of ADHD (Babinski, Hartsough, & Lambert, 1999; Beauchaine, Hinshaw, & Pang, 2010; Biederman et al., 2014; Halldorsdottir & Ollendick, 2014).

1.1. Temporal selective attention deficits in ADHD

In view of the obvious importance of attention in ADHD, many studies have tried to elucidate the mechanism underlying attention deficits. However, the results have been divergent (Blondis, Snow, & Accardo, 1999). Most studies differentiated between two main attentional processes: sustained attention and selective attention. A sustained attention deficit is defined as a gradual decline over time in the attention resources allocated to a given task. A selective attention deficit corresponds to difficulties in focusing on a relevant target while ignoring irrelevant information. Even though this topic has been hotly debated (for a review, see Wilding, 2005), previous research has indicated that children with ADHD suffer from sustained attention deficits more than they do from spatial selective attention deficits (Booth et al., 2005; Hazell et al., 1999; Karatekin & Asarnow, 1998; Mason, Humphreys, & Kent, 2003; Tsal, Shalev, & Mevorach, 2005; Van der Meere & Sergeant, 1988). Spatial selective attention has been studied through the application of visual search paradigms, in which participants are asked to detect the presence of a target among simultaneously presented distractors (Treisman & Gelade, 1980; Wolfe, 1998). The results of these studies showed that the time taken to correctly detect the target varies as a function of the number of distracters to be ignored. Other complementary studies have considered temporal aspects of selective attention by examining how the allocation of processing resources at one point in time might affect the processing of a subsequent event. Rapid serial visual presentation (RSVP) paradigms have been widely used to explore the temporal characteristics of information processing (Broadbent & Broadbent, 1987; Chun & Potter, 1995; Raymond, Shapiro, & Arnell, 1992; Reeves & Sperling, 1986; Shapiro, Raymond, & Arnell, 1994; Ward & Duncan, 1996; Weichselgartner & Sperling, 1987; for a review, see Shapiro, Arnell, & Raymond, 1997). Fig. 1a shows an example of an RSVP paradigm used to measure the attentional blink (AB) phenomenon. A participant's ability to detect a target (T2) in a control (single-target) condition is compared with his/her ability to detect the same target after already having identified a first target T1 (i.e. in a two-target condition). After the presentation of T1, the ability to detect T2 drops for a few hundred milliseconds; this phenomenon is referred to as the AB (Fig. 1b). Several explanatory models have been suggested (Chun & Potter, 1995; Raymond, Shapiro, & Arnell, 1995). The AB may occur because attention demands for the identification of T1 prevent (for a short period of time) the allocation of attentional resources to T2, which then become vulnerable to decay or overwriting by subsequent stimuli.

However, when T2 appears immediately after T1 (typically within 100 ms), its detection is not subject to an AB. This so-called "lag-1 sparing effect" (see Fig. 1b) has been ascribed to the dynamic functioning of an attentional gate (Chun & Potter, 1995; Shapiro & Raymond, 1994). The attentional gate may open rapidly when T1 is presented (in order to allocate attention to it) but may take some time to close and disengage attentional resources for T1. Sluggish closing may thus enable processing resources to access T2 at the same time as T1. In such a case, T1 and T2 will fall within a single attentional window lasting for at least 150–200 ms (Sperling & Weichselgartner, 1995). In addition to the lag-1 sparing effect, the AB is characterized by three other parameters (as defined by Cousineau, Charbonneau, & Jolicoeur, 2006; Fig. 1b). The amplitude of

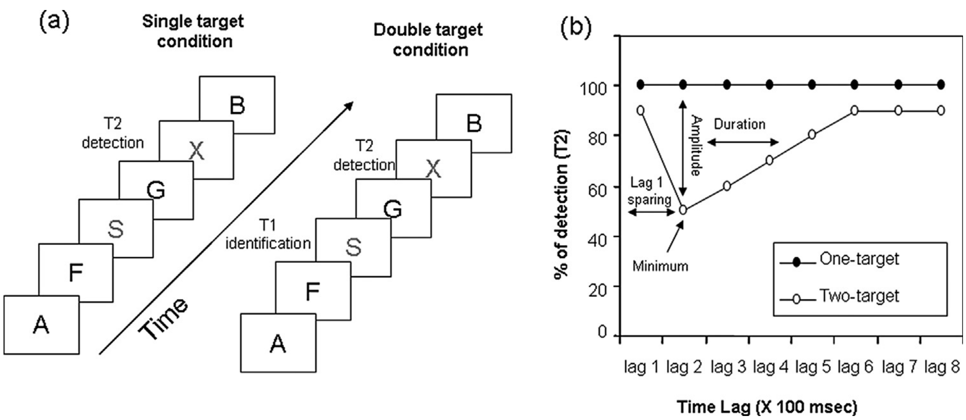

Fig. 1. (a) An illustration of the RSVP paradigm. In this behavioural task, a series of stimuli (letters, in this case) are presented in rapid succession. In the single-target condition, participants have to detect the presence of a target T2 (e.g. the letter "X"). In the two-target condition, participants have to identify an initial target T1 (e.g. the letter "S") and then detect T2 (e.g. the letter "X" from the single-target condition). (b) Typical AB curves for the detection of T2 in the single-target condition (filled circles) and the two-target condition (open circles). The vertical axis represent the accuracy of detection of T2 (i) in the single-target target condition (filled circles) and (ii) in the two-target condition (open circles) when T1 was successfully reported. The horizontal axis is the lag between the two targets (often a multiple of 100 ms).
Adapted from Cousineau et al. (2006).