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IMPULSIVENESS, AGGRESSION, READING, AND THE P300 OF THE EVENT-RELATED POTENTIAL

Eddie Harmon-Jones,* Ernest S. Barratt and Cindy Wigg

University of Texas Medical Branch at Galveston, Texas, U.S.A.

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Summary—In the present research, attentional impulsiveness and non-planning impulsiveness were found to relate positively with physical aggression, negatively with reading level, and negatively with the amplitude of the parietal-region P300 of the event-related potential evoked in an oddball and continuous performance task (CPT). In contrast, motor impulsiveness was found not to relate to aggression or reading level, but, interestingly, it was found to relate positively to amplitude of the parietal-region P300 in the oddball task. Additionally, physical and verbal aggression related negatively to reading level, whereas anger and hostility did not. Physical and verbal aggression also related negatively to the amplitude of the central- and parietal-region P300s in the oddball task but not in the CPT. Moreover, hostility related negatively to the amplitude of the central-region P300 in the CPT, but did not relate significantly to the P300 amplitude in the oddball task. Anger showed no significant relations with the amplitude of the P300 in any region or task. In addition to reading level relating negatively with these subtraits of impulsiveness and aggression, it related positively with the amplitude of P300. These results are discussed in terms of Eysenck's theory of impulsiveness. © 1997 Elsevier Science Ltd. All rights reserved.

INTRODUCTION

Previous research has demonstrated negative relationships between reading levels and impulsiveness, positive relationships between reading levels and the amplitude of the P300 component of the event-related potential recorded from the scalp, and negative relationships between impulsiveness and the amplitude of the P300 (e.g. Barratt, Stanford, Kent & Felthous, in press). Understanding these relationships is important because impulsiveness and verbal deficits relate to anti-social behavior (e.g. Eysenck & Gudjonsson, 1989; Lynam, Moffitt & Stouthamer-Loeber, 1993; Prentice & Kelly, 1963; West & Farrington, 1973; White, Moffitt, Caspi, Bartusch, Needles & Stouthamer-Loeber, 1994). In the present study, we examined relationships among these variables in an effort to better understand them.

Event-related brain potentials (ERPs), a non-invasive measure of neural activity related to sensory and cognitive information processing, have been used to assist in providing an understanding of dyslexia (Duncan, Rumsey, Wilkniss, Denckla, Hamburger & Odou-Potkin, 1994; Taylor & Keenan, 1990), attention-deficit hyperactivity disorder (ADHD; Klorman, Brumaghim, Salzman, Strauss, Borgstedt, McBride & Loeb, 1988), and impulsive and premeditated aggression (Barratt *et al.*, in press). The P300, an endogenous component of the ERP that measures cognitive processing, has been used successfully in much of this previous research. This research has shown that individuals who have dyslexia, ADHD, and impulsive aggression are more likely to have smaller amplitude P300s. These effects have emerged presumably because the reduced amplitude of the P300 reflects a reduction in attentional resources available for information processing, because these resources are not allocated effectively (Hoffman, 1990; Wickens, 1984), or because of decreased physiological arousal (Polich & Kok, 1995).

The negative relationship between impulsiveness and the amplitude of the P300 can be explained by Eysenck's (1993) theory of impulsiveness. According to Eysenck, impulsivity is due to low cortical arousal, and this low cortical arousal relates to poor functioning of the reticular activating system. With increased cortical arousal, activity in lower brain structures is inhibited, thus decreasing the probability of impulsive behaviors. In contrast, with decreased cortical arousal, activity in lower

* To whom all correspondence should be addressed at: University of Texas at Arlington, Department of Psychology, Box 19528, Arlington, TX 76019, U.S.A.

brain structures is disinhibited, thus enhancing the probability of impulsive behaviors. These ideas are supported by findings that indicate that impulsiveness is related to psychoticism and extraversion, and that psychoticism and extraversion are related to lower cortical arousal (Strelau & Eysenck, 1987). Additional findings supporting this idea are the effects of stimulant drugs decreasing impulsiveness (Eysenck, 1963; Eysenck & Gudjonsson, 1989) and increasing the amplitude of P300 (Klorman *et al.*, 1988). The negative relation between reading level and impulsiveness could be similarly be explained in terms of Eysenck' theory. That is, one could posit that lower cortical arousal causes poorer reading levels.

The present study

Thus, in the present study, we sought to assess the relationships between impulsiveness, aggression, reading level, and P300 evoked in two separate tasks. Few studies have assessed relationships between P300 and aggression. Moreover, very few studies have assessed this relationship in adolescents, and no studies have assessed it using both an oddball-type task and a continuous performance task (CPT). Thus, in the present study, we sought to extend this previous research by examining P300/aggression relations in adolescents, using two tasks designed to elicit the P300—an oddball task and a continuous performance task. Moreover, we also assessed the relations between these two variables and reading level and impulsiveness. Assessing all of the variables within one study allowed us to examine and thus contribute to an understanding of their interrelations.

We also attempted a more fine grained analysis of the interrelations among these variables by examining the subtraits of impulsiveness and aggression, both reading accuracy and reading comprehension, and the amplitude of the P300 in the mid-frontal, mid-central, and mid-parietal regions during an oddball-type task and a CPT. Our endeavour to examine the subtraits of impulsiveness and aggression was possible because of recent, large-scale, factor-analytic studies that have shown impulsiveness to be composed of three second-order factors, labeled attentional, motor, and non-planning impulsiveness (Patton, Stanford & Barratt, 1995), and aggression to be composed of four factors, labeled physical aggression, verbal aggression, anger, and hostility (Buss & Perry, 1992).

METHOD

Participants

Participants were 20 boys and 14 girls between the ages of 11 and 17 ($M = 12.91$) selected from an adolescent psychiatric in-patient unit at the University of Texas Medical Branch at Galveston ($N = 9$) or one of two middle schools located in Galveston, Texas ($N = 25$). They and their primary caretakers volunteered them to participate, and they received no compensation for participation. The racial composition of the sample was 12 Blacks, 10 Hispanics, 11 Whites, and 1 Asian.

Procedure

The session began at 9:00 a.m. Life history was assessed first. Participants were then prepared for the recording of an electroencephalogram (EEG). Participants performed an oddball-type task followed by two CPTs. A 45-min break was then taken for lunch. Participants were then administered eight subscales of the Wechsler Intelligence Scale for Children-III (Wechsler, 1991), the Gray Oral Reading Test (Wiederholt & Bryant, 1992), the Barratt Impulsiveness Scale (BIS-11; Patton *et al.*, 1995), Buss and Perry's (1992) aggression questionnaire, and other measures not relevant to the purposes of present research.

Psychophysiological recording

For the recording of the EEG, participants were seated in a comfortable chair in a dimly-lit room. They wore stereo headphones that emitted continuous white noise (in the 45–60 dB range) that masked extraneous sounds. EEG activity was recorded monopolarly using tin electrodes that were in a stretch-lycra cap (Electrocap). EEG activity was recorded from 29 scalp sites. All sites were referenced on-line to linked ear lobes. All electrode impedances were less than 5 K ohms. A Nihon Koden Electroencephalograph Model 4221 amplified signals by a factor of 20,000 (bandpass 0.026–