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Attentional blink in adolescents with varying levels of impulsivity

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Abstract

We explore the temporal attention function in a non-clinical sample of adolescents varying in impulsivity, as assessed with the Barratt Impulsiveness Scale. In a Rapid Serial Visual Presentation task, in which two targets (T_1 and T_2) were presented in close temporal proximity among distractors, participants tried to identify T_1 and detect T_2 in one (dual-task) experiment and only to detect T_2 in a second, control (single-task) experiment. The sensitivity of T_2 detection was analyzed using signal detection theory. The attentional blink – the impairment in T_2 detection following the identification of T_1 – was increased in magnitude and protracted in adolescents with high impulsivity, compared with those with low impulsivity. Moreover, a few more participants with high impulsivity appeared to have a blink temporally weighing toward a later time, an observation also made in children with attention deficit hyperactivity disorder (ADHD) in an earlier study. Taken together, these findings suggest impairment in temporal attention in adolescents with high impulsivity. As in ADHD children, a gating deficit may play a central role in this attention impairment.

Keywords: Attention; Temporal; Gating; Attentional blink; Impulsivity; ADHD

1. Introduction

Impulsivity is an important behavioral construct that has attracted considerable clinical attention (Allen et al., 1998; Askenazy et al., 2003; Barratt et al., 1999; Brady et al., 1998; Cools et al., 2003; Corruble et al., 2003; Corruble et al., 1999; Dougherty et al., 1999a,b; Dougherty et al., 2000; Hoptman et al., 2000; Kashden et al., 1993; Lejoyeux et al., 1998; Mulder et al., 1999; Soloff et al., 2003; Swann et al., 2000; Welch and Fairburn, 1996). Perhaps because of the wide range of behavioral conditions in which impulsivity is involved, current knowledge of the biological or psychological basis of impulsivity has drawn heavily on studies of psychiatric disorders in which impulsivity is manifested. In particular, as impulsivity is a core behavioral deficit in children with attention deficit hyperactivity disorder (ADHD), a myriad of studies have addressed impulsivity-related issues in this disorder (Babinski et al., 1999; Barkley, 1992; Burns and Walsh, 2002; Bussing et al., 2002; Chhabildas et al., 2001; Gomez, 2003; McKay and Halperin, 2001; Oades et al., 2002; Overtoom et al., 1998; Perchet et al., 2001; Retz et al., 2003; Rubia, 2002; Vitacco and Rogers, 2001).

Laboratory measures of impulsivity have mainly focused on two different but not mutually exclusive dimensions: inability to delay reward, leading to a tendency to choose immediate small rewards over larger delayed ones (Monterosso and Ainslie, 1999; Sagvolden et al., 1998; Solanto et al., 2001; Sonuga-Barke et al., 1992); and inability to withhold inappropriate response, leading to errors of commission on tests that require updating of response strategy based on contextual

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information. In the latter conceptual framework, many studies have reported an increased number of commission error (response to a non-target) in the Continuous Performance Test (CPT), for instance, as a measure of higher impulsivity (Corkum and Siegel, 1993; Dougherty et al., 1999b; Inoue et al., 1998; Klorman et al., 1988; Parasnis et al., 2003), although the specificity of this finding has been questioned in others (Barkley, 1992; Epstein et al., 2003; Thompson and Nichols, 1992; see also Riccio and Reynolds, 2001 for a review). Likewise, increased failures in withholding a response (response despite signal to stop) in a go/no-go or stop-signal task have been suggested to reflect impulsivity in ADHD or other psychiatric disorders (Brown et al., 1989; Dougherty et al., 2003; Horn et al., 2003; LeMarquand et al., 1999; Marinkovic et al., 2000; Oades et al., 2002; Trommer et al., 1991). Within a broader conceptual scheme, increased perseverative error in the Wisconsin Card Sorting Test (i.e., an error made when one continues to sort card according to an earlier rule despite having been told that the rule is incorrect) has been suggested to implicate defective inhibitory function, leading to premature decision and response in the patients (Gansler et al., 1998; Gorenstein et al., 1989; Houghton et al., 1999; Loge et al., 1990; Rapport et al., 2001; Reeve and Schandler, 2001; Wilding et al., 2001). Behavioral paradigms less structured than these neuropsychological tests have also been used to study impulsivity in ADHD. For instance, using a variant of Posner's cuing paradigm, Perchet and colleagues characterized the neurophysiological correlates of attentional shifting (Perchet et al., 2001). It was found that, compared to healthy participants, ADHD children demonstrated more anticipatory errors along with physiological evidence for deficient early perceptual processing. The results were suggested to implicate motor impulsivity in these children. In essence, these neuropsychological studies have looked for an experimental analogue of behavioral impulsivity. They have provided an objective measure of impulsivity and an important first step toward delineating the perceptual, attention and decision processes underlying impulsivity.

Here we adopt a slightly different approach to examine impulsivity in this study. We examine whether impulsivity is a consequence of impaired cognitive function; specifically, whether it is correlated with a deficit in temporal attention in the first place. One could hypothesize that defective temporal attention lead to inefficient and strenuous processing of information and individuals may have learned to adapt to this difficulty by moving attention away from the current task before channeling processed information for adequate actions. This premature switch from one cognitive agenda to another may thus manifest as behavioral impulsivity. We explore this issue in a non-clinical sample of adolescents by examining whether there is a correlation between self-reported impulsivity as assessed by the Barratt Impulsiveness Scale (BIS, Patton et al., 1995) and temporal attention function, as demonstrated in a rapid serial visual presentation (RSVP) paradigm.

The RSVP task has been used extensively in the literature to explore the temporal characteristics of information processing (Broadbent and Broadbent, 1987; Chun and Potter, 1995; Raymond et al., 1992; Reeves and Sperling, 1986; Shapiro et al., 1994; Ward and Duncan, 1996; Weichselgartner and Sperling, 1987; see also Shapiro et al., 1997 for a review) and, more recently, to examine attention deficits in people with neurological and psychiatric disturbances (Hollingsworth et al., 2001; Husain et al., 1997; Li et al., 2002; Li et al., 2004; Rizzo et al., 2001; Rokke et al., 2002). Fig. 1 illustrates a typical example of this behavioral paradigm, in which a series of stimuli are presented in rapid succession and the

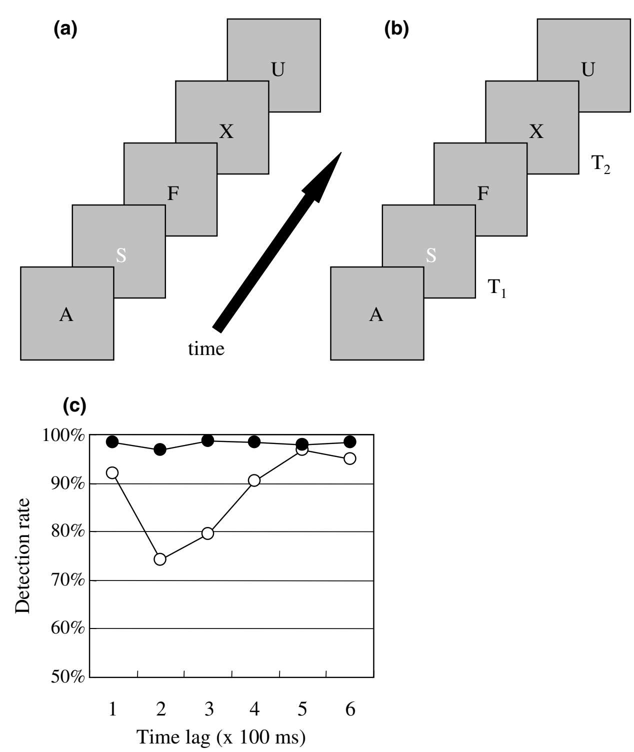

Fig. 1. A typical RSVP paradigm and attentional blink. (a) Single-target task. A stream of characters appears rapidly one after another. The participant's task is to identify whether there is an "X" in the stream. (b) Dual-target task. The visual display is exactly the same as in the single-target task. The participant has to identify the character that appears brighter than the others (T_1, an "S" in this case) and then detect whether there is an "X" (T_2) in the characters that follow T_1. (c) Attentional blink. The detection rate of "X" in the single- (filled circles) and dual- (open circles) target task is plotted with respect to the time "lag" between T_1 and "X". Characteristically, the detection rate of "X" in the dual-target task drops for a period of several hundred mseconds after the identification of T_1, compared to that in the single-target task.