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Drug and Alcohol Dependence 82 (2006) 47–60
DRUG and ALCOHOL DEPENDENCE
www.elsevier.com/locate/drugalcdep

Neurocognitive skills moderate urban male adolescents' responses to preventive intervention materials

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Received 9 December 2004; received in revised form 10 August 2005; accepted 11 August 2005

Abstract

The present experiment was designed to determine whether individual variation in neurobiological mechanisms associated with substance abuse risk moderated effects of a brief preventive intervention on social competency skills. This study was conducted in collaboration with the ongoing preventive intervention study at Johns Hopkins University Prevention Intervention Research Center (JHU PIRC) within the Baltimore City Public Schools. A subsample ($N = 120$) of male 9th grade students was recruited from the larger JHU study population. Approximately half of the participants had a current or lifetime diagnosis of CD while the other half had no diagnosis of CD or other reported problem behaviors. Measures of executive cognitive function (ECF), emotional perception and intelligence were administered. In a later session, participants were randomly assigned to either an experimental or control group. The experimental group underwent a facilitated session using excerpted materials from a model preventive intervention, Positive Adolescent Choices Training (PACT), and controls received no intervention. Outcomes (i.e., social competency skills) were assessed using virtual reality vignettes involving behavioral choices as well as three social cognition questionnaires. Poor cognitive and emotional performance and a diagnosis of CD predicted less favorable change in social competency skills in response to the prevention curriculum. This study provides evidence for the moderating effects of neurocognitive and emotional regulatory functions on ability of urban male youth to respond to preventive intervention materials.

Keywords: Neurocognitive; Emotional regulation; Adolescents; Drug abuse; Prevention; Intervention

1. Introduction

Evaluations of a number of interventions for the general adolescent population provide evidence for their effectiveness in preventing or delaying onset of drug abuse (see especially Botvin et al., 1995; Eggert et al., 1994; Kellam, 1999; Olds et al., 1998; Spoth et al., 1998; Thompson et al., 1997; Webster-Stratton and Hammond, 1997). However, in all cases, substantial benefits have accrued only to a subset of participants (Conduct Problems Prevention Research Group, 1992; Kellam and Anthony, 1998; Greenberg and Kusche, 1996; Rebok et al., 1996) suggesting that individual-level characteristics may moderate responsiveness to prevention programs. Few studies have, however, attempted to delineate the individual characteristics that portend outcome. Once these factors are identified, prevention success can be potentially improved by targeting intervention strategies to specific facets of risk for substance abuse. Research on vulnerability and protective factors suggests that tailored, targeted interventions will be most effective when psychosocial manipulations are "matched" to an individual's unique constellation of social, psychological, and biological attributes, thereby reinforcing more adaptive and normative phenotypes (Scheier and Botvin, 1995).

Notably, evidence is accumulating to demonstrate that neurocognitive processes, especially deficits in executive cognitive

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0376-8716/$ – see front matter © 2005 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.drugalcdep.2005.08.008

function (ECF) and emotional regulatory capacities, amplifies risk for drug abuse (Aytaclar et al., 1999; Deckel et al., 1995; Fishbein, 2000; Harden and Pihl, 1995; Peterson and Pihl, 1990; Giancola et al., 1996) and propensity to relapse in drug abusers in treatment (Bauer, 1997; Self, 1998; Winterer et al., 1998). ECF, largely regulated by the prefrontal cortex (PFC) (Giancola et al., 1996; Grant et al., 1978; Meek et al., 1989), includes several dimensions of higher order cognitive processing skills, such as strategic thinking, attention, impulse control, working memory and self-monitoring of behavior during goal directed motivation, and assessing the consequences of behavior (Andrew and Bentley, 1978; Fishbein, 2000; Shafer and Fals-Stewart, 1997; Giancola et al., 1996). Youths at high risk for substance use perform poorly on neuropsychological tests measuring various aspects of ECF capacity, particularly impulsivity, risky decision making, inability to delay gratification, and inattention (Aytaclar et al., 1999; Blume et al., 1999; Giancola et al., 1996, 1998; Moss et al., 1997; Tarter et al., 1995; Weinberg, 1997).

Neurocognitive mechanisms that underlie the perception of emotional and social cues contribute to decision making within a social context. Emotional perception is modulated by neural connections between the PFC and limbic system. Deficits in ECF may affect emotional responses via a reduction in inhibitory controls and/or inaccurate appraisals of environmental or interpersonal inputs. Dysfunction of these emotional centers within the limbic system and PFC may play a direct, instrumental (not just a subservient) role in behavioral problems such as drug abuse by compromising the ability to regulate reactions to such inputs (Fishbein et al., 2005b; Weiss et al., 2001). Cognitive tasks that include an emotional component (e.g., aversive stimuli or penalties) invoke specific interconnected regions of the PFC and limbic system, suggesting that when task demands modify emotional functions, neural responses occur within this network (Elliott et al., 2000; Liberzon et al., 2000). Thus, a functional disconnection between the PFC and limbic regions may be responsible for a developmental lag in social competency skills, including disinhibited behavior, poor decision making, and poor emotional regulation (Davidson et al., 2000). In essence, the ability to perceive emotional cues and regulate affective responses in the form of effective and adaptive behaviors may be equally as important as higher order cognitive skills in understanding various competencies, including risk for drug abuse and ability to process and act on intervention curriculum materials.

Inasmuch as the prefrontal cortex does not functionally mature until early adulthood, ECF capacities accordingly improve with age; as children develop, they become more accurate, process information more quickly, and do so with increasing complexity and ease (Morris, 1998). It is thus plausible that the ECF impairments observed in high-risk youths reflect a neuromaturational disturbance. Given critical connections between the PFC and limbic structures, it is not surprising that childhood psychological characteristics associated with substance abuse risk also encompass disturbances in emotional regulation and behavioral undercontrol (Barkley et al., 1992; Nigg et al., 1999). In adolescence, maturational lags in the complexity and automaticity of ECF precursors become more obvious and may increase the likelihood of risk behaviors.

Externalizing behaviors such as conduct disorder (CD), frequently shown to magnify the risk for substance abuse (Clark and Cornelius, 2004; Chilcoat and Breslau, 1999; Tarter et al., 1999), are associated with impaired ECF capacity, behavioral dysregulation and deficient modulation of emotion (Bauer et al., 2001), suggestive of developmental delays (Giancola and Moss, 1998). CD children, particularly with the early age onset variant (Moffitt, 1993), may insufficiently experience emotional responses to negatively sanctioned behaviors and, thus, have a greater likelihood of engaging in high-risk behaviors. For these children, the prognosis is poor (Ruchkin et al., 2003; Herpertz et al., 2003; Dalsgaard et al., 2002). Whether prognoses can be improved following preventions tailored to the specific facets underlying the disorder and other related behaviors has yet to be determined.

Refraining from drug abuse requires development of multiple capacities, including risk appraisal, perception of social interpersonal cues, behavioral control and emotion modulation. Thus, delineating particular ECF and emotional substrates of behavioral disorders related to and including drug abuse may provide valuable insights for developing therapeutic interventions for children who tend to be refractory to both conventional and novel treatments. Intact ECF and its regulation of emotional tone may, in fact, be a prerequisite for a favorable response to any prevention or treatment program that involves cognitive processing of curriculum materials.

The model tested in the present experiment is based on the hypothesis that, while certain neurocognitive and emotional deficits may antedate and possibly contribute to drug abuse in general, specific functions may further moderate an individuals' ability to respond to intervention materials. Adolescents with and without CD were facilitated through a component of a selective intervention developed for high-risk urban minority youth that, similar to other programs, targets problem solving, sensitivity to consequences, regulating emotions, and resisting impulses. Processing of program materials requires children to (a) be cognizant of and responsive to potential negative consequences of their behavior, (b) inhibit inappropriate behavioral responses, (c) understand and act on the benefits of deliberate and cautious decision making, and (d) process and translate new information and social-cognitive skills training into pro-social behavior. This large laboratory-based experiment is the first attempt to explore the possibility that adolescents with deficiencies in these complex skills are less likely to benefit from universal prevention programs as adolescents with relatively higher levels of ECF and emotional regulation.

2. Methods

2.1. Background

This study accessed a subsample ($N = 120$) of 9th graders from a longitudinal project conducted under the aegis of the Johns Hopkins University Prevention Intervention Research Center (JHU-PIRC) (Furr-Holden et al., 2004; Ialongo et al., 1999, 2001) within the Baltimore City Public School System. The JHU-PIRC population consisted of 678 first grade students

distributed in 27 classrooms in Baltimore City public schools. The schools, located in the western section of the city, are in a region where the rate of crime, drug use and drug trafficking, and single mother homes is very high. Ten years of longitudinal data consisting of intelligence, school achievement, psychological and psychiatric status, drug use, neighborhood conditions, and behavioral information has been collected from students, parents, teachers, and peers on this prospectively studied population. The subsample selected from this larger population for the present study is described below.

2.2. Participants

Students were identified from the JHU longitudinal database and were all male and primarily African-American. Half of the sample selected had a past or current diagnosis of CD to ensure sufficient numbers of high-risk youth; however, CD was not the basis for assessing group differences. Consistent with that diagnosis, these youth also exhibited other indicators of risk behaviors, including measures of delinquency and school misconduct ($N = 57$). Diagnoses were based on lay interviewer administration of the C-DISC-IV to the youth and a parent; a diagnosis generated by either the child or the parent was considered for this characterization. Another sample was selected without any current or past diagnosis of CD or other externalizing behaviors ($N = 63$). The total number of refusals was 47 (20 with CD and 27 without CD). Only males were recruited given that the females had a very low rate of CD diagnoses; thus, the sample for this group would have been too small for gender comparisons. The average age of participants was 16, 105 were African-American, and their mean full scale IQ was 82 (S.D. = 13).[1] Recruitment of students falling into one of these groups occurred during JHU interviews of parents; JHU interviewers informed parents of the additional testing and requested permission for RTI research staff to contact them. Research staff conducted follow up phone calls to interested parents and sent them a new consent form. After obtaining parental consent, research staff tested each participating student at baseline using an extensive neurocognitive and behavioral test battery, followed by an acute laboratory intervention and subsequent outcome evaluation 6–8 weeks later. A break and a snack were provided to students whenever needed. Monetary compensation was provided for each test session.

2.3. Protocol design

Testing was conducted in the same youth-friendly laboratory-type environment during two sessions. In the baseline session, participants received an IQ test, a neurocognitive test battery, and "outcome" measures of social competency skills, including both virtual reality and questionnaires, as described below. In the subsequent session 6–8 weeks later, participants initially completed the Facial Recognition Task (the last neurocognitive task). Half of the participants were subsequently exposed to an acute intervention stimulus and the other half received no intervention, although all other testing conditions were identical. CD was nearly equally distributed between the two groups: no CD and no intervention = 34; no CD and intervention = 30; CD and no intervention = 31; CD and intervention = 26. Outcome measures were then readministered and two additional forms were completed to assess participants' level of engagement and other reactions to both the virtual reality measure and the brief intervention. Longitudinal data on behavior, psychological state, psychiatric diagnoses, drug use, and other extensive background information was collected by JHU previously and, thus, no additional personal information was collected during these two test sessions.

2.4. Instrumentation

Tasks specifically selected for this study were designed to measure sensitivity to consequences, impulsivity, risky decision-making, delay of gratification, and facial (emotional) recognition. These functions are conceptually consistent not only with the phenomenology of drug abuse, but with presumptive neurocognitive prerequisites of ability to process prevention materials in order to test our primary hypotheses. Also, these tasks have been shown in neuroimaging studies to activate regions of the PFC and functionally relevant regions of the limbic system. Knowledge regarding the functional neuroanatomy of a neurocognitive task has potential implications for understanding the pathophysiology of behavioral dysregulation and a mechanistic account of how interventions mediate their effects (Charney and Deutch, 1996; Bremner, 2003). The following tasks were administered as part of the baseline assessment.

2.4.1. Estimated IQ

An estimate of IQ was derived from the vocabulary and block design subtests of the Wechsler Intelligence Scale for Children-III (WISC-III; Wechsler, 1974, 1991). The combination of these subtests correlates positively at more than 0.90 with full scale IQ (Sattler, 1988). Adjustments were made in analyses for IQ, assuming the hierarchical nature of complex cognitive functions (Zelazo et al., 1997), with the intention of isolating effects of higher order neurocognitive abilities on intervention outcomes.

2.4.2. Dice task

This task was adapted from the Rogers Decision Making Task (RDMT) for use with adolescents. The RDMT has been shown to dissect cognitive components of sensitivity to consequences and risk taking and consistently activates the orbital portion of the prefrontal cortex in neuroimaging studies (Fishbein et al., 2005a; Rogers et al., 1999). This region has been consistently shown to modulate both higher order cognitive functions, such as risky decision making and consequence sensitivity, and emotional responses environmental and social stimuli (Bechara et al., 2000; Bolla et al., 2003). The computer screen displays six dice faces, some in yellow and others in blue. They are told

[1] As described below, IQ was based on the vocabulary and block design components of the WISC-III. Both scores were relatively low in this population; however, mean scores on the vocabulary portion, which is sensitive to experience and level of education, were particular low.

that the number of yellow (Y) versus blue (B) faces will change as they play the game and to select the color that they believe will result in a "win" when the dice is rolled. Participants are instructed that the probability of either color being the winner is based upon the ratio of the number of yellow to blue faces; 1:5, 2:4, and 3:3. This decision further involves gambling a certain number of points associated with each yellow versus blue ratio; 10 points for blue and 90 points for yellow; 20 points for blue and 80 for yellow; 30 points for blue and 70 points for yellow; 40 points for blue and 60 points for yellow; and 50 points for blue and 50 points for yellow. The ratio of colored boxes and the balance between the associated rewards vary independently from trial to trial according to a fixed pseudorandom sequence. This sequence ensures that each balance of reward and each ratio of colored die co-occurred an equal number of times, with the restriction that on all trials with an unequal ratio of yellow and blue die (i.e., 1:5 or 2:4), the larger reward was always associated with the least likely outcome (i.e., yellow faces), thus capturing the conflict inherent in risk taking situations. Correct choices result in the addition of those points to the total score; however, the same number of points will be subtracted if the choice is incorrect. At the start of each sequence, the subject is given 100 points and instructed to make whatever choices are necessary to increase this score. A tendency to take more risks in all conditions in pursuit of a large reward and a willingness to tolerate an even higher probability of a large loss was expected to predict a lack of positive behavioral change in response to the experimental intervention. Performance measures generated by this task included in our model are (1) number of the riskiest decisions (i.e., one yellow die face associated with 90 points); (2) mean deliberation time for entire task; and (3) mean deliberation time for riskiest decision.

2.4.3. Stop Signal Task (Solanto et al., 2001)

This task measures impulsivity and distractibility and has been shown to activate the right hemispheric anterior cingulate cortex, supplementary motor area, and inferior prefrontal and parietal cortices, which modulate error monitoring, interference control, and task management (Rubia et al., 2001). The training portion of the task begins with the computer alternately displaying an asterisk and a circle. Participants are instructed to press the left button on a button box when the asterisk is displayed and the right button on a button box when the circle appears, both as quickly as possible. If the response is too slow, the screen exhibits "too slow" and, if they respond before the stimulus is presented, the screen exhibits "too fast".

Following this training exercise, the formal task is automatically invoked. The same stimuli are presented, however if a tone sounds after the stimulus is presented, subjects must alter their response and press the middle button on the button box. If the right or left button is pressed before the tone is presented, the screen presents an "incorrect" display and the next trial is presented. The interval between the stimulus and the distracting tone varies throughout the task; shorter delays are easier than longer delays that occur well after stimulus presentation. Central measures generated by this task include: (1) number of correct responses for baseline; (2) number of correct responses for the short tone delay and the lengthy tone delay portions of the task; (3) commission errors; and (4) omission errors.

2.4.4. Choice Delay Task (Sonuga-Barke and Taylor, 1992)

This delay of gratification task creates a tension between (1) selecting an option slowly but earning more points and (2) selecting more quickly but earning fewer points. Imaging research (Davis et al., 2002) suggests that this task activates the anterior attention system (Posner, 1995) and paralimbic cortex (McClure et al., 2004), responsible for the perception and experience of emotionally salient stimuli. Participants choose between response options that either require a 30 second delay to earn more points or no delay to earn fewer points. Instructions for this task were intentionally vague; that the object is to earn as many points as possible, but that there is no right or wrong choice. No encouragement or advice is given, however, regarding the particular strategy to use. Participants were instructed that, depending upon how they performed, a monetary reward may be provided. At the end of the task all participants are paid $5. Prior to implementing this task, the implications of their choices are discussed with the participants to ensure that they understand the "smaller sooner" versus "larger later" distinction. The scores are the number of smaller sooner responses and omission and commission errors.

2.4.5. Facial Recognition Task (Ekman and Friesen, 1975)

This task measures the ability to accurately identify emotional expressions in other people's faces. This ability has been directly related to the function of the brain's amygdala (responsible for perception of negative emotions) and is shown to be impaired in children and adults with externalizing disorders, such as conduct disorder, violence, and drug abuse (Blair et al., 1999; Phillips et al., 1997; Calder et al., 1996). Participants are instructed to identify the emotion (happy, anger, disgust, surprise, sadness, and fear) that best describes the facial expression. A practice trial familiarizes the subject with the procedure, after which 60 pictures of varying emotional intensity are presented. The scores produced include the number of errors in attributions of each emotional expression and total correct responses.

2.5. Brief experimental intervention

Curriculum materials were excerpted from Positive Adolescent Choices Training (PACT), a prevention program that targets high-risk, African-American youth between the ages of 12 and 16. It was designed to teach specific social skills that will help reduce teens' risk of becoming victims or perpetrators of violence. PACT is recommended by the Hamilton Fish School Violence Prevention Center and by the CDC's Division of Youth Violence Prevention within the National Center for Injury Prevention and Control (Thornton et al., 2000). PACT training goals are to (1) learn appropriate and socially effective ways of interacting with others, (2) recognize and control angry emotions that can interfere with verbal resolutions to conflict, and (3) understand and avoid violence risk (Yung and Hammond, 1998). Like the components of many other "effective" prevention programs, PACT training involves problem

solving, negotiating outcomes, processing feedback, and resisting temptations. Participants must be sensitive to consequences of their behavior, able to inhibit inappropriate behavioral responses, able to understand and act on the benefits of deliberate and cautious decision-making, and to process and apply information and skills conveyed by the PACT curriculum to respond favorably. Differential responses to such programs, therefore, may be a function of the integrity of these cognitive and affective skills in recipients (see Graham and Harris, 1999, p. 349). PACT's curriculum is particularly relevant to this study given that psychosocial outcomes targeted by the program, including several indices of antisocial behavior, are risk factors for adolescent drug abuse (Hawkins et al., 1992). More specifically, among the strongest psychosocial predictors of drug abuse in African-American youth are beliefs supporting aggression, hostility, and conflict-resolution skills (more than perceived risk) (Orozco and Lukas, 2000; Paschall and Flewelling, 1997). Furthermore, early initiation of drug use and peer drug use may be early risk factors for violence (Ellickson and McGuigan, 2000), and early aggressive behavior predicts later drug abuse (Kellam and Anthony, 1998; Rebok et al., 1996). Thus, aggressive behavior and drug abuse may share antecedents that should be targeted in prevention programs.

The PACT program uses interactive strategies that allow students to observe and practice positive behaviors in group meetings and at home. Three training videotapes feature real-life conflict situations and are realistic in terms of cultural issues, language, and dress. They also do not require any prior skill building exercises, and are expected to affect social-cognitive skills related to risk for drug abuse. One videotape, "Workin' It Out" (how to negotiate a solution without resorting to aggressive or violent behavior) was chosen for this experiment given that the skills targeted by the role play are conceptually related to skills implicated in resistance to drug abuse (Botvin, 2000; Botvin et al., 1995). The videotape presents a conflict situation that can escalate into a potentially dangerous confrontation. Exposure to the videotape was facilitated by trained staff that froze the action on occasion to teach skills that could have been used to defuse the situation. Participants were encouraged to replay the action through a brief discussion using newly learned problem solving skills. Although the PACT curriculum in its entirety is designed to affect behavioral and social cognitive skills, like most programs, this acute experimental exposure is not expected to be sufficient to invoke long-term change in these processes.

2.6. Outcome measures of social competency skills

Two different measurement strategies were used to gauge intervention-induced change in social competency skills at baseline and post-intervention: three interactive virtual reality vignettes and three multi-item self-report measures of violence-related psychosocial constructs. Both were designed to measure social-cognitive and behavioral skills that are targeted by the PACT curriculum (e.g., ability to negotiate, request more information, delay gratification, control impulses, etc.).

2.6.1. Virtual reality (VR) vignette exercises

Desktop VR vignette exercises were developed using 3D graphical software and language processing technology to simulate real life interpersonal verbal interactions (Hubal et al., 2003). Based, in part, on the content of the scenario in the PACT video, scripts were developed for a virtual teenage character to entice the participant to engage in several types of risky behavior. The scripts included provocative introductory statements and multiple response options for different types of verbal feedback from the participant, including questions intended to elicit additional information from the virtual character and statements expressing the participant's position or preference. An algorithm was developed by which the virtual teenager would initially entice the risky behavior but gradually back off if the participant demonstrated appropriate avoidance and/or de-escalation behavior (i.e., information seeking, negotiation) (Hubal et al., 2004). The language employed by the virtual teenager was modeled on that used by youth in the study sample, though for the present study, speech was computer-generated. The virtual teenager remained in one position because the entire interaction was based primarily on conversation, so the gestures were not complex, relying mostly on beat gestures and idle motions. However, when the virtual character became agitated or aggressive, the gestures became more representational (e.g., pushing, pointing, placing hands on hips, backing away), depending on the content of the conversation.

The participants were informed that they would be interacting with a teenage character on the computer and that they should behave just as they would in real life. They were told that the character could hear them and would respond directly to their utterances; the tester recorded participant responses according to a categorical scheme behind participants on a keyboard to produce standardized responses which elicited a direct response by the virtual character. They were also told that there were no correct responses. At the beginning of the first scenario, the virtual character introduced himself as "Greg" and asked the participant questions to provide practice and familiarization with the interactive procedure.

Three scenarios were developed and administered in random order at both baseline and post-intervention. For baseline testing, Scenario 1 consisted of the virtual teenage character asking the participant to store a gym bag with unknown materials in his school locker. The virtual character provided no information about the gym bag contents. Participants who asked about the contents were told by the virtual character not to be concerned and to put it in their locker. If the participant inquired further, he discovered that a pair of sneakers was in the gym bag and, although never explicitly stated, there were inferences that they were stolen. Thus, participants who agreed to store the bag in their locker were taking a risk. Participants who declined to keep the bag were enticed with a large bribe from the virtual character that they would receive in one week. If the participant refused, then a smaller, immediate reward was offered as an indication of ability to delay gratification. The participant could also refuse the immediate reward.

In Scenario 2, the virtual character invited the participant to attend a drinking party with girls at his home. A request

by the subject for either information or a rejection of the offer elicited a persuasive response from the virtual character. Eventual decline of the invitation was indicative of strong social competency skills, while an acceptance indicated poor skills. In Scenario 3, the virtual character accused the participant of bumping into him in the hallway and began to provoke a fight. If the participant declined the challenge, the virtual character made provoking comments. Participants responding to the provocation in an inflammatory manner were aggravated further by the virtual character. These situations represented actual experiences of urban minority adolescents that are used for role plays in prevention programs such as PACT (Yung and Hammond, 1998) and life skills training (Botvin, 2000; Botvin et al., 1995).

The post-test measure consisted of another set of three virtual reality vignettes that were based on the same concepts, but varied slightly with respect to social context. The drinking game with girls was altered to be a joy-ride in the parents' car; the scene in which the virtual character is bumped was replaced with a fight about a girlfriend; and the gym bag of stolen sneakers was changed to a stolen wallet.

Social competence was rated according to the participant's verbal and non-verbal behavior along seven dimensions using a 5-point scale, from low to high level of function: general engagement, verbalizations, emotion control, information seeking, expressing preferences, compromise/negotiation, and non-provocative style. The ratings conducted independently by two individuals had an excellent level of agreement (Cohen's kappa = 0.92–0.97). Exploratory factor analysis revealed two multi-item factors that reflected emotional composure and interpersonal communication style (Chronbach alpha > 0.88). Additional analyses with baseline data provided further evidence that these novel measures of social competency skills had good psychometric properties, as they were associated with other psychosocial and behavioral measures in the expected directions (Paschall et al., 2005).

2.6.2. Psychosocial factors

2.6.2.1. Beliefs supporting aggression. Participants completed a 10-item self-report questionnaire, adapted from Slaby and Guerra (1988) to measure Beliefs Supporting Aggression. They were asked how strongly they agreed or disagreed with statements such as, "It makes you feel big and tough when you push someone around," and "A guy who doesn't fight back when other kids push him around will lose respect." The mean score was computed for each participant.

2.6.2.2. Conflict-resolution style. Four vignettes, developed by Slaby and Wilson-Brewer (1992), were administered to reflect Conflict-Resolution Style. Participants were presented with a hypothetical confrontational situation and then queried about how they would respond. The response options were (1) verbal aggressive, (2) information seeking, (3) passive non-response, (4) verbal assertiveness, and (5) physical aggressive. Responses were rated 1–4 according to the following characteristics: neither verbally nor physically aggressive (1); verbally but not physically aggressive (2); physically but not verbally aggressive response (3); verbally and physically aggressive (4). The mean score was computed for each participant across all four vignettes, with a higher score indicating a more aggressive conflict-resolution style.

2.6.2.3. Hostility. A 5-item hostility rating, based on the symptom checklist-90 (Derogatis et al., 1973), was administered. Participants were asked questions such as, "How often do you have temper outbursts that are hard to control?" Responses were scored on a 4-point scale ranging from "never" (1) to "most of the time" (4). The mean was computed for each participant.

A pre–post change score was computed for each outcome measure described above and used in statistical analyses to test the primary study hypothesis. Higher change scores reflect positive change in the social competency skills targeted by the excerpted PACT curriculum.

2.7. Drug use

The drug and alcohol use component of the private youth interview was self-administered in the larger longitudinal JHU study via a computer with audio and visual presentation of the questions. Measures are consistent with the national monitoring the future (MTF) survey (Johnston et al., 2004). The measure of self-reported lifetime illicit drug use during grade 10 was used for purposes of the present study to assess its relationship with social competency measures. Drugs included in this assessment were marijuana, cocaine, crack, inhalants, heroin, and ecstasy.

2.8. Statistical analyses

A conceptual basis for this study was that social competency skills often targeted by prevention programs are (a) predictive of drug use and (b) malleable with the appropriate intervention. Hypothetically, those who show a lack of improvement in these skills in response to an intervention may have ECF and emotional perception deficits that interfere with intervention effects. Thus, in order to substantiate the relationship between a relative lack of change in these skills and actual drug use, participants with and without any prior illicit drug use self reported in the 10th grade were initially divided. Group comparisons of social competency change scores were performed using analysis of covariance (ANCOVA) as a validity check based on the expectation that constructs reflecting less behavioral change would characterize the drug use group.

The primary hypothesis was tested using linear regression analyses for multiple variables. For each behavioral outcome, the before/after change in measure from pre-intervention to post-intervention was modeled as a function of treatment status (intervention or control), and an interaction between treatment status and neurocognitive, emotional and CD variables, as well as IQ (a covariate). Thus, the models fitted were of the following form:

$$Y_{ij} = \mathrm{b0} + \mathrm{b1} \times \mathrm{Tx}_i + \mathrm{b2} \times \mathrm{Tx}_i \times M_{ik} + \mathrm{b3} \times \mathrm{IQ}_i + e_i \quad (*)$$

where Y_{ij} is the pre/post-intervention change for the jth outcome from the ith participant, Tx_i denotes his treatment status

(0 for control and 1 for intervention), M_{ik} the kth neurocognitive/emotional moderating factor (or CD indicator) for this subject with IQ_i, e_i is a normally distributed random error term and b0–b3 are regression coefficients, $i = 1, 2, \ldots, n$ (total number of participants); $j = 1, 2, \ldots, p$ (total number of outcomes); $k = 1, 2, \ldots, q$ (total number of moderating factors). Thus, a total of $p \times q$ models of this type were fitted, and in each case interest was focused on determining whether b2 was statistically significant, which would provide evidence that neurocognitive abilities and the presence of a CD diagnosis modify the impact of the intervention on behavioral outcomes. In a separate series of analyses, CD was also included in model (*) as another covariate, but the results for the neurocognitive factors were unaltered and, thus, are not shown herein. Also, it should be noted that the first grade intervention was not related to any of the outcome variables in this study.

3. Results

3.1. Association between social competency skills and illicit drug use

Significant differences in most of the baseline social competency skills measures were observed between adolescents who reported a history of illicit drug use (primarily marijuana) compared to youths who had no history of illicit drug use. As expected, results in Table 1 show that adolescents who reported any use of illicit drugs in the past had generally lower levels of baseline social competency skills than those who had not yet used illicit drugs. These findings are consistent with expectations that poor social competency skills would be associated with onset of drug use.

3.2. Differential effects of intervention materials on behavioral outcomes

3.2.1. Virtual reality outcome measures

Table 2 provides a summary of results of regression analyses conducted to assess differential effects of selected intervention materials on performance on neurocognitive and emotional perception tasks. Analysis results (i.e., t statistics for intervention × moderator term) indicated that performance level on the three neurocognitive tasks and the emotional perception task moderated effects of the intervention materials on VR measures of emotional composure and communication skills. The first row in Table 2 shows that the effect of the intervention on emotional composure depended on the total number of correct responses on moderately difficult trials (delays in tone midway between stimulus and end of trial) of the stop signal task (t value = 2.64; $p = 0.009$); participants with poorer performance on this neurocognitive task had less improvement in emotional composure scores in response to the excerpted intervention materials. The rest of the table shows that trends for similar moderating effects were observed for the total correct score in most difficult trials (lengthy delays in tone that occur just before end of trial) (t value = 1.67; $p = 0.098$) and number of correct responses identifying sadness expressions on the facial recognition task (t value = 1.76; $p = 0.08$). The intervention was less effective in improving interpersonal communication skills among participants who were not able to accurately detect the facial expression of fear (t value = 2.44; $p = 0.016$). Selection of high-risk choices on the dice task also marginally lessened intervention effects on improvement in interpersonal communication skills (t value = 1.73; $p = 0.087$). Similarly, participants diagnosed with CD had relatively less improvement in interpersonal communication skills in response to the PACT program component relative to participants without CD (t value = 2.78; $p = 0.006$).

3.2.2. Psychosocial outcomes

The moderating effects of measures from all four tasks on psychosocial outcomes are also summarized in Table 2. Less positive change in the hostility rating in response to exposure to the intervention was associated with several neurocognitive factors primarily reflective of impulsivity and failure to accurately identify emotional cues, specifically including (1) a higher number of omission errors during the baseline phase of the Stop Signal Task (t value = 2.08; $p = 0.04$), (2) commission errors on the Choice Delay Task (t value = 2.2; $p = 0.03$), and (3) an increased number of errors on a few dimensions of the Facial Recognition Task (total score: t value = 2.08; $p = 0.04$; happiness: t value = 1.65; $p = 0.10$; disgust: t value = 1.86; $p = 0.065$; anger: t value = 2.0; $p = 0.048$). A relative lack of change in beliefs supporting aggression from exposure to the intervention was predicted by several indicators of risky decision making, including (1) longer reaction time while making the riskiest decision (t value = 1.95; $p = 0.053$), (2) longer average reaction time throughout the task (t value = 2.84; $p = 0.005$), and (3) a somewhat higher rate of selecting the riskiest decision (t value = 1.90; $p = 0.06$). And finally, CD played a marginal moderation role on intervention effects on conflict-resolution skills; i.e., those with CD tended to show less improvement in conflict-resolution skills from pre to post-intervention (t value = 1.75; $p = 0.08$).

Table 1
Differences (ANCOVAs) between participants with and without prior illicit drug use in baseline social competency measures reported at age 15

Baseline measures of social competency	No illicit drug use ($N = 63$): mean (S.D.)	Prior illicit drug use ($N = 52$): mean (S.D.)	F ratio (sig)
Emotion composure	0.03 (1.09)	−0.05 (0.91)	0.16 (NS)
Communication	0.22 (1.05)	−0.21 (0.92)	5.70 (0.019)
Beliefs supporting aggression	2.12 (0.35)	2.30 (0.48)	7.10 (0.000)
Aggressive conflict-resolution	1.80 (0.75)	2.40 (0.92)	14.30 (0.000)
Hostility	1.76 (0.53)	2.14 (0.54)	14.90 (0.000)

Table 2
Linear regression analyses showing that poorer neurocognitive performance attenuated the effects of exposure to the preventive intervention materials

Moderating factor	Outcome	*t* value (*p* level) for PACT × moderator term	Interpretation
Impulsivity (total correct – lengthy delay)	Emotional composure	1.67 (0.098)	Lower impulsivity enhanced PACT effects on emotional composure
Impulsivity (total correct – moderate delay)		2.64 (0.009)	
Emotion misattribution (errors – sad faces)		1.76 (0.080)	Misattribution of sad faces attenuated PACT effects on emotional composure
Risky decision making (riskiest selection)	Communication	1.73 (0.087)	Risky decision making attenuated PACT effects on communication
Conduct disorder		2.78 (0.006)	CD attenuated PACT effects on communication
Emotion misattribution (errors – fearful faces)		2.44 (0.016)	Misattribution of fearful faces attenuated PACT effects on communication
Impulsivity (total omission errors)	Hostility rating	2.08 (0.04)	Higher impulsivity attenuated PACT effects on hostility
Delay of gratification (total commission errors)		2.20 (0.03)	Higher hyperactivity/impulsivity attenuated PACT effects on hostility
Emotion misattribution (total correct for all faces)		2.08 (0.04)	Accurate attribution of emotional expressions enhanced PACT effects on hostility
Emotion misattribution (errors – happy faces)		1.65 (0.10)	Misattribution of happy, disgust and angry faces attenuated PACT effects on hostility
Emotion misattribution (errors – disgust faces)		1.86 (0.06)	
Emotional misattribution (errors – angry faces)		2.0 (0.05)	
Risky decision making (reaction time for riskiest decision)	Beliefs supporting aggression	1.95 (0.05)	Risky decision making attenuated PACT effects on beliefs supporting aggression
Risky decision making (average reaction time for all scenarios)		2.84 (0.005)	
Risky decision making (riskiest selection)		1.90 (0.06)	
Conduct disorder	Aggressive conflict-resolution	1.75 (0.08)	CD attenuated PACT effects on aggressive conflict-resolution

The *t* value reflects the extent to which the interaction between PACT exposure and neurocognitive functioning effects intervention-related behavioral change (e.g., hostility or emotional composure).

Differential intervention effects are illustrated in Figs. 1 and 2 which show the results of separate univariate ANCOVAs comparing session two means (adjusted for baseline outcome and IQ) for aggressive conflict-resolution style and communication skills by intervention exposure and CD status. These figures demonstrate that subjects without CD responded more favorably to the intervention materials than did subjects with CD in terms of aggressive conflict-resolution ($F = 4.8$, $p = 0.04$) and communication skills ($F = 5.5$, $p = 0.02$), respectively.

3.3. Effect of IQ

The mean full scale IQ for this sample was particularly low (~82), suggesting the possibility that more general deficits in subservient functions, manifested as higher order cognitive deficits, may plausibly relate to intervention response. To avoid this possibility, adjustments were made for IQ to isolate the effects of specific ECF deficits that may affect differences in intervention response. Also, correctional analyses showed that the CD groups did not differ on full scale IQ. As CD was not the basis for analyses, however, additional analyses were also conducted to determine whether IQ was related to (a) primary measures of cognitive performance on tasks and (b) difference

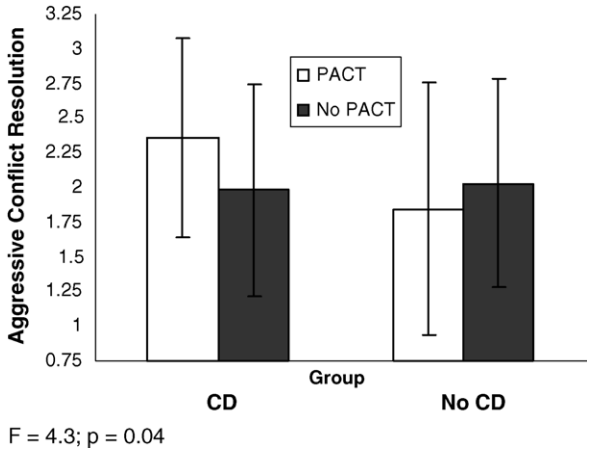

Fig. 1. For the regression model testing PACT and CD group effects on aggressive conflict-resolution style, session 2 outcome means and S.D.s are shown by PACT and CD status, with adjustments for baseline outcome means and IQ, representing different responses by CD and no CD participants to the intervention. PACT effects on conflict-resolution style were stronger among subjects without CD while CD participants actually worsened with PACT.

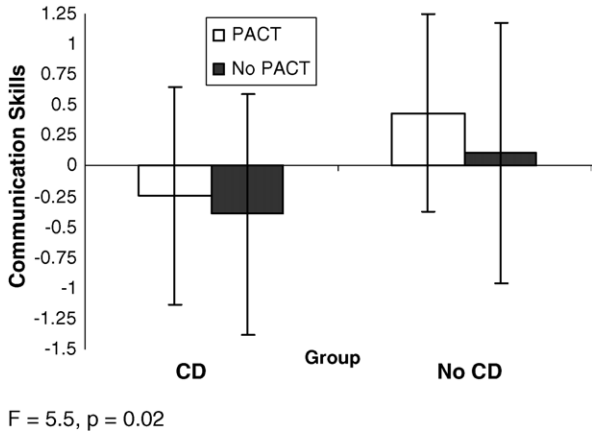

Fig. 2. For the regression model testing PACT and CD group effects on communication skills, session 2 outcome means and S.D.s are shown by PACT and CD status, with adjustments for baseline outcome means and IQ, representing different responses by CD and no CD participants to the intervention. PACT effects on communication skills were stronger among subjects without CD while CD participants actually worsened with PACT.

scores. The data support the notion that IQ is not directly related to performance on these tasks, particularly the dice task; there were no significant relationships whatsoever. The only significant relationships between IQ and task performance were for the Facial Recognition Task (ranging from $R = 0.24$ [$p = 0.007$] to 0.48 [$p = 0.0001$]), which has been previously reported (Simon et al., 1995) and for the "easy" trials on the stop signal ($R = 0.20$, $p = 0.02$). There were no significant relations found between IQ and difference scores on outcome measures. In sum, significant findings for effects of dimensions of ECF and emotional perception on intervention response persisted with adjustments for IQ.

4. Discussion

In the present study, performance measures from each of the neurocognitive and emotional perception tasks moderated effects of the abbreviated intervention on outcome measures of social competency skills (e.g., emotional composure, interpersonal communication and conflict-resolution skills). Adolescents who did not respond favorably to the intervention exhibited deficits in task performance reflecting constructs that included decision making ability, sensitivity to consequence, ability to delay gratification, impulsivity, and recognition of emotion in others. The central interpretation of these findings is that within this sample of adolescents, those who exhibited lower levels of specific ECF abilities and emotional perception were less able to execute behavioral change in response to an acute preventive intervention as adolescents with higher levels of function. While in need of confirmatory studies, these findings are intriguing and provide direction for further inquiries. Additional support for these findings may warrant the design of novel interventions and/or directing current interventions more appropriately.

Traditional methods to evaluate intervention effects in a population often only involve an analysis of main effects, which may generate conclusions that the program has limited value or that the impact on behavior is statistically significant but with low effect sizes. Our findings suggest that effect sizes would likely increase by subtyping to account for differential effects of interventions, assuming that characterizations are specifically linked to the prerequisites for absorption of curriculum materials. In other words, grouping simply on demographic or other external characteristics to identify subgroup differences in responsivity may be inadequate. A more effective approach may be to subtype on underlying mechanisms that directly relate to the ability of particular individuals to cognitively and emotionally process curriculum materials and then execute behavioral change based on that knowledge and skill acquisition. Based on this evaluation strategy, we may find that particular preventive interventions work very well for certain subgroups, but not for others.

4.1. Implications of specific task performance deficits

The present findings suggest that particular neurocognitive measures were more likely to moderate the brief intervention effects than others. For example, risky decision making on the dice task moderated intervention effects on interpersonal communication skills and beliefs supporting aggression. Risk taking on this task has been consistently shown to activate the orbital portion of the prefrontal cortex (PFC: Fishbein et al., 2005a; Rogers et al., 1999) which modulates planning skills, sensitivity to consequences, impulse control, and other complex social behaviors. As the entire PFC is underdeveloped relative to other regions of the brain until at least age 21 (Giedd, 2004), risk taking behaviors are developmentally expected in adolescence. Yet, it appears from these findings that adolescents with particularly high levels of risk taking propensity, irrespective of IQ, are less responsive to components of an intervention training session that attempt to reinforce skills involving impulse control, verbal negotiations, problem solving, and cautious decision making. If the basic cognitive and emotional skills that underlie these behaviors are in deficit, then interventions that do not first instill the prerequisite building blocks will be ineffective. Interventions may be more beneficial to this subgroup if they first assess the sophistication of an adolescent's decision making and planning skills and the use of techniques for weighing consequences. Then, training in the prediction of outcomes and development of a future orientation, among other related skills, may help these adolescents to be better equipped to make decisions about risky behaviors (Trad, 1993).

In addition to risk taking on this task, longer reaction times when selecting a risky decision under conditions of the highest risk also lessened the impact of the intervention. Intuitively, one would surmise that the longer the reaction time, the greater the time would be for deliberation of choices and consequences, rather than impulsive decision making. But instead, those who deliberated longer made riskier decisions and exhibited worse behavioral outcomes. The subgroup that made more risky decisions and had longer reaction times while making those decisions received less benefit from the intervention. Reaction time may therefore be indicative of the quality of individuals' decision making under these circumstances. Thus, prevention program strategies to help children and adolescents

simply "slow down and think" may not be effective given that the subgroup most likely to be unresponsive to intervention may already be slowed in cognitive processing, resulting in an ineffective decisions. These data suggest that a more effective approach, once again, may be to teach youths how to accurately evaluate the risks associated with their decisions and act on that assessment. A "harm reduction" approach may also be called for in light of evidence that adolescence is associated with risk proneness in general (Steinberg, 2005).

In contrast, measures of impulsivity generated by the stop signal task specifically moderated intervention effects on emotional composure. Impulsivity has been shown to act as a significant risk factor in drug use and other high-risk behaviors (Butler and Montgomery, 2004; Dawe and Loxton, 2004; de Wit and Richards, 2004; Dawes et al., 2000). Development of the neural circuitry subserving impulse control is in transition during adolescence, conferring vulnerability to drug abuse (Chambers et al., 2003). Thus, impulsivity may also play a role in intervention responding which relies heavily upon the ability to resist impulses to engage in behavior that has yielded instantaneous intrinsic rewards (e.g., the high from illicit drugs) despite longer-term negative consequences. Impulsivity has been shown to significantly predict cocaine use and treatment retention, suggesting the need for targeting impulsivity in intervention programs in general (Moeller et al., 2001).

When deliberating a risk scenario that involves emotional regulation, however, a sole focus on tactics to enhance impulse control may not be entirely sufficient. Under conditions that require emotional or behavioral restraint in a confrontational situation (as in the VR scenario), efforts to suppress impulses must translate effectively to real world situations which often evoke emotional responses. The interactive VR scenario presenting an actual provocation requires emotional composure during play, whereas the self-report questionnaires do not intrinsically invoke an emotional response in the laboratory. Therefore, different cognitive styles may be implicated by these separate measures. Thus, it is important to consider the source of the outcome measure found to be moderated by impulsivity when identifying appropriate intervention approaches.

In addition, omission errors on the Stop Signal Task moderated intervention effects on hostility and beliefs supporting aggression. This particular stop signal variable is more related to inattention than to impulsivity, per se (Overtoom et al., 2003). In this task, a lack of response could be due to the inability of certain participants to efficiently and effectively respond to the demand to activate inhibitory processes under time constraints. Thus, their ability to observe, monitor, interpret, decide and respond quickly may be compromised. This breakdown may be the result of attention deficits, fatigue or cognitive inflexibility. Recent studies have shown that children with ADHD who receive pharmacological treatment for their disorder are less likely to use drugs in adolescence (Fischer and Barkley, 2003). There are additional psychosocial strategies employable either in the home or in schools shown to improve attentional focus and shifting (Barkley, 2004).

Interestingly, performance on the Choice Delay Task only moderated intervention effects on hostility ratings and in this case, the central measure of delay of gratification was not significant. Rather, an increased number of commission errors was associated with an attenuation in behavioral change—measures which are oftentimes considered clinical signs of hyperactivity or impulsivity (Halperin et al., 1990). As this particular task is response driven and without time constraints, it is possible that the higher rates of commission errors in those who did not shift strategies in response to the intervention reflect mainly a motoric hyperactivity; it appears to be without intentional purpose and is not related to their inability to wait for the stimulus to appear or to be cued for a response, as in impulsivity. Attention deficit accompanied by hyperactivity (ADHD) is a known contributor to substance abuse disorders (Wilens, 2004; Molina and Pelham, 2003), but the role of hyperactivity in intervention outcomes remains largely unexplored with one exception. Gorman-Smith et al. (2002) found hyperactivity to be one factor predictive of poor engagement in a family-focused preventive intervention. There is a larger treatment literature reporting that the presence of ADHD increases the likelihood of relapse (Carroll and Rounsaville, 1993). Instructive in the development of preventive interventions that may alter the trajectory for children with ADHD are studies such as van Lier et al. (2004) which found a universal classroom intervention in elementary school to be somewhat effective in this regard. However, effect sizes were somewhat small possibly due to the lack of a targeted approach which characterizes all universal programs that focus upon individual characteristics.

The inability to accurately attribute emotion to facial expressions also moderated intervention effects on hostility, emotional composure, and interpersonal communication skills. Interestingly, both the hostility and emotional composure measures are reflective of an aggressive orientation, which has been related to impairment in ability to accurately perceive emotion in others (Best et al., 2002). Prior research has fairly consistently shown that the amygdala, a structure within the brain's limbic system and inhibited by the orbital PFC, is primarily responsible for this ability particularly when emotions expressed are negative (Lee et al., 2004; Stark et al., 2004; Hamann and Mao, 2002). The increased number of errors on this task in the context of an intervention suggests that adolescents who are less apt to alter behavior based on an acute but intensive training episode may be impaired in accurately perceiving negative emotions due to either compromised amygdala function or PFC modulation. Because perception of emotional cues and expressions is a prerequisite for regulation of emotion and adaptive responding in a social context (Ochsner, 2004; Battaglia et al., 2004; Skuse et al., 2003; Bar-On et al., 2003), such misattributions may cause affected individuals to misread situations, react inappropriately, and/or miss important social signals that may predispose them to aggressive or otherwise maladaptive behavior. Interventions that provide training in reading social cues may enhance the ability not only to respond appropriately in challenging situations, but also may improve verbal communications which are highly reliant upon perception of emotion in others.

The presence of CD lessened or reversed intervention effects on both interpersonal communication and conflict-resolution skills. CD is, as previously mentioned, one of the strongest

predictors of drug use (Clark and Cornelius, 2004; Chilcoat and Breslau, 1999; Tarter et al., 1999). Interestingly, CD children often exhibit a range of neurodevelopmental vulnerabilities including low verbal IQ and other aspects of language processing deficits relative to children without CD (Gilmour et al., 2004; Dery et al., 1999). Because their conduct is a primary source of concern for these children, often the underlying cognitive and emotional deficits, such as language processing problems, go unattended suggesting that their basic skill level may not allow them to execute change in communication skills without intensive intervention. The management of many disruptive children could be addressed by ameliorating their social and communicative skill deficits (Gilmour et al., 2004).

4.2. Overall implications

Although several investigators and clinicians have stated the obvious – that prevention efforts must be comprehensive and developmentally sensitive – many programs do not take into account the underlying conditions of subgroups of participants that make them differentially susceptible to drug use and to preventive interventions. Rather, prevention programs focusing upon the individual tend to focus on the distal outcomes, such as drug abuse or conduct problems, as a way of identifying the type of intervention to administer; e.g., targeted, indicated, or universal. In this view, all individually based prevention programs are universal in that participants with multiple risks and special needs all receive the same intervention by virtue of their behavior, demographics, family situations, and other external factors that model programs often assess and attempt to target. As a result, prevention programs typically have small effects due to variation in the populations they serve that is not addressed by the program (Hall and Heather, 1991; Tobler, 1994; Wells-Parker et al., 1995).

A replication of these findings would suggest that conventional approaches are not sufficient and that additional attention needs to be paid to individual vulnerabilities in neurodevelopmental capacity to absorb and act on prevention curriculum materials as presented. While it may not be feasible to match specific interventions to specific individuals, knowledge generated from this study may eventually help inform the field as to individual characteristics that distinguish between subgroups of adolescents positively affected by various interventions relative to those least affected and suggest what components are needed to design an effective intervention strategy. Evaluations of resultant programs will yield substantially more power by enabling a targeted approach that will reach a wider population.

Although early insult to prefrontal development may compromise integrity of ECF abilities, the brain's plasticity also bodes well for its malleability in the presence of effective manipulations later in life. The implications are that neurocognitive and emotional deficits resulting from prefrontal dysfunction or disconnection with the limbic system are potentially alterable and may respond favorably to appropriate interventions (Riggs and Greenberg, 2004; Hermann and Parente, 1996; Manchester et al., 1997; Rothwell et al., 1999; Wilson, 1997); thus, this line of research is likely the most fruitful regarding adolescents with special programming needs. Using neurocognitive and emotional regulatory measures of prefrontal and limbic function, this study was the first to evaluate the prerequisites for favorable responding to a preventive intervention that focuses on executive cognitive-emotive regulatory skills. Adolescents with delays or defects in prefrontal and emotional development may respond poorly to most universal interventions and require more intensive and/or specifically targeted programming efforts. Confirmatory research may, therefore, provide significant strategic information on which individual attributes will respond best to a universal intervention and which require a more targeted individually based approach.

Findings of this study should be considered in light of several potential limitations. Our study sample may not be representative of the entire JHU-PIRC sample or the general population of at-risk urban youth as it was limited largely to African-American males with a disproportionate number of participants who were diagnosed with CD. Therefore, our results may not generalize beyond the study sample, pointing to the need for replication studies with more representative samples. Our reliance on an abbreviated version of the PACT intervention (itself geared towards African-American adolescents) may have yielded results that would differ if the entire intervention had been used; i.e., participants who exhibited poorer performance on neurocognitive and emotional perception tasks and those with CD may have benefited to a greater extent from the complete PACT intervention. Although our primary hypothesis was supported by results of most regression models run, our findings should be considered with some caution until they are replicated with other samples of high-risk youth. And finally, participants may have been exposed to other interventions during elementary, middle or high school that could potentially affect these results. However, based on the large number of elementary schools from which these participants were sampled, it is reasonable to assume that each subject had an equal chance of being exposed to some type of intervention. Random assignment of subjects to experimental and control groups minimizes these concerns.

In sum, the present study addressed the critical need to identify underlying processes that interfere with adolescents' ability to respond favorably to drug abuse or violence preventive intervention curricula. Findings suggest that the link between integrity of brain functioning and preventive intervention responsivity may be moderated by altered cognitive capacities, particularly those involving ECF and emotional perception. Impaired ECF compromises the ability to interpret social cues during interpersonal interactions and undermines the ability to generate alternative socially adaptive behavioral responses and to execute a sequence of responses necessary to avoid or cope with stressful interactions (Giancola, 1995). Emotional responses are, in turn, regulated by these neurocognitive abilities, most likely contributing to decision making within a social context. Compromised executive control over behavior may permit negative affective states and other maladaptive responses, including drug abuse, aggression, and related risk behaviors, to dominate. As a result, ineffective and inefficient processing of social information, executing appropriate responses, and coping with daily stressors may interfere with the

ability to process prevention curriculum materials and act on that knowledge.

Acknowledgements

We would like to express our gratitude for the critical contributions of our data collectors, DiAngelo Lewis, Dana Darney, Kejuana Walton, and Dawn Blumenthal from JHU, as well as Ryan Springer from PIRE who assisted with scoring. And a very special expression of thanks extends to Courtney Patterson from Johns Hopkins University who assisted in the coordination of the two ongoing studies between JHU and RTI. Funding for this study was provided by the National Institute on Drug Abuse (#5 R01 DA14813-02).

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