SHIFTING OUR ATTENTION TO ENCODING: INTERVENING AT THE
FORGOTTEN STAGE OF SOCIAL INFORMATION-PROCESSING
AMONG REACTIVELY AGGRESSIVE YOUTH

by

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ABSTRACT

Despite decades of research on Social Information-Processing (SIP) based on Dodge’s (1986) model, this model’s first stage (encoding), in which youth perceive, attend to, and store cues, has long been overlooked. Aggressive youth are believed to engage in encoding errors which further their aggression, but current research addresses these distortions after they have occurred. This is due to their preconscious, involuntary, and automatic nature, which makes their measurement challenging.

This study could impact the field of aggression in several ways. First, it introduces a new, precise reaction time (RT) measure of encoding deficits that improves our understanding of what occurs during stage one. Second, it intervenes at the encoding stage for the first time by introducing a cognitive training task for altering youths’ encoding deficits. The results have prevention/intervention implications as they illuminate the malleability of encoding deficits. Thirdly, this study’s training task could easily be integrated into the aggression treatment milieu.

Participants were 60 reactively aggressive youth. A computer-based cognitive task was created from a task used to retrain the selective attention biases of anxious individuals (Dandeneau & Baldwin, 2004). For the experimental group, this task contained 50 pre-training assessment trials, 112 training trials, and 50 post-training assessment trials. Each trial was a 4x4 matrix of happy or angry facial expressions. The child quickly searched for either the one happy target among angry distractors (happy target trials) or the angry target among happy distractors (angry target trials). Assessment trials measured selective attention bias by comparing average RTs on happy vs. angry target trials. All training trials were happy target trials to train youth to
notice the happy cues they typically overlooked. The control group completed identical assessment trials. Their training trials were an equivalent computer task wherein they searched matrices of seven-petaled flowers for the five-petaled flower.

Results showed that subjects demonstrated a selective attention bias towards aggressive cues on the matrix RT encoding measure. Also, the training task successfully decreased this attention bias in the experimental group by post-training. Implications for SIP assessment and aggression interventions are discussed, as well as possible directions for future studies utilizing these tasks.
DEDICATION

It is with a great sense of pride and joy that I present this doctoral dissertation. This represents the culmination of an enjoyable, exciting, stimulating, and irreplaceable graduate career as part of a wonderful psychology department that truly fosters student growth. This dissertation is dedicated to my exceptional research advisor, Dr. John Lochman, who is at once extremely accomplished and humble, and who seems to truly enjoy the process of guiding and molding upcoming graduate students. I have learned so very much about child clinical psychology and the ins and outs of conducting high quality research from Dr. Lochman. I am so very thankful for the unique and exciting opportunities I have been granted due to his guidance. It is with a mixture of happiness and sorrow that I look ahead to leaving his direct supervision to pursue post-doctoral work.
LIST OF ABBREVIATIONS AND SYMBOLS

&  And
%
$  Dollars
=  Equals
#  Number
α  Alpha Coefficient
<  Is less than
≤  Is less than or equal to
+  Plus
-  Minus
†  Denotes a statistical significance value less than or equal to 0.10
*  Denotes a statistical significance value less than or equal to 0.05
**  Denotes a statistical significance value less than or equal to 0.01
2SD  Two times the standard deviation
3SD  Three times the standard deviation
7th  Seventh
8th  Eighth
9th  Ninth
(A)  Represents the between-subjects factor of condition included in the Analysis of Variance
AA/C Indicates that corresponding values in the chart refer to values for African American participants followed by Caucasian participants

ADHD Attention-Deficit/Hyperactivity Disorder

AD/HD Attention-Deficit/Hyperactivity Disorder

ANOVA Analysis of Variance

(B) Represents the within-subjects factor of target included in the Analysis of Variance

(C) Represents the within-subjects factor of time included in the Analysis of Variance

CBT Cognitive-Behavioral Therapy

DANVA-2 Diagnostic Analysis of Nonverbal Accuracy

df Degrees of freedom

e.g., For example

et al. And others

F A test statistic whose sampling distribution is an F-distribution

f Effect size index

i.e., That is

M Mean value

M/F Indicates that corresponding values in the chart refer to values for Male participants followed by Female participants

MAX Maximum value

MIN Minimum value

ms Milliseconds
n  Sample size of a subsample
N  Sample size of a population
p  Statistical significance
PDT  Probe Detection Task
PSST  Problem Solving Skills Training
Q-Q  Refers to a probability plot (“Q” stands for quantile)
r  Correlation
RT  Reaction time
SD  Standard deviation
SES  Socioeconomic status
SIP  Social information-processing
t  A test statistic whose sampling distribution is a Student’s t distribution
TEA-Ch  Test of Everyday Attention for Children
t-test  Statistical hypothesis test in which the test statistic follows a Student’s t distribution
VIRA-R  VIRA-R measure of reactive and proactive aggression
x  By
ACKNOWLEDGMENTS

This doctoral dissertation has been a true labor of love, based on an idea and methodologies that have truly excited my research mind. It has not gone unnoticed that the quality of this study is also largely attributed to the patient and enthusiastic support of my accomplished dissertation committee. In addition to my research advisor, Dr. John Lochman, who is acknowledged above, Drs. Mark Klinger and Edward Merrill have provided invaluable advice as I have attempted to meld both cognitive and clinical methodologies to strengthen this study. Their engagement and support around my forays into cognitive methodologies has been priceless. Similarly, Drs. Joan Barth and Randall Salekin have engaged in numerous productive discussions around the clinical aspects of my study, in attempts to increase the validity of the findings and my ability to answer exciting research questions. I truly believe that this study’s success is as much due to my committee’s support and guidance as to my own efforts.

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INTRODUCTION

Violence and aggression remain public health concerns among teenagers and young adults. In 2004, violence (i.e., homicide) was the second leading cause of death among this population, with mortality rates increasing with age (National Adolescent Health Information Center, 2007). Although violent crime rates among this population decreased between 1994 and 2004, non-fatal violent crimes remain common. Adolescents and young adults are now more likely to be a victim of non-fatal violent crimes, with individuals between the ages of 12 and 24 at greatest risk for victimization (National Adolescent Health Information Center). Thus, it is evident that aggression and violence are significant issues among youth.

The Social Information-Processing Model of Social Adjustment

Aggression is an interpersonal act through which adolescents exert a negative impact on those in their environment through physical, verbal, emotional, or relational means (Berk, 1999). Whether an impulsive, reactive behavior or a deliberate act, aggressive behavior is an attempt to produce a desired effect or obtain a desired goal in one’s social environment (Berkowitz, 1980; Dollard, Doob, Miller, Maurer, & Sears, 1939). A closer examination of the social cognitions of aggressive youth can help us better understand, predict and influence these aggressive behaviors.

For years, researchers have proposed models which account for how youth appraise social situations and problem solve (Dodge, 1986; Dodge, Pettit, McClaskey, & Brown, 1986; Huesmann, 1988; Lochman, Nelson, & Sims, 1981). Since 1986, Dodge’s social information-processing (SIP) model of social competence has been among the leading models guiding these
efforts. In 1994, Crick and Dodge reformulated the SIP model of children’s social adjustment to more accurately reflect the growing body of research surrounding the mental stages that occur from the time a youth is faced with a social cue to the final enactment of a behavioral response to that cue. This reformulated model contains six stages (see Figure 1): (a) encoding of external and internal cues, (b) interpretation and mental representation of those cues, (c) clarification or selection of a goal, (d) response access or construction, (e) response decision, and (f) behavioral enactment (Crick & Dodge, 1994). When faced with social situations, youth progress through these stages selectively attending to, encoding, and interpreting specific internal and external cues; selecting a desired outcome; accessing possible response choices from memory or
constructing new ones; evaluating their options to select the best response choice; and enacting the chosen response.

With this established and accepted understanding of how youth make social decisions regarding their own behavior, this model has been used to inform intervention research across several areas (e.g., aggression, anxiety, depression, ADHD). The SIP model allows researchers to examine the cognitions of maladaptive youth, determine where in the SIP model their maladaptive processes originate, and propose ways to intervene at the appropriate stages to effect positive change in these youth’s information processing and social behaviors.

Current Social Information-Processing Interventions

When examining the variety of current interventions which target the interpersonal cognitions of aggressive youth, there is a noticeable skew towards interventions which address the latter stages of the SIP model. For example, family-based interventions and parent training typically rely on social learning through which parents alter their evaluation and response to their children’s behavior (Forehand & McMahon, 1981; Webster-Stratton, 1996). This encourages the youth to perceive more prosocial behaviors as plausible choices during stages four through six of the SIP model.

Among the more child-oriented interventions are social skills interventions, Problem Solving Skills Training (PSST), the Dinosaur School program, and the Coping Power program. These focus on a variety of skills from SIP stages two through six. Through frequent practice and deliberate processing of social behavior, social skills training attempts to influence the youth at stages four through six by striving to “reprogram” their automatic responses in social interactions (Bierman, Miller, & Stabb, 1987). PSST focuses on stages two through five of the SIP model by helping youth make more accurate attributions, generate alternative solutions to
interpersonal problems, and realize the consequences of their own actions (Spivak & Shure, 1976). The Dinosaur School program combines the fundamentals of social skills training and PSST to more effectively combat conduct problems (Webster-Stratton & Hammond, 1997).

The Coping Power program focuses on stages two through six of the SIP model. Among the topics covered during this program are the interpretation of social cues, attribution retraining, practicing appropriate social skills, identifying and controlling physiological arousal, and developing problem-solving skills (Lochman & Wells, 1996). The problem solving component of the Coping Power program explicitly walks the adolescents through a specific model of problem solving which follows stages three through five of the SIP model and culminates in behavioral enactment (stage six). The youth practice this problem solving model continuously in hopes of making its use more automatic.

Thus it is apparent that among the available interventions for childhood aggression, there is a strong focus on the last five stages of the SIP model, but a limited, if not absent, focus on the first stage of the model (cue encoding). The current interventions seem to pass over this stage. While they may acknowledge that aggressive youth perceive social cues differently than their socially adaptive counterparts, rather than attempting to alter this perception process, these interventions focus on ways to deal with the distorted perceptions after they have already occurred. Due to the current lack of interventions in the area of stage one deficits, this study attempts to aid the development of encoding interventions by exploring the malleability of encoding and introducing ways to effect change in encoding abilities through training. These topics will likely form the building blocks for the later construction of encoding-based interventions.
However, is it truly a surprise that there are currently no encoding-based aggression interventions? If we look at the current research on the social cognitions of aggressive youth, we would respond with an astounding “no.” As research typically informs practice, we should not be shocked by the neglect of the encoding stage among interventions for aggressive youth. Since the conception of the SIP model 22 years ago, research efforts have also focused primarily on the final SIP stages, providing a detailed understanding of the deficits individuals may show at these stages (e.g., Lochman & Dodge, 1994; Lochman, Wayland, & White, 1993; Milich & Dodge, 1984; Orobio DeCastro, Veerman, Koops, Bosch, & Monshouwer, 2002) but largely overlooking those at stage one.

While researchers have recently begun to consider the subtleties and patterns of performance related to the encoding stage, a substantial portion of this research is being conducted outside of aggression research with anxious or depressed populations. So even though the SIP model implicates the distorted perceptions of the encoding stage as the foundation of aggressive interactions by proposing that the reactions of aggressive children are initially due to distortions in their perceptions of social events, researchers are largely looking elsewhere to understand aggression. In fact, through their research endeavors, they are in fact demonstrating their own attention bias towards other stages and away from encoding. Let us then shift our attention towards this initial stage.

*Stage One of Social Information-Processing: Encoding*

So, what do we know about stage one encoding? During this stage, children rely on sensory input, selective attention, and storage of cue information into short term memory to receive and encode relevant aspects of their social environment (Dodge, 1993). Due to the complexity of their environments, over time children learn that effective responding requires that
they attend selectively to certain aspects of their social environment (e.g., others’ intent, social norms, threats) in order to respond more effectively. Selectivity of attention refers to the fact that some cues will be perceived as more salient and will be encoded more accurately and completely than others. Salience is based on a stimuli being inherently more salient (e.g., weapons) or possessing a personal relevance for the individual.

However, aggressive and nonaggressive youth alike bring diverse goals to their social interactions. For example, an adolescent who lives in a violent neighborhood may come to expect aggression during social interactions. Therefore, that youth may enter social interactions with an attentional set towards aggressive cues, or a heightened preparedness/expectation to receive aggressive cues. This attentional set is thought to play a powerful role in where an individual’s attentional resources will be allocated, often leading an individual to completely overlook cues that are thought to be unrelated to their general goal. While these cues may be attended to, their perceived insignificance does not allow them to reach subjective awareness (Most, Scholl, Clifford, & Simons, 2005). This selective attention is also referred to as inattentional blindness (Mack & Rock, 1998).

In addition to the personal goals and stimuli content which influence an individual’s attentional set during encoding, Eysenck (1988) proposed that efficiency of encoding is also influenced by: a) the amount of attentional resources that are available for the task, b) the individual’s level of distractibility or ability to remain focused on the stimuli, and c) the number of cues to which attention resources are simultaneously allocated (selectivity). As such, there are a number of things thought to influence accuracy of encoding, and successful encoding is only achieved when a child is able to attend to as many relevant cues as possible in an unbiased manner (Dodge, 1993).
A few researchers have examined the repercussions of stage one encoding abilities on typical functioning. Among a normal population, the ability to encode relevant hostile and non-hostile cues is positively related to behavioral competence in regards to provocation, responding to demands, and peer group entry situations (Dodge et al., 1986; Dodge & Price, 1994). Furthermore, socially rejected-aggressive children consistently demonstrate an inability to attend to relevant social cues (Dodge & Tomlin, 1987; Lochman & Dodge, 1994). Thus, stage one encoding abilities appear to contribute substantially to youths’ behavioral competence.

As discussed above, aggressive and nonaggressive youth alike bring specific social goals to their social interactions which spur on their selective attention to those social cues which are particularly relevant to their attentional set. Also, for both aggressive and nonaggressive youth, high levels of emotional arousal are thought to lead to cognitive deficits during SIP. Therefore, both nonaggressive and aggressive youth have been known to display SIP deficits under these circumstances. However, the encoding deficits demonstrated by aggressive youth are more consistent, habitual, and extreme than those occasional deficits that a nonaggressive youth may demonstrate. Due to difficulties with emotion regulation, aggressive youth may experience greater emotional arousal in response to situations which are not overly arousing for nonaggressive youth, who can then effectively process the presented social cues without interference. Also, aggressive youth often enter social interactions with an aggressive attentional set, causing them to focus on different social cues than their nonaggressive peers.

Due to these differences, aggressive children appear to demonstrate more consistent encoding deficits than nonaggressive youth. They are thought to attend to fewer relevant cues and rely on more recent and more hostile cues than their nonaggressive counterparts (Dodge et al., 1986; Dodge & Newman, 1981; Milich & Dodge, 1984). Gouze (1987) also found that
aggressive youth are systematically biased towards hostile cues. They selectively attend to hostile social cues and have a difficult time diverting their attention away from these cues. This selective attention bias has also been described as a hypervigilence towards hostile cues and a failure to process relevant non-hostile cues (Dodge, Bates, & Pettit, 1990). Aggressive youth’s selective attention bias also impacts their later SIP stages, as their interpretation of an event determines their response to that event. Selective attention to hostile cues often leads children to interpret situations in a hostile manner and respond with retaliatory aggression. Therefore, continual aggressive processing often leads to the development of chronic aggression.

However, it does not appear that stage one deficits occur uniformly across all aggressive youth. Within the aggression literature, there has been growing research particularly surrounding two subsets of aggressive adolescents, reactively and proactively aggressive youth. Reactive aggression is conceptualized as a defensive, automatic frustration response to a perceived threat, whereas proactive aggression is predominantly characterized by intentional aggressive acts initiated due to an expectation that such an act will produce a desired outcome (Bandura, 1983; Berkowitz, 1989). In hopes of better understanding these subgroups, Dodge, Lochman, Harnish, Bates, and Pettit (1997) examined their differences, finding clear distinctions between reactively and proactively aggressive youth in the areas of developmental history, social adjustment, and profiles of SIP deficits. Reactively aggressive youth were more likely to have experienced traumatic childhood events and to demonstrate an earlier age of onset. They also demonstrated more significant emotion regulation problems and adjustment problems in the realm of peer relations, experiencing higher levels of peer rejection than their proactively aggressive and nonaggressive peers. Dodge et al. (1997) also found a stronger connection between comorbid ADHD symptoms (i.e., attention problems, impulsivity) and reactive aggression than was present
for proactive aggression. Of further note, the differences between proactively and reactively aggressive youth were not completely explained by these comorbid ADHD symptoms, as reactive aggression and proactive aggression differences persisted even after controlling for these comorbid ADHD symptom levels.

However, perhaps of the greatest relevance to the current study are the discrepant profiles of SIP deficits demonstrated by these two aggressive subgroups. Reactively aggressive youth typically struggle more with the early SIP stages, demonstrating inadequate encoding and problem-solving abilities (Dodge et al., 1997). They struggle to attend to relevant social cues, often attending to fewer relevant cues than their proactively aggressive counterparts. In addition, other studies have shown that reactively aggressive youth also struggle more with the early interpretation stage (stage 2), having more difficulty accurately interpreting peer intentions (Crick & Dodge, 1996; Dodge & Coie, 1987) than their proactively aggressive peers. In contrast, proactively aggressive youth illustrated a profile of later SIP stage deficits (Crick & Dodge, 1996; Dodge et al., 1997; Dodge & Coie, 1987). More specifically, they expected that aggressive responses would be met with positive outcomes (i.e., reduction of a peer’s aversive behavior) and they reported higher levels of ease with implementing aggressive responses (Dodge et al., 1997). As the current study is focused on encoding deficits, it will examine primarily reactively aggressive youth, as it is this aggressive subgroup that will most benefit from the retraining of encoding deficits presented during this study.

While there is a subgroup of aggressive youth who are better described as both reactively and proactively aggressive (also referred to as pervasively aggressive; Dodge et al., 1997), the distinction between reactively aggressive youth and pervasively aggressive youth is not considered critical for the purposes of this study. This is due to research which shows that
reactively aggressive youth and pervasively aggressive youth are very similar across a variety of relevant variables (Dodge et al., 1997). Reactively and pervasively aggressive youth both received significantly higher problem scores, and they were the same on all developmental history variables (e.g., physical abuse, harsh discipline, peer stability), except for SES (Dodge et al., 1997). Both groups of aggressive youth also received significantly lower peer rating scores and were more often considered “socially rejected” than proactively aggressive and nonaggressive youth (Dodge et al., 1997). In reference to SIP errors, both reactively and pervasively aggressive youth have demonstrated consistent encoding errors. Also, both groups displayed significantly more attention problems than nonaggressive youth, with pervasively aggressive youth also receiving higher impulsivity scores than even the reactively aggressive youth (Dodge et al., 1997). However, this last point is not seen as a problem, as levels of hyperactivity-impulsivity will be controlled for in several of this study’s analyses. Due to these similarities between reactively and pervasively aggressive youth, it is not thought necessary to distinguish between these subgroups in the current study.

*The Measurement Question*

Despite the availability of this basic knowledge regarding the encoding stage, and in spite of its potential importance, many studies begin by acknowledging each of the deficits described in the SIP model, but then proceed to further examine or intervene at stage two through six, avoiding stage one. However, this neglect may be expected and quite understandable, as there are several inherent road blocks to studying this initial SIP stage. Each of these challenges emanates from the fact that encoding is an on-line process thought to be initially preconscious, fast, involuntary, and automatic. On-line processes are those cognitive processes that are thought to occur “in-the-moment” during real time SIP. Fontaine (2008) stated that the progression
through the Crick and Dodge (1994) SIP stages is a series of on-line processes leading to a final response decision. However, working with on-line processes leads to several methodological quandaries. How are we to conceptualize and measure something that is automatic and not consciously accessed?

Consequently, faced with these hurdles, many studies examining the encoding stage have actually focused on aggressive children’s deficits in memory for and recall of relevant social cues (Dodge & Price, 1994, Dodge & Tomlin, 1987). Typically, these studies present youth with various audio or visual hypothetical vignettes and ask the youth to recall as many events from these vignettes as possible (Dodge & Frame, 1982; Dodge et al., 1997; Dodge & Price; Lansford et al., 2006; Lochman & Dodge, 1994; Milich & Dodge, 1984). While this is important information, it fails to directly examine selective attention. This is not to say that selective attention and cue recall are unrelated and conclusions regarding selective attention can not be made based on this biased recall. However, this methodology does not rule out such possible alternative explanations as storage, retrieval, or interpretation problems. For example, perhaps aggressive children attend to both hostile and non-hostile cues but make errors during interpretation of those cues which influence their recall. Alternatively, maybe the impulsivity that frequently accompanies aggression causes them to fail to consider all of the cues that they have encoded. As such, to truly understand aggressive youth’s encoding deficits, there is a need for a more direct and precise measure of selective attention.

This methodological need may be met by reaction time measures adopted from cognitive psychology, as these measures allow for the measurement of rapid on-line processes. Since these measures do not allow conscious (off-line) processes to influence measurement, they more directly tap attention. While these measures have yet to become a regular component of
aggression research, one such reaction time measure of selective attention, the Probe Detection Task (PDT), was developed by MacLeod, Mathews, and Tata (1986) and modified for use with children by Vasey, Daleiden, Williams, and Brown (1995). During this computer task, participants are presented with two words appearing one above the other. The words belong to either a threat-related category or a neutral category, and each word pair belongs to one of three conditions: threat-neutral, neutral-threat, and neutral-neutral pairs. For half of the trials, when the word pair disappears, a dot probe immediately appears in the same position where one of the words had been (Vasey, 1996). Attentional bias is measured based on the participant’s latency in response to the dot probe during the threat-neutral and neutral-threat conditions. The PDT makes the assumption that the time to respond to the dot probe is indicative of the amount of visual attention allocated to the particular word which the dot replaced (Vasey). As such, on a measure of this type, an individual who is biased towards threatening social cues would presumably demonstrate a shorter reaction time to a dot probe appearing in the place of a threat word, than a neutral word.

Schippell, Vasey, Cravens-Brown, and Bretveld (2003) is one of the only studies which has used a reaction time measure (the PDT) to measure selective attention among aggressive youth. They examined reactively aggressive youth’s attention to social-threat and physical-threat cues and found a pattern of attention bias. Using this reaction time measure, reactively aggressive youth showed suppressed attention towards social-threat cues, rather than the expected hypervigilance, and no attention bias towards physical-threat cues.

Schippell et al. (2003) proposed that the unexpected attention bias away from social threat cues may have been protective behavior. Aggressive youth often overestimate their social competence (Hoza, Pelham, Dobbs, Owens, & Pillow, 2002; Hughes, Cavell, & Grossman,
Thus the reactively aggressive youth may have suppressed their attention to the social threat cues, as they were inconsistent with their self-concept. Research has shown that aggressive-rejected youth will defend their inflated self-perceptions even when clearly presented with conflicting evidence of peer rejection (Zakriski & Coie, 1996).

Schippell et al. (2003) also hypothesized that the lack of attention bias towards physical threat cues found using the reaction time measure may have been due to the fact that these cues were more related to general illness or injury (e.g., injury, bleeding) and only included a few aggression-relevant physical-threat cues (e.g., killed, murder). The authors predicted that, consistent with the existing SIP literature (Crick & Dodge, 1994; Dodge, 1991), the reactive aggressive youth may have shown an attention-bias towards physical-threat cues had more aggression-relevant physical-threat cues been utilized.

It is also possible that while we have long-since assumed that our existing studies of attention bias accurately portray a selective attention for aggressive cues among aggressive youth, Schippell et al. (2003) may have brought these beliefs into question by demonstrating an opposing effect not previously perceived using the less efficient vignette-based measures. Regardless of their specific results, the fact remains that by using a reaction time measure of selective attention, Schippell et al. were able to obtain a more focused picture of these youth’s encoding tendencies. As such, it seems critical that researchers continue to explore this attention bias using more direct measures of encoding.

Is Attention Bias Malleable? Should We Intervene?

As mentioned earlier, the SIP model has provided a structured understanding of youth’s aggressive social cognitions from which numerous interventions have been formed, but few of
which have focused on stage one deficits. It is clear that the challenges of measuring and 
intervening with on-line processes are daunting, but they merely force us to think differently 
about how to impact this attention bias and what interventions can be. Armed with the more 
accurate reaction time measures discussed above and the specific on-line intervention task 
explored below, we can begin to delve deeper into the encoding stage and its malleability.

Despite the relatively limited information regarding encoding, we know enough about 
encoding deficits and errors to acknowledge that the endeavor to examine their malleability in 
order to inform later interventions aiming to prevent negative outcomes is a worthwhile activity. 
Encoding abilities are related to behavioral competence and social functioning. Children who 
have not yet developed the ability to encode relevant hostile and non-hostile cues are at serious 
risk of responding in a maladaptive manner to provocation, demands from authority, and the 
stressors of peer group entry situations, as encoding deficits set the ball rolling for later SIP 
errors (Dodge et al., 1986; Dodge & Price, 1994). Youth demonstrating these errors often end up 
on a trajectory towards such negative outcomes as peer-rejection and patterns of aggressive 
responding (Dodge & Tomlin, 1987). Furthermore, these problems are not likely to fade away 
with time, as social cognitions have been found to become more strongly related to actual 
behavior as children develop (Davis-Kean et al., 2005). So there is an unavoidable need to help 
these youth develop these abilities so they have a better prognosis in regards to social 
functioning.

While it is necessary to intervene to improve encoding abilities, are encoding deficits 
even a malleable construct and how would such an intervention be formatted among reactively 
aggressive youth? While stage one processes are often overlooked in aggression research, 
researchers outside of aggression (e.g., anxiety, depression) have recently begun to consider the
encoding stage in greater detail. Due to the paucity of this research among aggressive populations, and because anxious and depressed youth consistently demonstrate a similar attention bias, it makes theoretical sense for the SIP intervention work among these other populations to serve as a concrete starting point for examining the malleability within an aggressive population and eventually initiating similar interventions among aggressive youth.

Like aggressive youth, anxious and depressed youth have been shown to consistently demonstrate attention biases. Anxiety is often related to a hypervigilance towards threatening social cues (Mathews, 1990), while depression and low self-esteem are often related to hypervigilance towards rejecting social cues (Leary, Tambor, Terdal, & Downs, 1995). Similar to aggression research, these biases initiate a chain of information processing events that progressively influences later SIP stages (Bell-Dolan & Wessler, 1994; Vasey & Daleiden, 1996). For example, after attending selectively to threatening cues, anxious youth tend to select the more threatening interpretations of emotionally neutral social cues (Bell-Dolan & Wessler). Anxiety researchers have also acknowledged that this early error sets the tone for anxious individuals and may actually contribute to maintaining and magnifying anxiety states (Vasey & Daleiden), as is the case for aggressive youth and their biases. Additionally, although anxiety and reactive aggression are viewed as distinct disorders, they are not unrelated. Preadolescent aggressive children often demonstrate low self-esteem or low self-worth, with increased aggression significantly related to decreased general self-esteem (Barry et al., 2007; Lochman & Dodge, 1994), thus adding credence to the overlap in cognitions between aggressive and depressed samples.

Based on the current intervention research targeting cognitive risk factors among anxious and depressed individuals, we have reason to believe that encoding abilities are in fact malleable.
Anxiety intervention research focuses on these individuals’ attention bias towards anxiety-related arousal cues and social threat cues (anxiety sensitivity), and depression intervention research focuses on those individual’s attention bias towards rejection cues. Research has shown that even brief interventions can lead to a rapid and substantial change in these maladaptive biases. Reduction in hypervigilance towards anxiety-related cues has been found following a brief, three-session CBT intervention (Harrington, Telch, Abplanalp, & Hamilton, 1995). Similarly, among individuals high on anxiety sensitivity, a six-week, internet-based, self-guided CBT intervention successfully reduced panic-relevant cognitions (Kenardy, McCafferty, & Rosa, 2003). Also, a brief, 30-minute, computer-based prevention intervention designed to reduce anxiety sensitivity successfully produced greater decreases in anxiety sensitivity in the experimental condition than were seen in the control group (Schmidt et al., 2007). Dandeneau and Baldwin (2004) found similar reductions in attentional biases towards rejection cues among individuals with low self-esteem following a brief, computer-based cognitive retraining task which trained individuals to inhibit rejection information through repeated practice identifying acceptance information. Taken together, these results imply that, at least among internalizing individuals, the cognitions involved in biased attending are fairly malleable, and as such may be the same among aggressive populations.

As encoding deficits are on-line processes, it seems highly efficient and direct to attempt to alter these deficits using activities which tap on-line processes. As such, we look more closely at Dandeneau and Baldwin’s (2004) intervention study addressing the attention bias towards rejection cues demonstrated by individuals with low self-esteem. Through a one-time exposure to an implicit learning, cognitive retraining task in which individuals were reinforced for attending to accepting rather than rejecting cues (the typical focus of their attention bias),
Dandeneau and Baldwin were able to retrain the attention biases of anxious individuals. For the purposes of the current study, a slightly modified version of this task was utilized in an attempt to retrain the attention biases of a reactively aggressive adolescent sample.

Dandeneau and Baldwin’s (2004) training task required that participants examine numerous square 4 x 4 matrices to find the single smiling/approving face among a field of 15 angry faces (similar to Figure 2). The matrix appeared on the computer screen, and using a computer mouse, subjects were instructed to find and click on the smiling/approving face as quickly as possible. The smiling/approving face appeared in a different square of the 4 x 4 matrix each trial, and there was a variety of 16 smiling/approving faces which were randomly presented from one matrix to the next. Baldwin, Dandeneau, and colleagues originally created this task to train the response of inhibiting rejecting information by repeatedly identifying accepting faces within the matrix. In Dandeneau and Baldwin’s study, the control condition

![Figure 2](image)
viewed 4 x 4 matrices consisting of drawings of five-petaled flowers and seven-petaled flowers. The subjects were instructed to click on the five-petaled flower as quickly as possible in the matrix of seven-petaled flowers (similar to Figure 3).

![Figure 3. A sample matrix from the training task control condition in which subjects were instructed to select the five-petaled flower amidst the seven-petaled flowers.](image)

**Focusing Specifically on Attentional Biases Towards Emotion Cues**

When taking in their social environment, adolescents are faced with the task of encoding a large variety of social stimuli, which include physical and spatial stimuli, verbal stimuli, temporal events, and perceptions or internal states surrounding a social event. An individual’s ability to perceive these events accurately can have a tremendous impact on their social behavior and social development. More specifically, an individual’s ability to accurately identify the emotion cues articulated through the facial expressions of others during social interactions can greatly impact their response to that interaction. Due to the crucial role that emotion identification abilities play in SIP, this study will focus particularly on retraining the encoding of these emotion cues among aggressive youth.
Considering emotion identification abilities within the framework of the SIP model, it is fairly easy to see how inaccuracies in this skill at the encoding stage can lead to substantial social difficulties. The encoding of emotional expressions paves the way for accurate, or inaccurate, interpretations of social situations and decisions about appropriate social responses. For example, a child who accurately perceives the offending peer’s sad facial expression after the peer bumps into them is likely to realize this cue indicates this was an accidental exchange and respond in a benign manner. However, an adolescent who inaccurately perceives that peer’s sad face as a scowl may misinterpret this accidental encounter as an act of intentional aggression. This adolescent may then select a more hostile response towards their unsuspecting peer. Thus, early SIP stage errors in attending to emotion identification cues are often related to more aggressive problem-solving responses (Dodge et al., 1997). Furthermore, Lemerise and Arsenio (2000) propose that while the encoding of peer’s emotional expressions is a critical component of stage one encoding, youth also engage in an ongoing assessment of their peer’s emotional expression throughout all stages of SIP in order to gauge how the social interaction is progressing. This would indicate that biases in encoding of emotional expression have a widespread SIP impact.

While we have already concluded that attentional biases are likely malleable, what about attentional biases specific to the encoding of emotional expressions? Among typical youth, the ability to accurately identify others’ emotions as articulated with facial expression is thought to pass through various growth spurts which coincide with specific brain development (Kolb, Wilson, & Taylor, 1992; Kolb & Wishaw, 2003). Kolb, Wilson, and Taylor proposed that these “spurts” in ability occur around ages 10- and 14-years-old, while Baron-Cohen, Wheelwright, Spong, Scahill, and Lawson (2001) proposed that similar improvements occur around 8- and 10-
years-old. Tonks, Williams, Frampton, Yates, and Slater (2007) recently found that children ages 9 to 10-years old demonstrated significantly more errors when identifying facial expressions of emotion than did youth age eleven and older. As such, it would seem that children in mid to late adolescence have typically progressed through a series of developmental periods critical to the maturity of emotion identification abilities. This adolescent change has also been attributed to transitions in the youth’s social environment. Around this same age, social interactions become more complex as youth expand their self-awareness and awareness of others (Turkstra, 2000).

Despite these periods of development, emotion identification abilities have been found to be malleable even after these periods have passed (Feldman, Philippot, & Custrini, 1992; Minskoff, 1980; Nowicki, 1998). Grinspan, Hemphill, and Nowicki (2003) employed a fairly simple training task (six 30-minute sessions) with third and fourth graders and found improvements in the treatment group’s accuracy at identifying the emotional expressions of both adults and children. Thus it would seem that while emotional identification skills may naturally develop over time, they may also be subject to change following intervention efforts. Due to their link to social outcomes and their possibility for malleability, attempting to retrain the attentional biases towards encoding angry emotional expressions among reactively aggressive youth is particularly valuable.

*Purpose of This Study*

This study aims to advance the research surrounding the encoding deficits of reactively aggressive adolescents in two ways. First, this study will examine the possibility that reaction time measures of selective attention toward emotion cues may represent a more precise means of measurement among reactively aggressive populations. Second, this study will attempt to
reconceptualize how we think about SIP-based interventions by attempting to manipulate the in-the-moment errors that occur during the encoding stage for the first time with reactively aggressive youth, using an implicit learning task to examine the malleability of and retrain the cognitive deficits related to emotion cue encoding demonstrated at this stage. As such, various primary, secondary, and exploratory hypotheses are proposed, along with some broad research questions.

**Hypothesis 1:** Additional pre- and post-training trials were added to the revised version of Dandeneau and Baldwin’s (2004) matrix implicit learning task. These additional trials served as a reaction time measure of selective attention towards angry emotion cues. It was hypothesized that due to their selective attention towards angry expressions, the reactively aggressive adolescents would allocate greater attentional resources to aggressive cues and would be drawn towards images of angry expressions. As such, the reactively aggressive sample was expected to respond more quickly to matrices requiring them to find an angry expression among a field of happy expressions than to matrices requiring them to find a happy expression among a field of angry expressions.

**Hypothesis 2:** The matrix implicit learning task (Dandeneau & Baldwin, 2004) was utilized as a cognitive training task to examine the malleability of reactively aggressive youth’s selective attention bias towards angry emotional expressions. It was hypothesized that this attention bias is malleable and that following on-line training with the matrix task, the youth would show more equitable reaction times in response to both types of matrices (i.e., happy target and angry target matrices), indicating a reduction in their attention bias towards angry emotional expressions.)
Secondary Hypothesis 1: The traditional hypothetical vignette-based video measure of selective attention (Dodge & Price, 1994; Lansford et al., 2006) was also administered to the reactively aggressive adolescents at pre- and post-training. At pre-training, the results of this measure were compared to the results of the matrix reaction time measure of selective attention toward emotion cues to determine if these two encoding measures of attention bias tap the same construct. It was hypothesized that results of the matrix reaction time measure would be related to the results from the hypothetical vignette-based measure, with both measures examining the adolescents’ attention bias for angry emotion cues. However, it was predicted that the reaction time measure would provide a finer-grained look at these encoding deficits when compared to the hypothetical vignette measure.

Secondary Hypothesis 2: As ADHD symptoms are highly comorbid with aggression, the above Hypothesis 1 was also examined while controlling for baseline levels of general inattention, and hyperactivity-impulsivity (i.e., ADHD-like symptoms). This allowed us to determine if any attention bias towards angry emotional expressions that might exist occurred above and beyond the impact of these related variables. It was hypothesized that despite possible elevated levels of inattention and hyperactivity-impulsivity, these reactively aggressive adolescents would demonstrate an attention bias at pre-training, as measured by our reaction time measure, which is attributable to their aggression above and beyond the impact of any symptoms of ADHD.

Exploratory Hypothesis 1: As ADHD symptoms of inattention and hyperactivity-impulsivity, when present, can impair an individual’s ability to attend to and garner information from a task, we also examined whether the subjects’ ADHD symptoms measured at pre-training influenced their ability to benefit from the matrix training task. Levels of inattention and
hyperactivity-impulsivity were included as covariates to examine their impact on training (as examined in Hypothesis 2).

**Exploratory Hypothesis 2:** Emotion identification abilities are central to adolescents’ performance on the matrix training task. Emotion identification abilities were measured at pre-training to determine: a) the typical amount of errors that reactive aggressive adolescents demonstrated during emotion identification tasks (i.e., encoding emotion cues), and b) whether level of emotion identification ability at pre-training influenced the adolescents’ ability to benefit from the matrix training task.

**Research Question 1:** Research has eluded to possible gender differences in emotion identification abilities, implying that females may possess better developed emotion identification abilities. However, this is still a contested fact among researchers in this field. As such, we will examine the emotion identification data for possible gender differences.

**Research Question 2:** The DANVA-2 measure of emotion identification abilities is a standard measure in emotion research. The adult faces and child faces subtests are each composed of 24 trials. However, of the 24 child faces trials, only one of the pictured children is of an ethnic minority status, and of the 24 adult faces trials, only three depict adults of an ethnic minority status. The DANVA-2 manual implies that during scale construction these images were tested among a variety of ethnicities. However, as the majority of this study’s sample is African American, we examined whether ethnicity might be related to performance on the DANVA-2 measure of emotion identification.

**Research Question 3:** The traditional hypothetical vignette measure is composed of 24 individual video vignettes. This measure is used frequently in SIP research with aggressive youth. However, of the 24 vignettes, only four of these vignettes contain a child actor of an
ethnic minority status. The other 20 vignettes contain only Caucasian child actors. As the majority of this study’s sample is African American, we examined whether ethnicity was at all related to performance on the vignette measure.
METHOD

Participants

Subjects were contacted for participation during the winter/spring of the 2008 to 2009 academic year, which was the eighth grade school year for the majority of participants. All subjects had been previously identified as reactively aggressive adolescents/teens through their participation in a larger research project evaluating the effectiveness of the Coping Power intervention program for adolescents with conduct problems (Lochman & Wells, 2002; Lochman & Wells, 2003). During the 2008 administration of the annual Coping Power assessment battery (late spring/summer), teacher-data was collected from these youths’ seventh grade teachers. This teacher data included the VIRA-R measure of proactive and reactive aggression (Hendrickx, Crombez, Roeyers, & Orobio de Castro, 2003). There was a possible sample size of 316 youth included in the larger Coping Power research project who had complete teacher-reported VIRA-R data. These 2008 VIRA-R scores were examined to identify those subjects whose reactive aggression scores fell in the top 50% for reactive aggression when compared to the entire sample. Of these 158 teacher-identified reactively aggressive youth, 148 had also consented to being contacted for future research studies during the previous annual Coping Power assessment battery. This sample of 148 subjects was identified as the possible subject pool from which all subjects were obtained for the current study.

A power analysis was conducted to determine the sample size necessary to provide meaningful answers to the current study’s research questions. An a priori power analysis was conducted to determine the sample size needed to detect a medium effect, given the desired
minimal level of power (0.80). Under these conditions, a sample size of 34 was considered adequate. Subsequently, a sensitivity power analysis was conducted, and it was determined that with a sample size of 60 subjects and the desired minimal level of power (0.80), these analyses would be able to detect an effect size of .18, which is between a small (f=.1) and medium (f=.25) effect size. Furthermore, a post-hoc power analysis was conducted. This analysis concluded that, with a sample of 60 subjects, there would be power of .30 to detect a small effect size and .95 to detect a medium effect size. Though the previous study that used the matrix training task to retrain subjects’ attention biases was conducted on a different sample (low self-esteem adults) and included slightly different analyses, it found a significant training effect with a sample size of only 49 participants (Dandeneau & Baldwin, 2004). Additionally, Dandeneau and Baldwin were able to detect a significant attention bias among a sample of only 31 participants when utilizing a reaction time measure of attention bias. Based on the power analysis and previous literature in this area, the current study utilized a sample size of 60 reactively aggressive youth.

The first 60 subjects who met the inclusion criterion and were willing to participate were randomly assigned to either the control or experimental condition. During the data collection process, 70 subjects were called to inquire about their desire to participate in the current study. Of these 70 subjects, two no longer had accurate contact information and could not be contacted. Of the remaining 68 that were contacted, 88.2% participated in the study (i.e., 8 subjects were unable to participate). These eight subjects were unable to participate for various reasons, including: one child’s father had recently passed away, four subjects no longer lived in the area either permanently or for the summer during data collection, one subject had an intensive upcoming medical procedures that precluded participation, and two children were unavailable during the researcher’s available times.
Among this sample of 60 reactively aggressive youth, 70% were male (n = 42), 91.7% were African American (n=55), and 8.3% were Caucasian (n=5). The average age was 14 years, 1 month old, with the age range being 13 years, 9 months to 15 years, 11 months. The subjects’ grade level in school at the time of data collection ranged from 7th to 9th grade, with seven seventh graders, 52 eighth graders, and one ninth grader. These gender and ethnicity representations are very similar to those found in the larger sample of 412 aggressive youth (65% male, 85% African American, 14% Caucasian), and are akin to the breakdowns typically found in aggression research.

Procedure

Those subjects who met the screening criteria and agreed to be contacted for future research were contacted via phone to ascertain their interest in participating in the current study. The primary investigator first moved through the list from top to bottom of local Tuscaloosa area residents and then proceeded in the same fashion through the list of Birmingham and surrounding area residents. Of the final sample of 60 subjects, 24 were Tuscaloosa area residents, and 36 were Birmingham area residents.

An appointment was scheduled with each caregiver and child that agreed to participate. The children and their primary caregivers met with the researcher, accompanied by a research assistant, either at the family’s home (n = 75%) or at The University of Alabama Psychology Clinic (n = 25%), depending on the participants’ preferences. All of these sessions were conducted between March and June of 2009. Parental consent and child assent were obtained prior to completing measures or training tasks. Following provision of consent, caregivers completed a brief demographic form and a measure of parent-reported ADHD symptoms (the ADHD Rating Scale-IV: Home Version). The remainder of the session consisted of
individually-administered child measures. For each measure, the researcher read aloud any written questions or instructions as the child followed along with their own copy. Each child completed a pre-training baseline battery, followed by the experimental or control training task, and finally post-training measures of attention bias towards emotion cues. The pre-training baseline battery consisted of (a) the Test of Everyday Attention for Children, (b) the Diagnostic Analysis of Nonverbal Accuracy, (c) a Hypothetical Vignette Video Measure of Encoding, and (d) the matrix reaction time measure of selective attention towards emotion cues. Following subsequent completion of the training task, each child was again administered the matrix reaction time measure and the hypothetical vignette video measure as post-training measures of attention bias towards emotion cues. On average, the entire data collection session took 92 minutes to complete, with a range of 78 to 135 minutes for completion. Both caregivers and children were reimbursed for their participation. The caregivers received $15 in reimbursement, and each child received $25.

The demographic information was compared for the control and experimental groups to determine whether these groups had relatively similar characteristics. In general, the groups were similar across variables. The average age was 14 years, 0 months for the experimental group and 14 years, 0.03 months for the control group. These groups were not significantly different in regards to age (t = -0.186, p = 0.85). Similarly, both groups consisted of nine females and 21 males. The experimental group consisted of 28 African American youth and two Caucasian youth, whereas the control group consisted of 27 African American youth and three Caucasians. For both groups, the majority of subjects were in the 8th grade. In the experimental group, there were 25 8th graders and five 7th graders. The control group consisted of 27 8th graders, two 7th graders, and one 9th grader.
On the demographic form, caregivers also provided information on their child’s current psychological diagnoses and prescription medication used to manage behavioral or emotional symptoms. From the entire sample of 60 subjects, 25% (n = 15) were reported to have current diagnoses, and 13.3% (n = 8) were currently prescribed medication for behavioral or emotional concerns. In regards to psychological diagnoses, seven youth in the experimental group had current diagnoses (one depression, four ADHD, one comorbid ADHD/Depression/Sleep Problems, one comorbid ADHD/Depression/Anxiety). Eight control group youth were reported to have current diagnoses (seven ADHD, one Math Learning Disorder). In regards to current medication for behavioral or emotional concerns, both groups had four youth with current prescriptions. Among the experimental group, three youth were prescribed a stimulant and one youth was prescribed a stimulant and two anti-depressants. Only one of these youth had taken their stimulant medication the day of participation in the current study. Among the control group, three youth were prescribed stimulant medication and one was prescribed an anti-depressant. Only two subjects had taken their medication the day of data collection.

In regards to data collection, within the experimental group, six subjects completed the study at the University of Alabama Psychology Clinic and 24 met with the researcher in their own home. Among the control group subjects, nine met in the Psychology Clinic, while 21 were seen in their own homes. There was a significant difference in the time it took to complete data collection. On average, the experimental group took significantly longer at 95.2 minutes to complete the study, while the control group took on average 88.5 minutes (t = 2.89, p = 0.005).

Measures

*Reactive aggression screener.* The **VIRA-R measure of proactive and reactive aggression** (Hendrickx, Crombez, Roeyers, & Orobio DeCastro, 2003), adapted from Dodge and
Coie’s (1987) original Teacher Rating Instrument for reactive and proactive aggression, was completed by each participant’s seventh grade teacher during the spring 2008 semester as described above. This measure was used as a screener to determine which of the pre-identified youth met criterion for inclusion in the current study. The VIRA-R is a 22-item measure of both reactive and proactive aggressive behavior, which takes 10 to 15 minutes to complete. Each item describes a specific aggressive behavior. The teacher was asked to rate the child on a scale of 1 (never true) to 5 (almost always true) in reference to 11 proactive and 11 reactive aggression items. Only the 11 reactive aggression items were used in this study. The scores on these 11 items were summed, with higher scores indicating greater reactive aggression. All subjects included in the current study obtained a reactive aggression scores on the VIRA-R that fell in the top 50% when compared to the entire sample.

In previous Coping Power samples, this measure has typically demonstrated high internal consistency with the alpha coefficient for the reactive aggression scale fluctuating around 0.91 to 0.97. For this study, the alpha coefficient for the reactive aggression scale was 0.92. The item-total correlation for each of the reactive aggression items was sufficient, ranging from 0.57 to 0.82. With possible reactive aggression scores ranging from 11 to 55, the average score in the overall sample was 31.2. The experimental (mean = 31.4) and control (mean = 31.0) groups were not significantly different from each other in regards to reported levels of reactive aggression (t = 0.16, p = 0.87).

As discussed as a likely possibility in the background section, it would appear that many of the subjects included in this study were best classified as pervasively aggressive youth, indicating that they demonstrated traits of both reactive aggression and proactive aggression. While the sample was described as more reactively aggressive than proactively aggressive by
their teachers, teacher reports ranged from endorsing no proactive aggression items to endorsing all proactive aggression items at the highest rating. With the same possible range of 11 to 55, the mean for proactive aggression among this sample was 24.

**Inattention and hyperactivity-impulsivity.** Existing SIP research with aggressive youth rarely considers the high co-occurrence rate of inattention and hyperactivity-impulsivity symptoms among aggressive youth when interpreting these youths’ attention biases. On top of that, reactively aggressive youth, of which our sample is composed, have been found to demonstrate even more difficulties with inattention and impulsivity than other aggressive and nonaggressive youth (Dodge et al., 1997). As noted by Waldman (1996), it is possible that aggressive youth attend accurately to aggressive and non-aggressive cues, but that their inattention or hyperactivity-impulsivity interferes with their processing of this information.

It is noted that the current study involves an implicit learning task which may likely require at least moderate attention abilities to benefit from the training. This study aims to determine whether reactive aggression is related to an attention bias and whether reactively aggressive youth can benefit from cognitive retraining of this bias. As such, it is crucial that we control for levels of comorbid inattention and hyperactivity-impulsivity, so that we can be sure that any traits or changes we observe are attributable to levels of aggression, rather than levels of comorbid ADHD symptoms. For this purpose, the current study used the Test of Everyday Attention for Children (TEA-Ch) and the AD/HD Rating Scale-IV to control for baseline levels of inattention and hyperactivity-impulsivity at pre-training. A copy of both of these measures can be found in the Appendix.

To measure general attentional capacity, youth were administered the **Test of Everyday Attention for Children** (TEA-Ch; Manly, Robertson, Anderson, & Nimmo-Smith, 1999) at pre-
training. This measure assesses the youth’s abilities across four factors of attention (selective/focused attention, sustained attention, attentional control/attention switching, and sustained-divided attention). The reactive aggressive youth were administered the four-subtest screener version of this measure, which took approximately 20 to 25 minutes to administer. This screener version included one subtest for each of the four factors of attention mentioned above. These subtest scores were to be used as covariates in the main analyses examining the overall training effect. It was noted that the areas of attention measured by the TEA-Ch that were thought to be most critical to completion of the study’s training task were selective/focused attention and sustained attention. In general, the various TEA-Ch subscales were not significantly correlated to each other. Therefore, the decision was made to only utilize these two most relevant subtest scores. The fact that they were not significantly correlated to each other (r = -0.01, p = 0.96) led us to believe that these subscales were measuring different aspects of attentional ability and should not be aggregated into one composite attention ability covariate. As such, these two subtests were entered as separate attentional covariates during later analyses.

The TEA-Ch produces age and gender-based scaled scores. For both the selective/focused attention and sustained attention subtests, possible scores ranged from one to 19, with higher values indicating better attentional abilities in these domains. In the overall sample, the average selective/focused attention score was 9.32, and the average sustained attention score was 8.38. Both scores fall in the average range of attention ability. The control and experimental groups obtained similar selective/focused attention (experimental = 9.50, control = 9.13) and sustained attention (experimental = 8.07, control = 8.70) scores. These scores were not significantly different from each other (selective/focused attention, t = 0.58, p = 0.56 / sustained attention, t = -0.71, p = 0.48), indicating that the two groups demonstrated
comparable performance on the TEA-Ch measure of attention. In previous studies, the TEA-Ch measure has demonstrated reliability scores between .57 and .87 among youth populations, with 71% to 76% test-retest reliability (Manly et al.).

In addition to the above measure of attention, parents completed the **AD/HD Rating Scale-IV: Home Version** (DuPaul, Power, Anastopoulos, & Reid, 1998) to measure specific levels of inattention and hyperactivity-impulsivity at pre-training. This rating scale corresponds with the DSM-IV diagnostic criterion for AD/HD and includes 18 items which assess nine symptoms of inattention and nine symptoms of hyperactivity-impulsivity. The caregivers rated their child’s behavior on a four-point scale ranging from 0 (*Never or Rarely*) to 3 (*Very Often*). Completion of this measure took approximately five minutes. Total scores could range from 0 to 54, with possible Inattention subscale and Hyperactivity-Impulsivity subscale scores ranging from 0 to 27 each. Higher scores indicate a greater number of ADHD symptoms endorsed by the caregiver. DuPaul et al. found that the AD/HD Rating Scale-IV: Home Version has demonstrated adequate test-retest reliability (0.85) and high correlations with classroom behavioral observations and scores on the Conners Parent and Teacher Rating Scales. The measure has also been able to reliably discriminate between children meeting a diagnosis of AD/HD and those who do not (DuPaul, Power, McGoey, Ikeda, & Anastopoulos, 1998).

In the overall sample, the average Total score was 14.6, with average subscale scores of 7.9 for the Inattention subscale and 6.7 for the Hyperactivity-Impulsivity subscale. The control and experimental groups’ caregivers reported similar symptom levels across the subscales and Total score. For the Inattention subscale, the experimental group had a mean of 7.57, and the control group had a mean of 8.27 (t = -0.58, p = 0.56). On the Hyperactivity-Impulsivity subscale, the experimental group obtained a mean of 6.53 and the control group of 6.80 (t = -
0.25, p = 0.81). On the Total score, the experimental group mean was 14.10 and the control group mean was 15.07 (t = -0.47, p = 0.64).

For this measure, the internal consistency was strengthened by using the Total scale of 18 items, rather than either 9-item subscale independently. The alpha coefficient for the Total scale was 0.87 (similar to that found in previous research by the measure’s authors), with all item-to-total correlations falling above 0.30. As such, the decision was made to use the AD/HD Rating Scale’s Total scale score as the covariate in later training analyses. It is also noted here that the three ADHD symptom covariates from the AD/HD Rating Scale and TEA-Ch measure above were not significantly correlated with each other (see Table 2), as such they were entered into later analyses as three separate attention covariates.

*Emotional identification.* At pre-training, youth were administered the **Diagnostic Analysis of Nonverbal Accuracy** (DANVA-2; Nowicki & Duke, 1994). This measure examines youths’ ability to decode nonverbal emotion cues. As the effectiveness of the training task included in the current study relied on the youths’ ability to identify emotions from images of human faces, it was possible that deficits in emotion identification ability could have impaired an individual’s ability to benefit from the training task. If so, it could have been these deficits, rather than the individual’s level of aggression that predicted any lack of change following training. Consequently we could have falsely concluded that aggressive youth in general did not benefit from our training. As such, the DANVA-2 was administered at pre-training to allow for an emotion identification covariate during later analyses. This is particularly relevant among an aggressive sample, as research has shown that emotionally disturbed individuals are less skilled at identifying facial expressions than their typical peers (Cooley & Treimer, 1991; Nowicki & DiGirolamo, 1989).
The computer-administered version of the child and adult facial expressions subtests was used in the current study. Each subtest consisted of 24 pictures of male or female, Caucasian, African American, or Asian American actors displaying one of four emotions (happy, sad, angry, fearful) at two levels of intensity (high and low). Each face appeared for 2 seconds, and subjects were forced to indicate which emotion was expressed by touching their answer on the touch screen monitor below where the picture had been displayed moments earlier. Complete administration of the DANVA-2 child and adult faces subtests took approximately 5 to 10 minutes. The DANVA-2 has been used repeatedly with child populations, continually demonstrating adequate construct validity (Nowicki & Duke, 1994; Nowicki, Glanville, & Demertzis, 1998), adequate internal reliability ($\alpha = .64 - .81$), and adequate test-retest reliability ($r = .74 - .81$) (Boni, Brown, Davis, Hsu, & Hopkins, 2001). Samples of the adult and child computer images presented on the DANVA-2 are included in the Appendix.

As this measure would be used as an emotion identification ability covariate during training analyses, the decision was made to use the Total Child and Adult Faces combined error score provided by the DANVA-2, as this appeared to be the most stable indicator of emotion identification ability. Exploratory Hypothesis 2, discussed below in the results section, explores the profile of errors this population demonstrated on all of the DANVA-2 variables which create this total score (see also Table 6). As such, these findings will not be discussed here.

It is noted that of the 24 child face DANVA-2 trials, only one picture depicts a child who belongs to an ethnic minority group. Similarly, among the 24 adult face trials, only three depict an ethnic minority adult. This could be perceived as a possible concern, as the majority of our sample is African American. However, the DANVA-2 is a commonly used measure of emotional identification abilities, which has proven to be a valid measure across numerous
studies of diverse samples (Hallin, 1991; Nowicki & DiGirolamo, 1989; Nowicki & Duke, 1989). Furthermore, initial research examining the validity of the DANVA-2 measure indicated that of the subjects examined, their ethnicity was consistent with community rates of ethnicity (Nowicki & Duke, 1994). Also, Glanville and Nowicki (2002) explicitly examined youth’s ability to identify the emotions expressed in same-ethnicity and cross-ethnicity pictures of facial expressions. They found that African Americans and European Americans did not differ in their ability to identify cross-ethnicity pictures (Glanville & Nowicki). Therefore, it is believed that minority populations typically perform as well on the DANVA-2 as do majority populations. Nonetheless, Research Question 2 below examines whether ethnicity may be related to performance on the DANVA-2. Due to our limited sample size, our conclusions are somewhat tentative.

Similarly, gender-based differences on the DANVA-2 were explored in Research Question 1 below, as research has long since eluded to possible gender differences in emotion identification abilities. As this finding is still contested among many researchers, we present our findings in this area below in the results section.

**Selective Attention.** Two measures of encoding were utilized during the current study to assess the youths’ selective attention bias towards aggressive emotion cues at pre- and post-training. The traditional Hypothetical Vignette Measure of Encoding, a video vignette measure, was administered during the pre-training baseline assessment and during the post-training assessment of selective attention. The matrix reaction time measure of selective attention towards emotion cues, a cognitive measure of on-line processing, was also administered during both the pre- and post-training assessments.
The traditional Hypothetical Vignette Measure of Encoding was adapted from Dodge and Price’s (1994) original version, which initially consisted of 81 video recorded vignettes, acted out by males and females, depicting three kinds of problematic situations (peer-group-entry, peer-provocation, and authority-directives) and three varying intentions (hostile, nonhostile, and ambiguous). These vignettes are brief clips of peer interactions, after which the individual is asked to recall all of the details surrounding the clip, in hopes of assessing encoding ability. Reactively aggressive youth have typically demonstrated deficits on this encoding measure due to their early stage SIP difficulties (Dodge et al., 1997).

For the purposes of the current study, peer-group-entry scripts and peer-provocation scripts were utilized. Previous studies which have used these vignettes successfully to measure attention to cues via cue recall among aggressive youth have relied on fewer than 27 vignettes (Lansford et al., 2006; Lochman & Dodge, 1994; Schippell et al., 2003). Lochman and Dodge successfully utilized twelve vignettes, with four of each kind of interaction (hostile, ambiguous, or benign) included in their assessment battery. During a longitudinal study, Lansford et al. utilized either a set of six video vignettes or a set of 24 video vignettes. While a larger battery of videos may present a more robust measure, it is desirable to avoid subject fatigue which could compromise the reliability and validity of the measure. As video measures containing as few as six vignettes have shown an ability to measure SIP errors, the current study included twelve video vignettes at pre-training and twelve video vignettes at post-training. At both time points, four vignettes depicted hostile child interactions, four depicted ambiguous child interactions, and four depicted accidental child interactions.

The role of the hypothetical vignette measure of encoding in the current study was two-fold. First, as the current study’s training task attempted to retrain reactively aggressive youth’s
ability to encode emotional expressions, the goal was for the hypothetical vignette measure to examine this same construct at pre- and post-training, and assess any change across time. Second, this measure was also intended to represent the traditional means of measuring encoding deficits predominantly used in today’s research. As such, we chose to utilize the video-version of the well-known hypothetical vignette measure of SIP (Dodge & Price, 1994). A meta-analysis of studies investigating SIP errors found that 32% of the studies examined utilized a video-based measure of SIP skills (Orobio de Castro et al., 2002). While this was not found to be the strongest measure of SIP errors, in the same meta-analysis, it was still selected for use in this study as it best met both of the necessary qualifications for its role in this study (to measure encoding of emotional expression and to represent a commonly used measure).

The reliability and validity of the hypothetical vignette measure is somewhat contingent on obtaining the greatest possible amount of information from the child. However, as this measure taps encoding and attention biases, in the quest to obtain maximum information, the interviewer must be careful not to plant memories or encourage subjects to provide a response that is not naturally based on their actual encoding. As such, at the start of the administration of the hypothetical vignette measure, each child was read the following directions:

Now we are going to watch some video clips of children your age interacting with their classmates at school. Watch each clip carefully. At the end of each clip, I will ask you to tell me everything that you noticed happening during that clip. I am interested in all that you see, including details about the people, what is happening, what the people are thinking, what they are doing, and what they are feeling. Tell me as much as you can. The more detail the better.

Each child was then presented a practice vignette, in which the interviewer provided extra probing to teach the child to give a lengthier response. After this practice item, the interviewer only probed the child to say “Tell me what happened in this story” when the vignette had ended,
and “What else were they saying and doing?” if they give a particularly short response.

Completion of this measure took approximately 15 to 20 minutes at each time point. Each subject was randomly assigned to receive vignettes 1 through 12 at either pre- or post-training, with them receiving vignettes 13 through 24 at the other time point. This method of counterbalancing controlled for the effect of the differences in vignettes, ensuring that systematic difference in these blocks of vignettes were not the source of observed change from pre- to post-training. However, it is noted that these particular vignettes were selected from an initial larger group of 108 vignettes because they each possessed sufficient and equivalent clarity (Dodge & Price, 1994). More specifically, these vignettes were each thought to clearly depict the antagonist’s intentions and the protagonist’s response, and they were clearly understood and interpreted by children and adults (Dodge & Price). Therefore, it seems unlikely that there would be substantial systematic differences among the various hypothetical vignettes.

Consistent with Dodge and Price’s (1994) scoring techniques, as well as those utilized by Lansford et al. (2006), responses were scored on a three point scale based on degree of attention to relevant information, with higher scores indicating better encoding of relevant cues. Subjects received a score of 0 (no attention to relevant details), 1 (partial attention to relevant details), or 2 (clear attention to relevant details) for each vignette response. To increase the reliability and objectivity of the scoring of these vignette responses, the researcher created a coding manual which outlined the specific relevant details for each vignette and also included the specific number of details that had to be included in the response to receive each of the three coding scores. A fellow social-information processing researcher was recruited to assist with reliability coding on the vignette measure. Reliability coding was conducted on 10% of the vignette responses at pre-training and 10% at post-training. Six subjects were randomly selected at pre-
training, and a separate six were chosen from post-training responses. After reviewing the coding manual, the primary investigator and assistant independently coded the randomly selected pre- and post-training responses. The two raters agreed on the scoring for 140 of the 144 selected vignette responses, with an inter-rater reliability score of 97.2%. This was taken as an indication that the coding manual was a sufficient scoring tool. For the four vignettes which received different scores, the score given by the primary investigator was used as the final score for those vignettes. The primary investigator proceeded to score the remaining subjects’ responses using the established coding manual.

These coded responses were subsequently used to examine the subjects’ attention biases at pre- and post-training. The ambiguous vignettes were not used in this measurement. Encoding of hostile cues was represented by the mean score across the hostile vignettes, and encoding of non-hostile cues was represented by the mean score across the accidental vignettes. A significant difference between these two means was considered indicative of the presence of an attention bias. If the subjects demonstrated an angry attention bias, it was predicted that they would encode fewer relevant details on hostile vignettes than on accidental vignettes as the increased arousal and attention to the hostile cues would cause them to overlook relevant non-hostile cues.

Possible mean scores range from 0 to 2, with higher scores indicating more complete attention to relevant details. The subjects’ performance on the vignette measure is presented in Table 1 broken down by intent (hostile, ambiguous, accidental) and type (peer entry, peer provocation). Mean scores are provided for the overall sample, the experimental group, and the control group at pre- and post-training.
Table 1

Performance Profile on the Hypothetical Vignette Measure of Encoding.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall Sample</th>
<th>Control Group</th>
<th>Experimental Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PRE-TRAINING</td>
<td></td>
<td>POST-TRAINING</td>
</tr>
<tr>
<td>Hostile Vignettes</td>
<td>1.12</td>
<td>1.12</td>
<td>1.13</td>
</tr>
<tr>
<td>Ambiguous Vignettes</td>
<td>1.17</td>
<td>1.18</td>
<td>1.16</td>
</tr>
<tr>
<td>Accidental Vignettes</td>
<td>1.19</td>
<td>1.23</td>
<td>1.16</td>
</tr>
<tr>
<td>Peer Entry Vignettes</td>
<td>1.24</td>
<td>1.25</td>
<td>1.22</td>
</tr>
<tr>
<td>Peer Provocation Vignettes</td>
<td>1.09</td>
<td>1.1</td>
<td>1.07</td>
</tr>
</tbody>
</table>

In the overall sample, subjects recalled significantly more relevant details on accidental vignettes (mean = 1.19) than on hostile vignettes (mean = 1.12) ($t = -2.33, p = 0.02$). This significant difference persisted at post-training in the overall sample, with an accidental vignette mean of 1.23 and a hostile vignette mean of 1.16 ($t = -2.13, p = 0.04$). In the overall sample, the subjects’ performance on hostile vignettes did not significantly change from pre- to post-training ($t = -1.24, p = 0.22$). The same was true for the accidental vignettes at pre- and post-training in the overall sample ($t = -1.22, p = 0.23$). The experimental and control groups also performed similarly on each of the main vignette variables. There were no significant differences between their scores on the pre-training hostile vignettes, pre-training accidental vignettes, post-training hostile vignettes, or post-training accidental vignettes.

As aggressive youth are thought to demonstrate more errors on this traditional hypothetical vignette measure of encoding, it would make sense that levels of reactive aggression
would be related to performance on this measure. However, in the overall sample this was not the case. Level of reactive aggression on the VIRA-R screener was not significantly related to performance on either the pre-training hostile vignettes ($r = 0.001$, $p = 0.996$) or the pre-training accidental vignettes ($r = 0.14$, $p = 0.30$).

The second measure of selective attention included in this study was the **matrix reaction time measure of selective attention** to emotion cues. This measure consisted of additional trials added to the beginning and end of the matrix training task discussed below (Dandeneau & Baldwin, 2004). These additional trials were used in the current study to measure attention bias for aggressive versus nonaggressive emotion cues at pre- and post-training. The matrix reaction time measure consisted of a series of $4 \times 4$ matrices of 16 images of youth displaying either a happy or angry facial expression. The matrices were presented on a touch screen monitor. Subjects began with 10 practice trials to get accustomed to the use of the touch screen monitor and the task instructions. The researcher read aloud the following instructions which appeared on the screen in front of the subject.

In this game, you’ll see lots of faces. Some faces will be angry and some will be happy. Your job will be to click on the HAPPY face. Try to be as fast and accurate as possible. In between pictures, you will see a plus symbol. When you see this symbol, place your hands on the table in front of you and look at the screen. Then the examiner will know you are ready for the next group of pictures. This first part will be practice, so that you get the hang of it. Let's get started.

The researcher provided the subjects with an outline of two hands which was placed in front of the monitor. The subjects were to place their hands on this outline after they selected their response on each trial and the focal point (a plus symbol) had appeared in the center of the screen. This was to ensure that variability in response time was not due to where the children placed their hands in relation to the screen prior to each new matrix trial. As this task included
the practice trials, two blocks of pre-training assessment trials, four blocks of training trials, and two blocks of post-training assessment trials, each subject was provided with a tracking chart they could use to check off each block of trials as it was completed. This was intended to help the children stay focused on the task and have a sense of their progress through this lengthier activity in hopes of decreasing their frustration and possible subsequent non-compliance or decreased effort.

After the block of 10 practice trials, subjects proceeded into two blocks each of 25 pre-training assessment trials. One block contained happy target trials in which the subject had to find the one happy face amidst the 15 angry distracter faces as quickly as possible. The other block contained angry target trials in which the subject had to find the one angry face amidst the 15 happy distracter faces as quickly as possible. A sample of a happy target trial is shown in Figure 2. For each trial, the images were randomly selected without replacement from a bank of images bearing the appropriate emotion. Each bank of images contained an equal number of male and female images, as well as Caucasian and African American images. Each image position within each matrix was also randomly determined. Subjects could not proceed to the next trial until they had selected the correct target response. Following every correctly completed trial, a plus symbol appeared in the center of the screen. As soon as the child was focused on this plus symbol and their hands were again placed on the hand outlines on the table, the researcher advanced the program to the next trial. Prior to each new block of trials, the child was visually and verbally reminded of the task instructions and given the opportunity to ask any questions. The program was also created to randomly order the administration of the happy target and angry target assessment blocks for each subject, with some completing the block of angry target trials first and some completing the happy target trials first. The procedures were
identical for the pre- and post-assessment trials. At pre- and post-training each, it took approximately 5 minutes to complete the two blocks of assessment trials.

The pre- and post-training assessment trials were used to measure the reactive aggressive youth’s selective attention bias by comparing their average reaction time on happy target trials with their average reaction time on angry target trials. It was expected that youth who demonstrated an angry attention bias at pre- and/or post-training would demonstrate a slower reaction time on happy target trials due to their bias towards angry emotion cues. This bias would draw their attention off-task in the happy target trials and would aid their efforts in the angry target trials. The subjects’ performance on the pre- and post-training assessment trials is the focus of later analyses, and as such is not discussed here.

Training Task. The experimental and control training tasks utilized in the current study were based on those created by Dandeneau and Baldwin (2004). This task is a computer-based cognitive training task which attempts to provide individuals with a new attentional set, such that they implicitly work towards inhibiting their natural attentional bias through repeated practice identifying information which is typically neglected due to this attentional bias. It was hoped that the reactively aggressive youth’s attentional bias would be retrained such that there was a reduction in their attentional bias towards angry emotion cues at post-training.

While to date this training task has only been utilized with adult populations, it has proven successful at retraining the attentional biases of these anxious adults (i.e., college students). At post-training, Dandeneau and Baldwin (2004) found that these adults demonstrated less of an attentional bias. However, not only did the training task reduce their tendency to attend primarily to rejecting facial expressions, it also generalized to situations involving rejection words and reduced their tendency to attend to these words. The implication here is that
the training task encouraged subjects to adopt the conceptual ability to look for accepting rather than rejecting information across cue types (Dandeneau & Baldwin). As the current version of the training task used images of college-aged individuals, to maintain the integrity of the task, we continued to use college-aged images. While there is evidence that as children age their emotion identification abilities improve (Haslett & Samter, 1997), there is no salient evidence indicating that aggressive children have substantial differential abilities for identifying emotions in children versus adults. Therefore, it was believed that this stimulus trait would not be problematic.

Like Dandeneau and Baldwin (2004), smiling/happy expressions and frowning/angry expressions of 16 individuals were obtained for use as test stimuli in the experimental training task. These images were in black and white and they depicted each individual from their shoulders up. Though similar in their characteristics, these images were of different people than those used in the pre- and post-training assessment trials to ensure that any implicit learning achieved during the training task was due to a shift in attention set rather than an increased familiarity with the target stimuli over time. The procedures for the training task were identical to those for the pre- and post-training assessment trials discussed above. However, all of the training trials were happy target trials. Subjects proceeded through four blocks of 28 happy target trials during training, for a total of 112 training trials.

Subjects randomly assigned to the control condition completed the same pre- and post-training assessment trials as the experimental group. However, their training task was composed of different stimuli. Rather than viewing facial expressions, subjects viewed images of five-petaled flowers and seven-petaled flowers. These images were also presented in black and white. Each trial consisted of a 4 x 4 matrix of 16 flower images, 15 of which were seven-petaled flowers and one of which was a five-petaled flower. These images were randomly
selected and positioned within each matrix. See Figure 3 for a sample image of a control training task matrix. During completion of the control training task, subjects were instructed to find and click on the five-petaled flower as quickly as possible within each matrix. As in the experimental training task, subjects were not allowed to progress to subsequent matrices without first selecting the correct target image. These 112 control training trials were also divided into four blocks of 28 trials each. On average, subjects took approximately 10 to 15 minutes to complete the experimental and control training tasks.

There is some inconsistency between the stimuli presented in the matrix training task and that presented in the hypothetical vignette measure, which is intended to measure change caused by the training task. While the matrix training task contains college-aged images, the vignette measure contains adolescent actors. However, based on previous research, this inconsistency should not be of great concern. Dodge and Price (1994) examined aggressive youth’s ability to encode peer-related and authority (or adult)-related social cues. They found that as children aged and were increasingly exposed to peer or authority interactions in their everyday lives, their skill in encoding peer and authority cues respectively increased. Our adolescent sample has been exposed to both peer and authority-related social cues for several years, so it is likely that they have developed the ability to encode both peer and authority social cues. Additionally, when examining the effects of the matrix training task on attentional biases, Dandeneau and Baldwin (2004) found that these effects generalized to conceptually similar domains. Not only did the matrix training task influence their encoding of emotion cues present in facial expressions (like the matrix task), but it also influenced their encoding of emotion cues present in emotionally-charged words. As such, it would seem that expecting changes in encoding to generalize from adult faces to adolescent faces is a much smaller conceptual leap.
**Processing Reaction Time Data**

There are certain issues that arise when processing reaction time data, such as that obtained from the matrix reaction time measure and matrix training task in this study. Due to certain natural restrictions, reaction time data is often not normally distributed. Rather, it is typically right skewed, bounded on the left side by human limitations regarding the fastest possible reaction time. With reaction time data, outliers bias data in one direction (i.e., towards the distribution’s tail). Therefore, researchers attempt to make use of all of the “real” data and throw out outliers thought to be caused by error. This is typically done by trimming outliers and then transforming the data to produce a normal distribution. The specific steps taken to address these issues in this data set are discussed below.

*Accuracy data.* For each pre- and post-training assessment trial, a variable was included in the output which indicated whether the subject had found the correct response the first time they touched the screen or whether they initially selected an incorrect response before eventually finding the correct response in order to move onto the next trial. Initially selecting an incorrect response could have indicated a poor understanding of the task. However, it could also have been indicative of impulsive responding, which is not uncommon among aggressive populations. There was no way to accurately distinguish between these two possibilities. As such, incorrect initial responses were not automatically assumed to indicate a lack of understanding.

Nonetheless, the percentage of trials on which subjects initially selected an incorrect response was examined. During pre-training, subjects accurately selected the correct response on their first attempt 93.5% of the time, and during post-training they did so 94.6% of the time. There was no significant difference between these percentages for the control and experimental groups at pre- and post-training. Typically, accuracy scores between 90 and 95% are thought to
indicate a subject’s general understanding of the task at hand. As such, we took our sample’s first attempt accuracy scores as an indication that they generally understood the task at hand. For trials in which the initial response choice was an incorrect response, the actual reaction time value for that trial was the time it took to eventually select the correct response. Assured that our subjects adequately understood the task, we did not discard trials in which the first response was incorrect, as we considered this incorrect response process to be a valid part of the length of time it took subjects to ultimately select the correct response. Subsequently, if these were excessively lengthy, we assumed they would be removed during the process of trimming extreme outliers.

Trimming outliers. The next decision was in regards to what standard to use in trimming outliers from the reaction time data. While we did want to trim extreme outliers present due to subject inattention or error, we did not want to trim extreme outliers that were due to subjects truly taking a longer period of time to locate the target image. In order to retain these latter reaction times, we hoped to use more extreme cut-off values for trimming outliers. Literature on this topic has pointed towards two types of outlier decisions. First, if the main effect between two groups is around the mean, meaning that the entire distribution of one group is completely shifted to the right in comparison to the other group, than it is ideal to fairly readily eliminate longer reaction times to increase the power by getting rid of non-meaningful outliers that are away from the mean (Ratcliff, 1993). On the other hand, if the effect between the two groups is in the tail, this means that the entire distribution of one group revolves around a similar mean as the other group but has a longer tail and as such the difference is spreading into the tail (Ratcliff). Reportedly, this is a more common pattern of results in reaction time studies than the “shifting” of the entire distribution. In the case of a spreading effect, if there are no outliers, you would not want to cut long reaction times because this would decrease the power by cutting real reaction
times that carry the effect. If outliers are present amidst a spreading effect, you would want to cut longer reaction times to increase the power but do so conservatively so as not to eliminate too many longer reaction times that are responsible for the actual effect (Ratcliff).

Based on this decision process, Ratcliff (1993) indicates that for the “shifting” effect, eliminating approximately 10% of the distribution would be reasonable. However for a “spreading” effect, it would be reasonable to select a cut-off value that eliminates only approximately 5% of the observations. After examining the means and distributions of our pre- and post-training assessment trials, there did not appear to be a significant shift in the entire distribution between our groups across time. As such, it seemed likely that recommendations for “spreading” effects were more appropriate for our sample.

However, before making this conclusion, we also examined the histograms of the pre- and post-training assessment trial distributions. These distributions were typically unimodal, right skewed distributions, and it appeared that values were typically falling off (i.e., there was a gap between the rest of the data and the outliers) above 15,000 to 20,000ms. However, for several subjects, it appeared that a cut-off of 15,000ms would eliminate several relevant data points that were a part of their normal response style.

Based on these assessments of our data the Mean + 3SD and Mean + 2SD cut-offs were considered for trimming outliers. The former cut-off would trim outliers above 19,822ms, whereas the latter would trim outliers above 15,100ms. As mentioned above, there was concern, based on looking at histograms that the latter would eliminate too many valid data points. Under the assumption that our data was demonstrating a spreading effect, we hoped to eliminate no more than 5% of our data using the Mean + 3SD cut-off, as this cut-off seemed more appropriate after viewing our histograms. Using this cut-off, there was a total data loss of 2% (117 out of
6000 pre- and post-training values). Individual subjects lost between 0 and 10% of their total pre- and post-training data, with only one subject losing 10% of their data. This amount of data loss was considered appropriate and acceptable. As such the Mean + 3SD cut-off was employed to trim high outliers.

We next examined the data for low outliers. The Mean – 3SD cut-off was not appropriate on the low end, as this led to impossible negative reaction time cut-offs in all cases. We then considered using a cut-off of 250ms as the lowest possible reaction time not attributable to a chance response or error. However, further examination showed that the lowest response time across all reaction time variables was 721ms. It was decided that due to our procedures, it was nearly impossible for subjects to respond impulsively in such a way as to obtain an invalid or erroneous low score. Subjects were made to keep their hands on the table until the stimuli appeared on the screen. As such, there was no way for them to accidentally touch the correct response before they truly searched the response choices. In fact, most subjects did not lift their hands from the table until they had deliberately searched the matrices for their response. An examination of the histograms did not reveal any apparent low outliers. As such, no low outliers were trimmed from the data.

Transforming skewed data. The next task was to determine whether our newly trimmed data remained skewed and in need of transformation prior to conducting our analyses which required normally distributed data. Various tests were run to assess the normality of the reaction time variables. The skewness and kurtosis of each variable was examined. None of the pre- or post-training assessment variables appeared to have concerning skewness or kurtosis values. Next the Kolmogorov-Smirnov statistic was run as a test of normality on each variable. In this case, a non-significant result indicates normality. Only one post-training variable for the control
group had a significant value, indicating a non-normal distribution. Next, histograms and Normal Q-Q Plots were examined for each variable. Each histogram appeared to follow a normal distribution, and each Q-Q Plot appeared to center around the straight line that suggests a normal distribution. Additionally, we examined the residuals of our main analysis (i.e., the 2 x 2 x 2 Mixed Model ANOVA) for normality. Similarly, the skewness, kurtosis, and histograms of these residuals were all within the normal distribution range. Based on these tests, it was decided that the reaction time variables were normally distributed and best left untransformed.

Non-normality is considered particularly problematic on tasks where most subjects respond very quickly. In these cases, there are very few opportunities to perform more quickly, but many opportunities to perform more slowly, leading to a right-skewed distribution. However, there are several general attributes to this study which may have contributed to a less skewed distribution which did not violate normality. First, younger subjects are overall somewhat slower responders than adults. Second, the visual search task involved in the training task and assessment trials is a more demanding and difficult task, which often lends itself to slower reaction times. Given these two characteristics, the typical responses were likely to be drawn further from the floor of 0ms, decreasing the likelihood of an extremely right-skewed distribution. The task innately provided more opportunity for variability around both sides of the mean, rather than more variability on the positive side of the mean.
RESULTS

Descriptive Statistics for Variables of Interest

Overall sample means, standard deviations, and correlations for the aggression screener (VIRA-R), pre-training measures of ADHD symptoms (ADHD Rating Scale, two TEA-Ch subscales) and emotion identification ability (DANVA-2), pre- and post-training vignette scores (for hostile and accidental vignettes), and pre- and post-training reaction time scores (angry target and happy target average reaction times) are presented in Table 2. Tables 3 and 4 contain these same main variable statistics for the experimental and control groups respectively.

Overall Sample. In the overall sample, level of reactive aggression, as measured by the VIRA-R teacher-report screener, was significantly correlated (p < .01) with parent-report of ADHD symptoms on the ADHD Rating Scale, with increased levels of reactive aggression related to report of a greater number of ADHD symptoms. Level of teacher-reported reactive aggression was not significantly correlated with any other main variables.

Among the covariates included in data collection, the ADHD Rating Scale, the TEA-Ch measure of selective/focused attention, and the DANVA-2 measure of emotion identification ability did not demonstrate any significant correlations to any other variables in the overall sample. Only the TEA-Ch covariate measure of sustained attention demonstrated a significant correlation (p < .05) with pre-training reaction time on angry target matrix trials, with stronger sustained attention abilities related to shorter angry target reaction times. These relationships are ideal in that the four covariates included in the main analyses are likely distinct variables, as they are not significantly correlated to each other. Thus, it can be assumed that they each contribute
Table 2

Means, Standard Deviations, and Pearson Product-Moment Correlations Between Model Variables in the Overall Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
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<tbody>
<tr>
<td>1) T1 VIRA-R</td>
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<td>2) T1 ADHD</td>
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†p ≤ 0.10; *p ≤ 0.05; **p ≤ 0.01
uniquely to the variance explained in the main analyses. However, it is not ideal that the covariates are not significantly correlated to the dependent variables (matrix reaction times). Nonetheless, these covariates will still be included in the analyses due to their strong theoretical significance in examining relations between ADHD-like symptoms, emotion identification abilities, and changes in attention bias following intervention.

Among the main model variables in the overall sample, the pre-training hypothetical vignette scores were not significantly correlated to each other or to the pre-training matrix reaction time variables, which were theoretically expected to measure the same construct. Subjects’ performance on the pre-training accidental intent hypothetical vignettes was significantly correlated with their post-training accidental intent (p < .01) and hostile intent (p < .05) hypothetical vignettes, with increased attention to relevant details on one set of vignettes related to similar high performance on the other set of vignettes. Subjects’ performance on pre-training hostile intent vignettes was only significantly and positively related to post-training accidental intent vignettes (p < .01). Unlike at pre-training, the post-training accidental intent and hostile intent vignettes were significantly and positively correlated to each other (p < .01).

Each of the pre-training and post-training matrix task reaction time variables was significantly and positively correlated to each of the others within time point and across time at p < .01 such that decreased reaction times on one variable was related to decreased reaction times on the others. The reaction time bias scores (i.e., difference between average happy and angry reaction times) were examined at pre- and post-training, and the bias change score (i.e., difference between T1 and T2 bias scores) was also examined. This was done to determine whether the bias scores, which remove variance solely due to speed of response time, evidenced other significant relationships not seen in the raw average reaction time variables. However, in the
overall sample, these bias scores were mainly correlated only to their component parts (i.e., the average reaction time variables). Only the post-training RT bias score was significantly and positively correlated to another variable, the post-training hostile vignette variable ($p < .05$).

Due to the fact that the matrix retraining task relied heavily on emotion identification abilities, particularly on the ability to identify happy and angry faces, correlations between the reaction time bias scores and the individual subtests (i.e., emotions) on the DANVA-2 were examined. Among the overall sample, those subjects who demonstrated more accuracy at identifying happy faces on the DANVA-2 were more likely ($p < .05$) to respond more slowly when searching for happy faces than when searching for angry faces on the pre-training reaction time bias score (i.e., angry attention bias).

**Experimental Group.** As stated above, the correlations, means, and standard deviations for the variables among the experimental and control groups specifically are presented in Tables 3 and 4 respectively. In general, the relationships among variables in these groups are similar to those in the overall sample, with some minor differences and some changes in significance levels likely due to the decreased power caused by having only a sample of 30 subjects in each of these groups.

Within the experimental group, the VIRA-R aggression screener and covariate measure correlations are largely identical to those in the overall sample with mainly only changes in levels of significance. However, in the experimental condition, the DANVA-2 covariate measure of emotion identification ability was significantly, negatively correlated with pre-training angry trial matrix reaction times ($p < .05$), indicating that as subjects’ emotion identification abilities declined they seemed faster at identifying angry targets at pre-training.
Table 3

Means, Standard Deviations, and Pearson Product-Moment Correlations Between Model Variables in the Experimental Group

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<tr>
<th>Variable</th>
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*p ≤ 0.10; *p ≤ 0.05; **p ≤ 0.01
Among the pre-training hypothetical vignette measure, the experimental group correlations were again similar to those in the overall sample, except the pre-training accidental intent vignettes were no longer correlated to the post-training hostile intent vignettes, but they were now positively correlated to the post-training happy target matrix reaction time variable (p < .01).

The post-training hypothetical vignette measures were similarly related as in the overall sample. The correlations among the experimental group’s reaction time variables were similar to those in the overall sample, with the only changes being declines in significance level likely due to the decreased sample size. It was also noted that for the experimental group the pre-training reaction time bias score was significantly correlated with the sustained attention TEA-Ch measure (p<.05), and the post-training reaction time bias score was significantly correlated with the pre-training accidental vignette score (p<.05) and post-training hostile vignette score (p < .05).

**Control Group.** Within the control group, the aggression screener is no longer related to the ADHD Rating Scale, though it does demonstrate a significant, negative relationship with the post-training happy target matrix reaction time (p < .05). Among the covariates, only the DANVA-2 is positively related to the post-training accidental intent hypothetical vignette (p < .05). Among the pre-training hypothetical vignette variables, the accidental intent vignettes are no longer related to either post-training vignette intents. Similarly, among the post-training vignettes, the hostile and accidental intent vignettes are no longer related to each other within the control group. However, the reaction time variables demonstrate the same pattern of relationships, with only some of the significance values weakened slightly, likely due to decreased power in the control group compared to the overall sample. It was also noted that the pre-training reaction time bias score was significantly correlated with the pre-training accidental
Table 4

Means, Standard Deviations, and Pearson Product-Moment Correlations Between Model Variables in the Control Group

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<td>0.70**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11) T2 Angry RT</td>
<td>-0.16</td>
<td>0.07</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.09</td>
<td>0.17</td>
<td>-0.12</td>
<td>0.42*</td>
<td>0.71**</td>
<td>0.43*</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12) T2 Happy RT</td>
<td>-0.43*</td>
<td>-0.08</td>
<td>-0.08</td>
<td>-0.33†</td>
<td>-0.02</td>
<td>0.22</td>
<td>-0.10</td>
<td>0.40*</td>
<td>0.72**</td>
<td>0.46*</td>
<td>0.75**</td>
<td>-</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13) T2 RT Bias Score</td>
<td>-0.44*</td>
<td>-0.20</td>
<td>-0.05</td>
<td>-0.44*</td>
<td>0.08</td>
<td>0.21</td>
<td>0.47**</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14) RT Bias Change Score</td>
<td>-0.10</td>
<td>0.03</td>
<td>0.14</td>
<td>-0.14</td>
<td>0.14</td>
<td>0.02</td>
<td>0.39*</td>
<td>0.31</td>
<td>-0.49*</td>
<td>-0.78**</td>
<td>-0.46*</td>
<td>-0.04</td>
<td>0.50**</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15) T2 Hostile Vignettes</td>
<td>-0.10</td>
<td>0.04</td>
<td>0.31†</td>
<td>-0.12</td>
<td>-0.04</td>
<td>-0.08</td>
<td>-0.05</td>
<td>0.06</td>
<td>-0.22</td>
<td>-0.29</td>
<td>-0.05</td>
<td>0.05</td>
<td>0.14</td>
<td>0.34</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>16) T2 Accidental Vignettes</td>
<td>-0.28</td>
<td>0.07</td>
<td>-0.01</td>
<td>-0.18</td>
<td>0.40*</td>
<td>0.53**</td>
<td>-0.02</td>
<td>0.26</td>
<td>0.07</td>
<td>-0.14</td>
<td>0.04</td>
<td>0.11</td>
<td>0.11</td>
<td>0.19</td>
<td>0.27</td>
<td>-</td>
</tr>
</tbody>
</table>

Mean | 31.03 | 15.07 | 9.13  | 8.70  | 10.50 | 1.11  | 1.17  | 5004  | 5350  | 346   | 4888  | 5209  | 322   | -24.41| 1.13  | 1.22  |
SD   | 8.55  | 8.03  | 2.73  | 3.20  | 4.61  | 0.14  | 0.18  | 941   | 1262  | 1169  | 1039  | 1256  | 841   | 1331  | 0.17  | 0.19  |

† p ≤ 0.10; * p ≤ 0.05; **p ≤ 0.01
vignette score (p<.05), and the post-training reaction time bias score was also significantly related to the VIRA and sustained attention TEA-Ch measure (both at p<.05). Additionally, among the control group, the reaction time bias change score was also significantly correlated to the pre-training accidental vignette score (p<.05).

While some differences might be expected at post-training between variables means for the control and experimental group due to intervention effects, it was hoped that the two populations were relatively comparable across the pre-training variables. As such, simple between-subjects t-tests were run to examine variable mean differences between the conditions at pre-training. Across all pre-training variables (aggression screener, covariates, pre-training vignette and reaction time variables), no significant differences existed between the control and experimental groups, indicating that they were statistically similar on all pre-training variables.

As the gender and ethnicity splits among the overall sample were not equitable, a comprehensive examination of the variable relationships within these sample subsets was considered minimally useful. However, supplemental gender and ethnicity analyses were conducted on select relevant variables where gender and ethnicity differences were thought likely based on previous research or intrinsic measurement characteristics. These gender and ethnicity-based analyses are discussed below under the supplemental and exploratory analysis sections.

Main Analyses

This study’s two main hypotheses examine: a) whether the overall sample of reactively aggressive youth demonstrated an attention bias using the new reaction time measure and b) whether the training task effectively altered the experimental group’s attention bias during the experimental period in comparison to the control group.
The pre-training matrix trials administered to all subjects were used to measure the presence or absence of an attention bias at pre-training. As part of *Hypothesis 1*, it was proposed that this reactively aggressive sample would demonstrate a selective attention bias towards angry expressions by responding more quickly to matrices requiring them to find angry expressions among a field of happy expressions than to matrices requiring them to find happy expressions among a field of angry expressions, as they are thought to allocate greater attentional resources to aggressive cues. A within-subjects t-test was run on all subjects at pre-training to determine whether there was a significant difference between their average reaction time on happy target trials versus angry target trials. These analyses found a significant difference in the average time it took subjects to find the happy target faces and the average time it took subjects to find the angry target faces (t = -2.3, p = .025). Subjects took significantly longer to find the happy target faces among the angry distractor faces than vice versa. This indicates that our implicit reaction time measure did identify a significant attention bias towards aggressive cues among our sample.

It was also noted that in the overall sample, there was a significant change in the reaction time bias score (i.e., difference between average happy and angry target reaction times) from pre- to post-training (t = 2.30, p = 0.025). At pre-training, the overall sample demonstrated an angry attention bias, whereas they showed a happy attention bias by post-training.

The second main analysis, *Hypothesis 2*, examined whether this attention bias is malleable as evidenced by whether the experimental group’s attention bias was influenced by the matrix implicit learning task. It was hypothesized that the bias is malleable and that following on-line training with the matrix task, the experimental group’s attention bias towards aggressive cues would be reduced compared to the control group. A 2 (condition: experimental vs. control) x 2 (target: angry vs. happy) x 2 (time: pre-training vs. post-training) mixed model ANOVA with
target and time as within-subjects factors was run to examine this hypothesis. All assumptions (i.e., normal distribution, homogeneity of variance) were met prior to interpreting the results. Follow-up analyses using post-hoc comparisons were run on significant interactions found within this model. To deal with familywise error rates, a Bonferroni correction was applied to alpha during follow-up analyses, as this correction is considered to be a conservative approach least likely to result in inflated Type I errors.

Table 5

*Analysis of Variance for 2 (Condition) x 2 (Target) x 2 (Time) Mixed Model ANOVA with Target and Time as Within Subjects Factors*

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>F</th>
<th>Partial Eta Squared</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition (A)</td>
<td>1</td>
<td>1.03</td>
<td>0.02</td>
<td>0.32</td>
</tr>
<tr>
<td>Error (A)</td>
<td>58</td>
<td>(3265864.88)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target (B)</td>
<td>1</td>
<td>1.18</td>
<td>0.02</td>
<td>0.28</td>
</tr>
<tr>
<td>Time (C)</td>
<td>1</td>
<td>0.13</td>
<td>0.002</td>
<td>0.72</td>
</tr>
<tr>
<td>A x B</td>
<td>1</td>
<td>3.63†</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>A x C</td>
<td>1</td>
<td>0.84</td>
<td>0.01</td>
<td>0.36</td>
</tr>
<tr>
<td>B x C</td>
<td>1</td>
<td>5.67*</td>
<td>0.09</td>
<td>0.02</td>
</tr>
<tr>
<td>A x B x C</td>
<td>1</td>
<td>5.14*</td>
<td>0.08</td>
<td>0.03</td>
</tr>
<tr>
<td>Error (B)</td>
<td>58</td>
<td>(748024.81)</td>
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</tr>
<tr>
<td>Error (C)</td>
<td>58</td>
<td>(598727.19)</td>
<td></td>
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</tr>
<tr>
<td>Error (B x C)</td>
<td>58</td>
<td>(696913.69)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Values enclosed in parentheses represent mean square errors. †p<.10. *p<.05. **p<.01

All of the main and interaction effects are presented statistically in Table 5. None of the three main effects were significant. Among the three two-way interactions, there was only a trend towards significance for the target x condition interaction (F = 3.63, p = 0.06). The effect size calculated using partial eta squared was moderate at .06. The target x time interaction was significant (F = 5.67, p = .021), with a moderate effect size (partial eta squared = .09). Follow-
up analyses showed that at pre-training, there was a significant difference between the average reaction times to happy targets ($M = 5437.71$, $SD = 164.33$) versus angry targets ($M = 5059.82$, $SD = 128.99$). However, reaction times were not significantly different at post-training [happy targets ($M = 5144.67$, $SD = 153.32$), angry targets ($M = 5280.02$, $SD = 146.09$)].

Of greatest interest was the one three-way interaction contained within the model. Analyses showed that this interaction of target x time x condition was significant ($F = 5.14$, $p = .027$) and demonstrated a moderate effect size (partial eta squared = .08). Follow-up analyses showed that the control group did not demonstrate a significant difference between their reaction time to angry targets versus happy targets at either pre-training [happy targets ($M = 5349.58$, $SD = 232.40$), angry targets ($M = 5003.49$, $SD = 182.41$)] or post-training [happy targets ($M = 5209.27$, $SD = 216.83$), angry targets ($M = 4887.59$, $SD = 206.60$)]. However, the experimental group did demonstrate some differences. At pre-training, this group showed a trend for a significant difference between their angry target ($M = 5116.15$, $SD = 182.41$) and happy target ($M = 5525.84$, $SD = 232.40$) reaction times. More importantly, at post-training, after receiving the intervention, they demonstrated a highly significant difference between their reaction time to angry targets ($M = 5672.45$, $SD = 206.60$) versus happy targets ($M = 5080.07$, $SD = 216.83$). This significant three-way interaction is depicted in Figure 4.

Secondary Hypothesis 1, described next, explores whether subjects performed similarly on our matrix reaction time measure of selective attention and the traditional hypothetical vignette measure of encoding, as these are thought to measure similar constructs. Though this is explored in greater detail below, it is worth mentioning here that the limited variability found in the hypothetical vignette measure made it impossible for the vignette measure to pick up on the
Figure 4. Depiction of significant three-way interaction of Condition x Target x Time.
same pre- to post-training change in subject’s attention biases discovered above using the reaction time measure. When the vignette scores were entered into the same 2 x 2 x 2 Mixed Model ANOVA described above, only the main effect of target was significant (F = 13.35, p = 0.001). This effect stated simply that subjects in the overall sample recalled more relevant details in the accidental vignettes than the hostile vignettes. The vignette measure did not pick up on any significant 2-way or 3-way interactions that would indicate a change in attention bias as indicated by a change in vignettes scores from pre- to post-training.

**Secondary Analyses**

Two secondary hypotheses examined other key issues in the data set aside from the attention bias and main training effect. **Secondary Hypothesis 1** compared participants’ performance on our new reaction time measure of selective attention to the traditional hypothetical vignette-based video measure of selective attention (Dodge & Price, 1994; Lansford et al., 2006). Both measures were administered at both pre- and post-training. The goal of secondary hypothesis 1 was to explore whether these two encoding measures of attention bias appear to be accessing the same construct. It was hypothesized that the two measures would be related but that the reaction time measure would represent a finer-grained measure of encoding deficits. As mentioned above in the discussion of Hypothesis 1, the overall sample did demonstrate a significant attention bias towards aggressive cues on the reaction time measure of encoding. When we look at the subject’s parallel performance on the hypothetical vignette measure of encoding, we also find a significant attention bias towards aggressive cues. On the vignette measure, subjects recalled significantly more relevant cues on accidental intent vignettes than on hostile intent vignettes (t = -2.33, p = .02). This is typically thought to mean that the subjects’ attention was drawn towards these aggressive cues at the expense of encoding other
relevant cues. Attending to aggressive cues, when present in the vignette, occupied the majority of their attention resources. However, this was not the case in accidental vignettes, due to the lack of aggressive cues, and subjects were subsequently better able to recall a greater number of relevant cues.

However, in order to truly compare whether these two measures of “attention bias” appear to be measuring the same construct, an attention bias score was created for both of the encoding measures at pre-training. As noted above in the descriptive statistic section, among the two component parts used from each of these two measures to create a bias score, significant correlations only existed between the two parts of the matrix task bias score. The component parts of the matrix task and vignette task were not significantly correlated with each other. In creating the bias score, for the matrix reaction time task, each subject’s average angry target reaction time was subtracted from their average happy target reaction time. Larger positive values were indicative of a possible angry attention bias. For the vignette measure, subjects’ average score across the aggressive intent vignettes was subtracted from their score across the accidental intent vignettes. As subjects with an attention bias towards aggressive cues would be expected to recall fewer relevant cues on aggressive vignettes due to their biased focus only on those aggressive cues at the detriment of others, higher attention bias scores on this computed bias variable would also indicate the possible presence of an angry attention bias. After creating these two separate attention bias scores, a simple correlation was run. The vignette-based bias score and the matrix-based bias score were not significantly correlated with each other ($r = -0.04$, $p = 0.74$). This correlation remained non-significant even when controlling for the influence of ADHD-like symptoms ($r = -0.07$, $p = 0.61$). Though they both appear to be measuring the
predicted angry attention bias present in our sample of aggressive youth, it would nonetheless appear that they are in fact measuring separate, possibly unrelated constructs.

Secondary Hypothesis 2 was driven by the high comorbidity of ADHD symptoms and aggression, a fact which has frequently been overlooked in previous research. This hypothesis attempted to examine whether the pre-training selective attention bias towards aggressive cues measured in Hypothesis 1 above also occurred above and beyond the presence of ADHD-like symptoms of inattention and hyperactivity-impulsivity measured at pre-training. It was hypothesized that despite possible elevated levels of inattention and hyperactivity-impulsivity, the reactively aggressive adolescents would demonstrate an attention bias on the reaction time measure at pre-training that is attributable to their aggression above and beyond the impact of any symptoms of ADHD. When the difference between pre-training reaction time on angry target trials versus happy target trials was again examined with the three ADHD-like symptom covariates included (one ADHD Rating Scale variable, two TEA-Ch variables) the difference between these reaction times was no longer significant ($F = 0.25, p = 0.62$), indicating that the subjects no longer demonstrated an attention bias when we controlled for ADHD-like symptoms.

Exploratory Analyses

Various exploratory analyses were used to examine a variety of gender- and ethnicity-based questions, and other peripheral issues.

Exploratory Hypothesis 1 examined whether subjects still demonstrated a benefit from the training task when we controlled for ADHD-like symptoms of inattention and hyperactivity-impulsivity. These covariates could potentially impair an individual’s ability to attend to and garner information from a task, and as such could influence their ability to benefit from the matrix training task. As such, the $2 \times 2 \times 2$ mixed model ANOVA from Hypothesis 2 was rerun
with the three ADHD covariates included in the model this time. The results were very similar to those in Hypothesis 2. None of the main effects or two-way interactions were significant. However, the three-way interaction (target x time x condition) remained significant ($F = 6.22, p = 0.016$) even with these covariates included. The effect size was still moderate with a partial eta squared of 0.102.

Due to variability in several variables (length of time to complete the study, location of data collection, and whether or not stimulant medications were taken that day that could have aided in performance) this analysis was also run with these additional variables entered as covariates to determine their effect on the results. For each of these variables, the main 3-way interaction effect remained significant even when the attentional covariates and these additional covariates were entered into the model. When length of time to complete the study was included in the model as a covariate, the three way interaction was significant at $F = 4.13, p = 0.047$. The same was true when location of data collection ($F = 5.74, p = 0.02$) and presence of stimulant medication ($F = 6.08, p = 0.02$) were entered as covariates. This indicates that despite the variability in these variables, they did not systematically influence the intervention results.

As emotion identification abilities are central to adolescents’ performance on the matrix training task, Exploratory Hypothesis 2, examined the youths’ pre-training performance on the DANVA-2 measure of emotion identification ability. Of particular interest were: a) a look at the typical profile of errors that reactive aggressive adolescents demonstrated during the DANVA-2, and b) whether level of emotion identification ability at pre-training influenced the adolescents’ ability to benefit from the matrix training task.

A look at the profile of the youth’s performance on the DANVA-2 is provided in Table 6. In general, subjects were more accurate when identifying child faces than when identifying
Table 6

Performance Profile on DANVA-2 Emotion Identification Ability in the Overall Sample.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th># of Items</th>
<th>M</th>
<th>SD</th>
<th>Variance</th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>2.29</td>
<td>5.24</td>
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<td>9</td>
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<td>0.32</td>
<td>0.11</td>
<td>0</td>
<td>1</td>
</tr>
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<td>0.85</td>
<td>0.73</td>
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<td>1.21</td>
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<td>4</td>
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<td>1.52</td>
<td>2.29</td>
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<td>7</td>
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<td>0.09</td>
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<td>1</td>
</tr>
<tr>
<td>High Intensity Sad</td>
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<td>0.22</td>
<td>0.45</td>
<td>0.21</td>
<td>0</td>
<td>2</td>
</tr>
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<td>1.47</td>
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<td>1.69</td>
<td>2.87</td>
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<td>9</td>
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<td>0.18</td>
<td>0.03</td>
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<td>1</td>
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<td>0.24</td>
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<td>2</td>
</tr>
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<td>3</td>
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<tr>
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</table>

*Note.* Table values represent number of errors made in that category.

adults faces. Among the 24 child stimuli, subjects were relatively accurate when working to identify happy and sad child faces. In general they were less accurate when identifying low-intensity faces across emotion type. Subjects struggled the most when attempting to identify angry and fearful images, especially the low-intensity depiction of these emotions. However, it
was noted that even on the high-intensity version of the child angry expression, subjects did worse than when identifying high-intensity happy and sad expressions. Among the 24 adult faces, subjects did well accurately identifying happy adult faces. However, they struggled considerably with identifying sad, angry and fearful expressions. Again, subjects were less accurate when examining low-intensity images. They were particularly inaccurate when trying to identify low-intensity angry adult faces.

Due to the fact that emotion identification ability is a core skill involved in the completion of the matrix training task, we examined whether subjects continued to demonstrate a benefit from the training task when we controlled for pre-training emotion identification ability. As such, the 2 x 2 x 2 mixed model ANOVA from Hypothesis 2 was rerun with the DANVA-2 variable included as a covariate. Similar to the results of Hypothesis 2, none of the main or two-way interactions were significant. However, the three-way interaction of time x target x condition remained significant (F = 4.94, p = 0.03), with a partial eta squared moderate effect size of 0.08.

Research Questions

Several research questions were posed to examine various gender and ethnicity profiles on several of this study’s measures. No specific hypotheses were proposed in regards to these questions, as these analyses were intended to simply explore this sample’s performance. The findings of these research questions are presented below.

Research Question 1 examined whether any gender-differences might exist on the DANVA-2 measure of emotion identification ability, as some controversy remains around whether females possess better developed emotion identification abilities than males. As such, gender profiles of performance on the DANVA-2 were examined qualitatively. Table 7 depicts
Table 7

Gender-Based Performance Profiles on DANVA-2 Emotion Identification Ability.

<table>
<thead>
<tr>
<th>Stimulus</th>
<th># of Items</th>
<th>M (M/F)</th>
<th>SD (M/F)</th>
<th>Variance (M/F)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHILD FACES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>3.69 / 3.22</td>
<td>2.16 / 2.60</td>
<td>4.66 / 6.77</td>
</tr>
<tr>
<td>Happy</td>
<td>6</td>
<td>0.14 / 0.06</td>
<td>0.34 / 0.24</td>
<td>0.13 / 0.06</td>
</tr>
<tr>
<td>Sad</td>
<td>6</td>
<td>0.55 / 0.33</td>
<td>0.80 / 0.97</td>
<td>0.64 / 0.94</td>
</tr>
<tr>
<td>Angry</td>
<td>6</td>
<td>1.64 / 2.06</td>
<td>1.21 / 1.21</td>
<td>1.46 / 1.47</td>
</tr>
<tr>
<td>Fearful</td>
<td>6</td>
<td>1.36 / 0.78</td>
<td>1.19 / 1.31</td>
<td>1.41 / 1.71</td>
</tr>
<tr>
<td>High Intensity</td>
<td>12</td>
<td>0.83 / 1.00</td>
<td>1.08 / 1.19</td>
<td>1.17 / 1.41</td>
</tr>
<tr>
<td>Low Intensity</td>
<td>12</td>
<td>2.86 / 2.22</td>
<td>1.48 / 1.56</td>
<td>2.17 / 2.42</td>
</tr>
<tr>
<td>High Intensity Happy</td>
<td>3</td>
<td>0.00 / 0.06</td>
<td>0.00 / 0.24</td>
<td>0.00 / 0.06</td>
</tr>
<tr>
<td>Low Intensity Happy</td>
<td>3</td>
<td>0.14 / 0.00</td>
<td>0.35 / 0.00</td>
<td>0.13 / 0.00</td>
</tr>
<tr>
<td>High Intensity Sad</td>
<td>3</td>
<td>0.26 / 0.11</td>
<td>0.50 / 0.32</td>
<td>0.25 / 0.11</td>
</tr>
<tr>
<td>Low Intensity Sad</td>
<td>3</td>
<td>0.29 / 0.22</td>
<td>0.55 / 0.65</td>
<td>0.31 / 0.42</td>
</tr>
<tr>
<td>High Intensity Angry</td>
<td>3</td>
<td>0.38 / 0.67</td>
<td>0.54 / 0.69</td>
<td>0.29 / 0.47</td>
</tr>
<tr>
<td>Low Intensity Angry</td>
<td>3</td>
<td>1.26 / 1.39</td>
<td>0.91 / 0.70</td>
<td>0.83 / 0.49</td>
</tr>
<tr>
<td>High Intensity Fearful</td>
<td>3</td>
<td>0.19 / 0.17</td>
<td>0.55 / 0.51</td>
<td>0.30 / 0.27</td>
</tr>
<tr>
<td>Low Intensity Fearful</td>
<td>3</td>
<td>1.17 / 0.61</td>
<td>0.88 / 0.92</td>
<td>0.78 / 0.84</td>
</tr>
<tr>
<td><strong>ADULT FACES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>6.93 / 5.67</td>
<td>2.93 / 2.30</td>
<td>8.61 / 5.29</td>
</tr>
<tr>
<td>Happy</td>
<td>6</td>
<td>0.36 / 0.22</td>
<td>0.53 / 0.43</td>
<td>0.28 / 0.18</td>
</tr>
<tr>
<td>Sad</td>
<td>6</td>
<td>1.81 / 1.06</td>
<td>1.37 / 1.06</td>
<td>1.87 / 1.11</td>
</tr>
<tr>
<td>Angry</td>
<td>6</td>
<td>2.71 / 3.11</td>
<td>1.02 / 1.18</td>
<td>1.04 / 1.40</td>
</tr>
<tr>
<td>Fearful</td>
<td>6</td>
<td>2.05 / 1.28</td>
<td>1.48 / 1.49</td>
<td>2.19 / 2.21</td>
</tr>
<tr>
<td>High Intensity</td>
<td>12</td>
<td>2.43 / 2.00</td>
<td>1.52 / 1.33</td>
<td>2.30 / 1.77</td>
</tr>
<tr>
<td>Low Intensity</td>
<td>12</td>
<td>4.50 / 3.67</td>
<td>1.80 / 1.28</td>
<td>3.23 / 1.65</td>
</tr>
<tr>
<td>High Intensity Happy</td>
<td>3</td>
<td>0.05 / 0.00</td>
<td>0.22 / 0.00</td>
<td>0.47 / 0.00</td>
</tr>
<tr>
<td>Low Intensity Happy</td>
<td>3</td>
<td>0.31 / 0.22</td>
<td>0.52 / 0.43</td>
<td>0.27 / 0.18</td>
</tr>
<tr>
<td>High Intensity Sad</td>
<td>3</td>
<td>0.79 / 0.44</td>
<td>0.78 / 0.71</td>
<td>0.61 / 0.50</td>
</tr>
<tr>
<td>Low Intensity Sad</td>
<td>3</td>
<td>1.02 / 0.61</td>
<td>1.00 / 0.85</td>
<td>1.00 / 0.72</td>
</tr>
<tr>
<td>High Intensity Angry</td>
<td>3</td>
<td>0.55 / 0.78</td>
<td>0.77 / 0.81</td>
<td>0.60 / 0.65</td>
</tr>
<tr>
<td>Low Intensity Angry</td>
<td>3</td>
<td>2.17 / 2.33</td>
<td>0.79 / 0.59</td>
<td>0.63 / 0.35</td>
</tr>
<tr>
<td>High Intensity Fearful</td>
<td>3</td>
<td>1.05 / 0.78</td>
<td>0.83 / 0.81</td>
<td>0.68 / 0.65</td>
</tr>
<tr>
<td>Low Intensity Fearful</td>
<td>3</td>
<td>1.00 / 0.50</td>
<td>0.96 / 0.86</td>
<td>0.93 / 0.74</td>
</tr>
</tbody>
</table>

*Note. Table values represent number of errors made in that category. M = male. F = female.*

these results. It is noted that the gender split in this sample was not equitable, with 18 females and 42 males. Such a small female sample may not be representative of the general female population, and may be more prone to the influence of outliers. Also, having different sample sizes in both groups could have affected the strength of our analyses. Based on our sample, the
same general gender profile was evident for both the child faces and adult faces. Among both sets of stimuli, females appeared to be more accurate than males in identifying everything except for angry faces (of both high and low intensity). However, it is noted that these observations are based solely on means, and with such a small sample of females the mean could be susceptible to the influence of possible outliers. Regardless, this consistent pattern emerged across stimuli.

T-tests were also run on each of these DANVA-2 variables to examine whether significant differences existed between the mean scores for males versus females. Again, these results are qualified by the fact that with this many t-tests run, we would expect a small percentage of comparisons to be significant by chance, thus the significant results should be viewed with that in mind. Of all of the DANVA-2 gender comparisons conducted, only three variables were significantly different based on gender. Females were significantly more accurate than males when identifying low intensity happy child faces (t = 2.61, p = 0.01). Similarly, females were more accurate at identifying low intensity fearful faces (t = 2.21, p = 0.03). Females were also more accurate when identifying sad adult faces (t = 2.09, p = 0.04).

Research Question 2 examined ethnicity-differences on the DANVA-2. Though the DANVA-2 is a traditional measure of emotional identification ability in current research, it is noted that of the 24 child stimuli, only one of the pictured children is of an ethnic minority status, and of the 24 adult stimuli only three depict adults of an ethnic minority status. While the DANVA-2 manual implies that these images were tested among a variety of races during scale construction, as the majority of this study’s sample is of ethnic minority status, we hoped to examine whether ethnicity-differences appeared on the DANVA-2. However, even more than with the gender-differences explored above, this sample is even less equitable in regards to ethnicity, with 55 African Americans and 5 Caucasians. Nonetheless, the results are presented in
Table 8

*Ethnicity-Based Performance Profiles on DANVA-2 Emotion Identification Ability.*

<table>
<thead>
<tr>
<th>Stimulus</th>
<th># of Items</th>
<th>M (AA/C)</th>
<th>SD (AA/C)</th>
<th>Variance (AA/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHILD FACES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>3.42 / 5.00</td>
<td>2.32 / 1.23</td>
<td>5.40 / 1.50</td>
</tr>
<tr>
<td>Happy</td>
<td>6</td>
<td>0.11 / 0.20</td>
<td>0.32 / 0.45</td>
<td>0.10 / 0.20</td>
</tr>
<tr>
<td>Sad</td>
<td>6</td>
<td>0.47 / 0.60</td>
<td>0.86 / 0.89</td>
<td>0.74 / 0.80</td>
</tr>
<tr>
<td>Angry</td>
<td>6</td>
<td>1.67 / 2.80</td>
<td>1.20 / 0.84</td>
<td>1.45 / 0.70</td>
</tr>
<tr>
<td>Fearful</td>
<td>6</td>
<td>1.16 / 1.40</td>
<td>1.29 / 0.55</td>
<td>1.66 / 0.30</td>
</tr>
<tr>
<td>High Intensity</td>
<td>12</td>
<td>0.87 / 1.00</td>
<td>1.14 / 0.71</td>
<td>1.30 / 0.50</td>
</tr>
<tr>
<td>Low Intensity</td>
<td>12</td>
<td>2.55 / 4.00</td>
<td>1.49 / 1.23</td>
<td>2.22 / 1.50</td>
</tr>
<tr>
<td>High Intensity Happy</td>
<td>3</td>
<td>0.02 / 0.00</td>
<td>0.14 / 0.00</td>
<td>0.02 / 0.00</td>
</tr>
<tr>
<td>Low Intensity Happy</td>
<td>3</td>
<td>0.09 / 0.20</td>
<td>0.29 / 0.45</td>
<td>0.08 / 0.20</td>
</tr>
<tr>
<td>High Intensity Sad</td>
<td>3</td>
<td>0.22 / 0.20</td>
<td>0.46 / 0.45</td>
<td>0.21 / 0.20</td>
</tr>
<tr>
<td>Low Intensity Sad</td>
<td>3</td>
<td>0.25 / 0.40</td>
<td>0.55 / 0.89</td>
<td>0.30 / 0.80</td>
</tr>
<tr>
<td>High Intensity Angry</td>
<td>3</td>
<td>0.44 / 0.80</td>
<td>0.60 / 0.45</td>
<td>0.36 / 0.20</td>
</tr>
<tr>
<td>Low Intensity Angry</td>
<td>3</td>
<td>1.24 / 2.00</td>
<td>0.84 / 0.71</td>
<td>0.70 / 0.50</td>
</tr>
<tr>
<td>High Intensity Fearful</td>
<td>3</td>
<td>0.20 / 0.00</td>
<td>0.56 / 0.00</td>
<td>0.31 / 0.00</td>
</tr>
<tr>
<td>Low Intensity Fearful</td>
<td>3</td>
<td>0.96 / 1.40</td>
<td>0.94 / 0.55</td>
<td>0.89 / 0.30</td>
</tr>
<tr>
<td><strong>ADULT FACES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>6.55 / 6.60</td>
<td>2.74 / 3.78</td>
<td>7.51 / 14.30</td>
</tr>
<tr>
<td>Happy</td>
<td>6</td>
<td>0.33 / 0.20</td>
<td>0.51 / 0.45</td>
<td>0.26 / 0.20</td>
</tr>
<tr>
<td>Sad</td>
<td>6</td>
<td>1.53 / 2.20</td>
<td>1.33 / 1.10</td>
<td>1.77 / 1.20</td>
</tr>
<tr>
<td>Angry</td>
<td>6</td>
<td>2.89 / 2.20</td>
<td>1.05 / 1.30</td>
<td>1.10 / 1.70</td>
</tr>
<tr>
<td>Fearful</td>
<td>6</td>
<td>1.80 / 2.00</td>
<td>1.51 / 1.73</td>
<td>2.27 / 3.00</td>
</tr>
<tr>
<td>High Intensity</td>
<td>12</td>
<td>2.24 / 3.00</td>
<td>1.44 / 1.73</td>
<td>2.07 / 3.00</td>
</tr>
<tr>
<td>Low Intensity</td>
<td>12</td>
<td>4.31 / 3.60</td>
<td>1.67 / 2.07</td>
<td>2.77 / 4.30</td>
</tr>
<tr>
<td>High Intensity Happy</td>
<td>3</td>
<td>0.04 / 0.00</td>
<td>0.19 / 0.00</td>
<td>0.04 / 0.00</td>
</tr>
<tr>
<td>Low Intensity Happy</td>
<td>3</td>
<td>0.29 / 0.20</td>
<td>0.50 / 0.45</td>
<td>0.25 / 0.20</td>
</tr>
<tr>
<td>High Intensity Sad</td>
<td>3</td>
<td>0.64 / 1.20</td>
<td>0.78 / 0.45</td>
<td>0.61 / 0.20</td>
</tr>
<tr>
<td>Low Intensity Sad</td>
<td>3</td>
<td>0.89 / 1.00</td>
<td>0.99 / 0.71</td>
<td>0.99 / 0.50</td>
</tr>
<tr>
<td>High Intensity Angry</td>
<td>3</td>
<td>0.64 / 0.40</td>
<td>0.80 / 0.55</td>
<td>0.64 / 0.30</td>
</tr>
<tr>
<td>Low Intensity Angry</td>
<td>3</td>
<td>2.25 / 1.80</td>
<td>0.73 / 0.84</td>
<td>0.53 / 0.70</td>
</tr>
<tr>
<td>High Intensity Fearful</td>
<td>3</td>
<td>0.93 / 1.40</td>
<td>0.81 / 0.89</td>
<td>0.66 / 0.80</td>
</tr>
<tr>
<td>Low Intensity Fearful</td>
<td>3</td>
<td>0.87 / 0.60</td>
<td>0.96 / 0.89</td>
<td>0.93 / 0.80</td>
</tr>
</tbody>
</table>

*Note.* Table values represent number of errors made in that category. AA = African American. C = Caucasian.

Table 8. Based on these descriptive, among child faces African American subjects were more accurate at identifying all of the emotions except for the high intensity fearful child face. Among the adult faces, African American subjects appeared less accurate at identifying happy faces, angry faces (of low and high intensity), and low intensity fearful faces. Again, t-tests were run to
compare the ethnic groups on the DANVA-2 variables, and again, the validity of these results should be considered given the skewed sample sizes and number of comparisons run. With this in mind, only two of these comparisons were found to be significantly different. African Americans were significantly more accurate at identifying child angry faces ($t = 2.04, p = 0.05$) and general low-intensity child faces ($t = 2.12, p = 0.04$).

Table 9

*Ethnicity-Based Performance Profiles on the Hypothetical Vignette Measure of Encoding.*

<table>
<thead>
<tr>
<th>Variable</th>
<th>M (AA/C)</th>
<th>SD (AA/C)</th>
<th>Variance (AA/C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hostile Intent Vignettes</td>
<td>1.12 / 1.10</td>
<td>0.18 / 0.14</td>
<td>0.03 / 0.02</td>
</tr>
<tr>
<td>Ambiguous Intent Vignettes</td>
<td>1.17 / 1.20</td>
<td>0.24 / 0.21</td>
<td>0.06 / 0.04</td>
</tr>
<tr>
<td>Accidental Intent Vignettes</td>
<td>1.20 / 1.15</td>
<td>0.18 / 0.22</td>
<td>0.03 / 0.05</td>
</tr>
<tr>
<td>Peer Entry Vignettes</td>
<td>1.24 / 1.20</td>
<td>0.21 / 0.14</td>
<td>0.05 / 0.02</td>
</tr>
<tr>
<td>Peer Provocation Vignettes</td>
<td>1.09 / 1.10</td>
<td>0.13 / 0.15</td>
<td>0.02 / 0.02</td>
</tr>
</tbody>
</table>

*Note.* Table values represent average relevancy score for that category of vignettes. Scores can range from 0 to 2, with higher scores indicating that more relevant details were recalled on the vignette. AA = African American. C = Caucasian.

Similar to the DANVA-2 stimuli, the traditional hypothetical vignette measure, used in this study and in other research for years, contains mainly Caucasian actors. Only four of the 24 vignettes contain a child actor of an ethnic minority status. As such, *Research Question 3* seeks to examine whether any ethnicity-differences exist in performance on this vignette measure at pre-training. Ethnicity based descriptive are presented on the main vignette variables in Table 9. Based on an examination of the descriptive statistics, African American and Caucasian subjects appear to have performed comparably across all vignette types. T-tests were run to further examine these ethnicity differences. Across the five vignette variables, none of the ethnicity comparisons were even close to being significant; indicating that both ethnic groups appeared to have performed similarly on the vignette measure despite the abundance of Caucasian stimuli.
DISCUSSION

The major contributions of this study are the introduction of a new, more direct measure of encoding biases than what has traditionally been available to researchers and the discovery that encoding deficits are malleable and amenable to intervention.

Capturing the Encoding Process

The matrix reaction time measure of encoding represents a precise, direct, on-line measure of an on-line process (attention/encoding). This means that the matrix task measures the involuntary, automatic, and preconscious attentional processes of encoding “in-the-moment” as they are occurring. Unlike traditional measures of encoding which are less direct and allow for extraneous explanations of results, this measure taps a specific implicit process as it is occurring, making it difficult for substantial error in interpretation.

Results from this new measure of attention bias support previous findings that aggressive youth demonstrate an angry attention bias (Dodge et al., 1986; Dodge & Newman, 1981; Gouze, 1987; Milich & Dodge, 1984). Subjects took significantly longer to find the happy target faces among angry distractor faces than vice versa, indicating that they allocated greater attentional resources to aggressive cues. While there was occasional ambiguity in previous studies around the strength of this bias or whether it truly existed (Schippell et al., 2003), this study confirms with minimal ambiguity that angry youth do demonstrate an angry attention bias which can cause them to overlook non-aggressive cues. It is hoped that future SIP studies will begin to integrate this measure into their methodology when examining stage one of the SIP model so that we can continue to develop a more accurate picture of aggressive youths’ stage one deficits.
In addition to its current value, this measure’s versatility could also be very beneficial to future research. By simply changing the stimuli presented in each matrix trial, other forms of attentional biases could be examined among aggressive youth. This could include biases based on other emotion states or personal characteristics.

A peculiar measurement issue that arose during this study was the fact that the matrix reaction time measure, which seems to clearly measure attention biases, was not significantly correlated to the traditional hypothetical vignette measure of encoding (Dodge & Price, 1994). Similarly, the vignette measure was not sensitive enough to pick up on any significant changes in the attention bias from pre- to post-training. While the reaction time measure was expected to be more precise and able to identify more variability in the subjects’ performance over time, it was expected that as these measures were intended to examine the same construct, they would at least be related.

Since the reaction time measure seems to clearly measure the subjects’ attention bias, the question remains, what construct is the traditional vignette encoding measure capturing? We would argue that it is more of a measure of memory/recall and reporting preference. It is true that the vignette measure questions the youth after they have attended to and encoded the social stimuli contained in the vignettes. However, there are several processes that occur between that encoding and their response that diverts their response from being a true measure of encoding. Obviously the youth will not recall stimuli that they did not encode; however, they could fail to report on stimuli that they did encode due to memory problems, recall errors, or a tendency to edit their response. They may edit their response if they have already begun the interpretation process and are more prone to present certain types of information to the researcher. So, while selective attention/encoding abilities do form the foundation for youth’s performance on the
vignette measure, there are too many other processes that occur in the meantime to allow this measure to truly assess solely the youth’s encoding abilities or deficits.

Regardless of the answer to the above question, it would seem that the vignette measure is not the measure that most closely accesses the process that is occurring during encoding. While it undoubtedly continues to have great use when examining other aspects of social-information processing (e.g., interpretation, response generation, response evaluation) it would seem that it is not the most sensitive measure of encoding. Integration of the reaction time measure into SIP assessments would be highly beneficial.

**Intervening at the Encoding Stage**

As noted above, to date many questions remained about the encoding stage. Researchers were uncertain as to the malleability of encoding deficits. Furthermore, despite the many high quality prevention and intervention programs for aggressive youth (Forehand & McMahon, 1981; Lochman & Wells, 1996; Spivak & Shure, 1976; Webster-Stratton, 1996), no specific interventions existed to address aggressive youths’ encoding deficits. Fortunately, this study hopes to contribute to attempts to answer these questions. Following on-line training with the matrix task, the experimental group’s attention bias towards aggressive cues was significantly altered (i.e., they demonstrated a happy attention bias at post-training) compared to the control group, who did not show a significant change in their attention bias from pre- to post-training. However, in providing these answers, this study has perhaps created a dozen or so new questions.

First, what this study can say is that on some level attention biases are malleable. Even when ADHD-like symptoms of inattention and hyperactivity-impulsivity and emotion identification abilities were controlled for, subjects in the experimental group still demonstrated
a significant change in their attention bias from pre- to post-training compared to the control
group. This was critical in that Eysenck (1988) stated that encoding efficiency is largely related
to an individual’s ability to remain focused. The ability of subjects to benefit from the training
task above and beyond levels of ADHD-like symptoms is consistent with previous research
which found that ADHD symptoms did not explain all of reactively aggressive youth’s problems
(Dodge et al., 1997).

Second, this study also introduced an implicit learning task as a new type of intervention
for aggressive youth. This training task has been used successfully with other populations (i.e.,
anxious or depressed samples) (Dandeneau & Baldwin, 2004), and it makes intuitive sense. As
interventionists attempt to alter an implicit process, it seems logical that they would utilize an
implicit task.

Based on previous research examining the comorbidity of anxiety and aggression, it
might not be a surprise that a training task proven effective with anxious youth might also
influence similar change among aggressive children. Anxiety and behavior disorders co-occur
three times more often than is likely by chance (Angold, Costello, & Erkanli, 1999). Among
researchers examining the co-occurrence of these two disorders, cognitive distortions
(particularly biased thinking) are thought to be a primary factor that links the disorders. Just as
anxious youth overestimate threat or danger (Treadwell & Kendall, 1996), aggressive youth
overestimate the hostile nature of individuals’ behaviors (Lochman, Whidby, & Fitzgerald,
2000). Across both disorders this is believed to be due to a certain level of hypervigilance.
Researchers propose that due to some similarities, treatment strategies that primarily target
anxiety will have an effect on comorbid externalizing behaviors (Levy, Hunt, & Heriot, 2007).
In fact, Levy, Hunt, and Heriot found that following a 9-session intervention targeting only
anxiety, youth with both internalizing and externalizing diagnoses displayed significant reductions in both problem areas. Therefore, it would seem that anxiety may partially contribute to aggressive children’s encoding problems. If so, we would have expected this cognitive training task to operate in a similar manner with aggressive youth as with anxious youth.

So how might this training task be integrated into prevention or treatment efforts? As experts work to ascertain the core issues leading to childhood mental health problems in order to work to prevent those issues from budding into ingrained disorders, there is a growing focus on universal preventions, which target broad populations; targeted preventions, which specifically target certain at-risk populations; and treatment, which attempts to reduce already existing symptoms. The National Advisory Mental Health Council Workgroup on Mental Disorders Prevention Research (1998) has been emphasizing both prevention and treatment for years now. Unfortunately, prevention studies targeting early encoding errors are rare among aggressive populations. However, Feldner, Zvolensky, and Schmidt’s (2004) review found that the similar information-processing deficits of anxiety disorders could be prevented through cognitive and behavioral prevention work. As such, it seems likely that this implicit training task could be considered for both prevention-based and treatment-based training.

However, before formulating a new program that addresses the encoding deficits of aggressive youth, there are a few general intervention issues to consider. While it would be wonderful if a simple prevention program aimed at developing adaptive encoding abilities was enough to meet the complex needs of at-risk or clinically aggressive youth, the many levels of SIP deficits that these youth often employ make that seem unlikely. However, this is not to say that any beneficial effects obtained through such prevention work would not have a substantial impact on these youths’ lives. Among anxiety research, changes in targeted cognitive risk
factors, such as hypersensitivity to specific types of cues, are thought to be critical in determining treatment response for clinically anxious individuals (Smits, Powers, Cho, & Telch, 2004). Some aggression research has also indicated that changes in attention bias and other early stage SIP skills are critical in determining responsiveness to other treatments (Lochman & Wells, 2002; Webster-Stratton, 1996). So, while altering cognitive risk factors among aggressive children (i.e., encoding deficits) may not be the sole key to eliminating their maladaptive aggression, it may be a critical mediator that allows them to benefit from other intervention efforts. If that is the case, an effective prevention program for encoding deficits could be conceptualized as a stand-alone treatment or as a component embedded in an existing intervention or prevention program which also addresses the other SIP deficits illustrated by these youth.

However, we must keep in mind that many existing interventions are delivered across 20 to 30 hours, and may already have limited feasibility due to their necessary time commitment. Thus, one way to enhance or aid feasibility would be to ensure that a new encoding-focused prevention program is brief and easily administered, requiring limited personnel and training, and maximizing the likelihood of dissemination. Fortunately, this is the case in regards to the matrix training task. This task is highly portable, interactive, and relatively brief compared to other twenty or more session interventions, making this task fairly simple to implement. It was also noted that despite the impulsive, hyperactive, and/or inattentive nature of many of this study’s participants, in general the youth responded very well behaviorally to the training task’s methods and activities. It was relatively simple to keep these subjects on task and engaged in the activity.
While this brief-one session training significantly influenced reactively aggressive youth’s attention biases, it is hypothesized that to influence lasting change, an augmented version of this task would be necessary. How might this amplified training be structured? Some suggestions are made based on previous anxiety interventions. Anxiety hypersensitivity has been shown to be fairly reactive to minimal intervention. Previous anxiety interventions targeting similar cognitions (i.e., hypervigilance towards anxiety-related cues) have influenced change following three-session interventions (Harrington et al., 1995); six-week, internet-based, self-guided interventions (Kenardy et al., Rosa, 2003); brief, 30-minute, computer-based prevention interventions (Schmidt et al., 2007); and brief, computer-based cognitive retraining tasks (Dandeneau & Baldwin, 2004). Schmidt and colleagues even found some decrease in anxiety at 24-months follow-up. However, they proposed that these effects may have been maintained and even increased with periodic re-administration of their training task through booster sessions.

Due to the impulsive and inattentive nature of many aggressive youth, it is possible that it may take additional exposure for aggressive youth to retain treatment gains. Given their inattention, it seems unlikely that lengthening the training task by adding numerous additional blocks of trials to each administration would be helpful. Perhaps, one or two extra blocks per administration would be sufficient. However, the youth would likely benefit from additional administrations of the training task across time. Perhaps completing the training twice a week for four or five weeks, or once a week for two to three months. This could then be supplemented by occasional booster sessions several weeks or months after the final standard administration. Taking approximately 15 minutes to administer, the training task could be implemented as a
stand-alone task or supplement an existing several session CBT intervention for aggressive youth. Subsequent studies should examine the treatment dosage necessary for lasting effects.

*Future Intervention Questions*

While the above findings and discussions of intervention programs are quite exciting, it seems we would be getting ahead of ourselves if we did not first answer some additional questions before widely implementing this training task. Future studies should seek to examine such questions as, could this training task be effective with even younger aggressive youth? The problems of aggression, if ignored, are not likely to fade away with time. In fact, social cognitions have been found to become increasingly related to actual behaviors as children develop (Davis-Kean et al., 2005). Therefore, if left unaided, young children’s aggression could become more stable. The earlier we can intervene, the better. As such, it would be very useful to find out if this training task works as well with a younger population of pre-eighth graders. If so, we may be able to improve younger children’s prognosis in regards to later social functioning.

Perhaps a more crucial question would be, does this training task have any effect on actual social behaviors. While a strong training effect during the experimental period is encouraging, if this effect does not translate to social behaviors it is of minimal use. Future studies could examine whether actual school or home behaviors changed following exposure to this training. Even a small effect could be encouraging, as this may expand to a large effect when combined with other SIP-based interventions. Related to this future research question would be a desire to determine how long training effects last? While a training effect was seen during this experimental period, it seems likely that multiple training sessions are necessary before the training effect is translated into lasting behavioral changes. However, as discussed above, it is
noted that brief interventions have been proven effective at changing social cognitions in other populations (Harrington et al., 1995; Kenardy et al., 2003; Schmidt et al., 2007). Though these studies encourage us to believe that even brief interventions can be influential, it is necessary to further examine the lasting effect of this training task in future studies.

If future research demonstrates that this training effect does have a positive impact on actual social behaviors, this final question may be less crucial, and merely an area of interest. Regardless, it is noted that a comparison group of non-aggressive youth was not included in this current study, as we were mainly interested in how aggressive youth performed and changed over time. However, it would be useful to examine how non-aggressive youth perform on the matrix reaction time measure. Do they show an attention bias in either direction? We might expect a smaller attention bias towards aggressive cues, as even non-aggressive individuals show some sort of arousal and attention towards angry or threatening cues. The difference is typically that aggressive youth show a more habitual, extreme and consistent bias. So how do aggressive youth’s biases at pre- and post-training compare to the biases shown by non-aggressive youth?

Is Change Good?

Amidst the excitement of significant results, one nagging question could not be ignored. Is it helpful and safe to change these youths’ angry attention biases? In fact, the training effect found in this study was a complete reversal of attention bias, such that the experimental group instead demonstrated a happy attention bias at post-training. At first glance, this seems positive. As the youth were noticing more than the angry stimuli at post-training, it seems likely that they would then be able to use those non-aggressive stimuli to also inform their social problem solving and decision making. It is hoped that this would reduce their aggressive schemas and aggressive problem-solving tendencies.
However, it could be argued that for some of these youth, they develop an angry attention bias because this is adaptive and protective in their environment. Do we want to completely remove or reverse an attention bias that could be protective despite its impairing nature in non-aggressive environments? Is an accurate attention bias safe for youth who spend the majority of their time in aggressive environments? An aggressive youth who comes to expect violence in their neighborhood, uses this expectation to stay safe at home, but this bias persists in the safe school environment and can lead to unnecessary and problematic aggressive behaviors. Just as we do not want these youth to be unsafe in their dangerous environments, we also do not want these youth to employ an aggressive attention set in a safe environment with such regularity that they miss out on successful, empathic and supportive social interactions when they are present. Though these non-aggressive interactions may be few and far between for some youth, they could serve as protective factors in regards to the development of self-esteem, self-identity, and mood.

It would seem that for attention biased youth from non-violent environments, it would be useful to adjust their attention bias to be more accurate. However, for youth from chronically violent environments a compromise might be indicated. In those cases, continued practice at retraining their attention bias could still be helpful, but perhaps with a simultaneous CBT-based intervention that trains them to become more aware of their attention sets in various environments. This CBT component could help them understand when to be more cautious and look for aggressive cues, as well as when to actively work to suppress this aggressive attention bias to notice non-aggressive cues. This would require an intervention that combined both implicit and explicit training methods for these youth’s benefit.
Gender Differences in Emotion Identification Ability

Though still ambivalent, research has indicated the possible presence of a gender difference in emotion identification abilities (Hall, 1978, 1984). Results of these studies have indicated a significant difference between females’ and males’ abilities to interpret nonverbal cues and facial expressions, with females typically outperforming males (Hall, 1978, 1984). While the studies incorporated into these meta-analyses included very few child populations, their presence at all led researchers to believe that this gender-based skill discrepancy was present from an early age. Research has since brought this early childhood development assumption into question, failing to find significant gender differences among youth (Brody, 1985; Butler, 1991; Gross & Ballif, 1991).

This issue was considered in the current sample in regards to their performance on the DANVA-2. It is noted that the gender split in this sample was not equitable (18 females, 42 males). As such, we cannot definitively say that this sample is representative of the general female population. However, in this sample it was noted that while at first glance females appeared to be more accurate than males at identifying most emotional expressions, statistical tests indicated that there were relatively few significant differences in emotion identification ability between males and females. It is possible that with a larger sample, these differences could have been significant, but this cannot be known for sure based on the current sample.

Limitations of the Current Study

Perhaps the largest limitation was the small sample size available for this study. While it is noted that despite the small size, the analyses were able to detect significant effects, it is always advisable to have a larger sample to increase power to uncover existing significant effects, as well as to be able to explore moderator effects such as gender or ethnicity.
Another limitation of this study relates to the post-training assessment. As this study was primarily focused on determining whether attention biases are malleable, long-term follow-up was not a major priority. However, it would have been useful, if time had permitted, to conduct a follow-up assessment of subject’s attention biases several weeks or months after their exposure to the training task, as well as to assess whether training effects generalized to actual social behaviors.

Again, the main focus of this study was to examine how aggressive youth responded to the matrix reaction time measure and training task. As such, having an aggressive control group was prioritized. However, the study’s findings may have had even more meaning if a non-aggressive control group had also been included. This would have allowed for the aggressive youth’s biases and changes following training to be compared to those of a non-aggressive sample.

Conclusions

This study has several exciting implications for the assessment of SIP deficits among aggressive youth and possible intervention methods that may be useful in correcting encoding errors. After decades of relying on an indirect measure of attention bias (the hypothetical vignette measure of encoding), this study presents a more precise and direct measure of attention bias that has the potential to provide researchers with a clearer picture of aggressive youths’ encoding deficits. Furthermore, this study introduces a training task that has shown great potential as an effective tool for retraining aggressive youth’s attention biases. Numerous future studies have been suggested that will help researchers determine the lasting strength and applicability of this new training task.
REFERENCES


Nowicki, S., Jr. (1998). *Diagnostic analysis of nonverbal accuracy: Remediation program (R-DANVA)*. Unpublished manuscript, Emory University, Atlanta, GA.


APPENDIX

IRB Approval Document

February 9, 2009

Laura Young, M.A.
Department of Psychology
College of Arts and Sciences
Box 870348

Re: IRB Application # 09-061
Measuring and Retraining Aggressive Youth's Attention Bias to Angry Ones

Dear Ms. Young:

The University of Alabama Non-Medical IRB recently met to consider your application. The board voted to approve your application pending satisfactory completion of revisions. The IRB has requested the following information or changes:

1) Please shorten the length of the consent and assent forms to fewer pages.

2) In reference to the incentive provided to participants, the wording “for completion or for completing” should be revised to “for participating.” Participants should not be penalized if they decide to discontinue participation at any point in the study. Please revise.

3) Please be sure to mention the incentive in the assent form.

Please submit the requested information to Ms. Tanya Myke for review at Box 870348 within 60 days of the issue date of this letter. If the IRB does not receive the requested revisions within 60 days you must submit a new application to the board for review.

If I can be of further assistance please feel free to contact me.

Sincerely,

PhD
Chair, Non-Medical IRB
University of Alabama
Assessment Measures

ADHD Rating Scale-IV: Home Version

Child’s name__________________________________________ Sex: M F Age______ Grade______
Completed by: Mother______ Father______ Guardian______ Grandparent______

Circle the number that best describes your child’s home behavior over the past 6 months.

<table>
<thead>
<tr>
<th>Item</th>
<th>Never or rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fails to give close attention to details or makes careless mistakes in schoolwork.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Fidgets with hands or feet or squirms in seat.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Has difficulty sustaining attention in tasks or play activities.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Leaves seat in classroom or in other situations in which remaining seated is expected.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Does not seem to listen when spoken to directly.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Runs about or climbs excessively in situations in which it is inappropriate.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Does not follow through on instructions and fails to finish work.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. Has difficulty playing or engaging in leisure activities quietly.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Has difficulty organizing tasks and activities.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10. Is “on the go” or acts as if “driven by a motor.”</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11. Avoids tasks (e.g., schoolwork, homework) that require sustained mental effort.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12. Talks excessively.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13. Loses things necessary for tasks or activities.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>14. Blurs out answers before questions have been completed.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15. Is easily distracted.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>16. Has difficulty awaiting turn.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>17. Is forgetful in daily activities.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>18. Interrupts or intrudes on others.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

From ADHD Rating Scale-IV: Checklists, Norms, and Clinical Interpretation by George J. DuPaul, Thomas J. Power, Arthur D. Anastopoulos, and Robert Reid. Copyright 1998 by the authors. Permission to photocopy this scale is granted to purchasers of ADHD Rating Scale-IV for personal use only (see copyright page for details). ADHD criteria are adapted by permission from DSM-IV. Copyright 1994 by the American Psychiatric Association.
### TEA–Ch

**Test of Everyday Attention for Children**

**Procedural Guide and Scoring Sheet**

#### Subject and test details

<table>
<thead>
<tr>
<th>Child’s name</th>
<th>Date of birth</th>
<th>Child’s sex</th>
<th>Date of test</th>
<th>Tested by</th>
<th>Assessment</th>
<th>□ First (Version A)</th>
<th>□ Second (Version B)</th>
</tr>
</thead>
</table>

Note: Before you start the test ensure you have all the necessary equipment: audio-cassette tape; audio-cassette player; cue book; A3 and A4 Sky Search cards; map; ‘Walk, Don’t Walk’ card; stopwatch; black non-permanent marker pen.

The instructions appearing on this Scoring Sheet are summaries. Refer to the Manual for full administration instructions.

Introduce the test by saying: I have got some tests here which are all about how well people can concentrate and pay attention. Almost everyone will make some mistakes on these tests so don’t worry if you do. Just do the best you can.

### Score summary

<table>
<thead>
<tr>
<th>Measure</th>
<th>First assessment (Version A)</th>
<th>Second assessment (Version B)</th>
<th>Difference from Version A</th>
<th>Difference in excess of 5% cut-off</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw score</td>
<td>Age scaled score</td>
<td>Percentile band</td>
<td>Raw score</td>
</tr>
<tr>
<td>1 Sky Search</td>
<td>B</td>
<td></td>
<td></td>
<td>B</td>
</tr>
<tr>
<td>Number of correctly identified targets</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time per target</td>
<td>C</td>
<td></td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Attention Score</td>
<td>G</td>
<td></td>
<td></td>
<td>G</td>
</tr>
<tr>
<td>2 Score</td>
<td>H</td>
<td></td>
<td></td>
<td>H</td>
</tr>
<tr>
<td>3 Creature Counting</td>
<td>I</td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Total correct</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Timing score</td>
<td>L</td>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>4 Sky Search DT (dual task decrement)</td>
<td>T</td>
<td></td>
<td></td>
<td>T</td>
</tr>
</tbody>
</table>
# Test of Everyday Attention for Children (TEA-Ch) Subtest 1 and 2 Scoring Sheet

## 1 Sky Search

**Administration of Practice**
- As you can see, these space ships always travel around in pairs.
  - Your job is to find all the pairs where both ships are the same, like these.
- Demonstrate first example on practice sheet.
- You need to do it as quickly as you can while trying not to miss any — so you don’t need to be too neat. When you think that you have finished, put a tick in the box at the bottom here as quickly as you can so that I know how long it took you. Just to make sure that I have explained it properly, could you tell me briefly what you have to do in this test?
- If the child has understood the idea of the test, administer the practice. Correct any further misunderstandings and then go on to the main subtest.

**Administration of Sky Search**
- Now let’s see how well you can do exactly the same thing on this big sheet.

**Timing**
- Begin timing on ‘start’.
- Finish timing when the box is marked. If it appears that the child has finished but forgotten to mark the box say ‘finished?’ and only on agreement stop timing.

**Scoring**
- Record the time and count the number of targets correctly circled.

**Administration of Sky Search (Motor Control)**
- It’s even easier now because we only have the real ships. When I say ‘start’ I want you to put a ring around all the pairs of ships that you can see as quickly as you can while trying not to miss any. Make sure you tick the box when you have finished. OR? ... Start.

**Timing**
- Start timing on ‘start’. Stop when the box is marked (or the child agrees that the task is finished).

**Sky Search**
- Time taken (seconds) □ A
- Number of correctly identified targets □ B
- Time per target = A/B □ C

*Note: Time per target (C) is re-entered in box marked ‘C’ at Sky Search DT on page 4.

**Sky Search (Motor Control)**
- Time taken (seconds) □ D
- Number of correctly identified motor targets. (If less than 15 do not proceed) □ E
- Motor control time per target = D/E □ F

**Sky Search Attention Score = C – F** □ G

## 2 Score!

**Administration**
- Check ability to count to 15.
- This test is all about counting. I am going to play you this tape and you have to count how many sounds you hear — as if you were keeping score by counting the number of scoring sounds in a computer game. The first sound is just a siren to tell us when each game begins and ends. You start counting from the first sound you hear after that, and tell me how many at the end. Listen to this example and count along with me.
- Repeat practice if necessary.
- Score 1 for each correctly counted string (maximum = 10).

### Version A

<table>
<thead>
<tr>
<th>Practice</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>X</td>
</tr>
<tr>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

### Version B

<table>
<thead>
<tr>
<th>Practice</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>11</td>
</tr>
</tbody>
</table>

**Total correct** □ H
### Test of Everyday Attention for Children (TEA-Ch)
#### Subtest 3 Scoring Sheet

#### 3 Creature Counting

**Administration**
- Check ability to count up to and down from 12.
- This is another test about counting but this time it needs you to count up, like one... two... three... and to count down, like three... two... one. We will be counting these creatures in their burrow.
- We always follow the burrow around from the top to the bottom like this.
- These arrows tell you the direction in which you have to count.
- So we start off counting up from one. Follow my finger... one, two, three, four, five, six,... then the arrow tells us to start counting down from six... so it would be five, four, three, two... then the arrow tells us to start counting up again from two... three, four, five. So the answer at the end is five. Watch me do that again and notice that when I come to the arrows I say 'up' or 'down' to remind myself of what they mean.
- Use your finger to indicate the next item. Make sure the child says 'up' and 'down' at arrows.

**Timing**
From 'one' to total.

**Scoring**
Score 1 for each correct answer and record the time taken for th page.

<table>
<thead>
<tr>
<th>Version A</th>
<th>Practice</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>1 2 3 4 5 6 7</td>
<td>8 5 6 6 8 8 6</td>
</tr>
<tr>
<td>Time (seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of switches</td>
<td>3 2 3 4 5 3 6</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Version B</th>
<th>Practice</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response</td>
<td>1 2 3 4 5 6 7</td>
<td>8 3 2 5 8 4 9</td>
</tr>
<tr>
<td>Time (seconds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of switches</td>
<td>4 2 3 3 4 3 5</td>
<td></td>
</tr>
</tbody>
</table>
4 Sky Search DT

Administration
- You remember that the ships we needed to find were the ones where both ships in the pair were exactly the same. You need to do that again for this test. At the same time as finding the ships you will have to do a second and equally important thing – to count the number of scoring sounds on the tape – like you did before.
- Remember that you have to count how many scoring sounds there are in each game and to tell me how many when the siren sounds. Let’s just remind ourselves with this practice.
- OK in a moment a voice on the tape will say ‘five ... four ... three ... two ... one ... start’. You should then start to circle all of the pairs of ships where there are two the same. At the same time, when you hear the siren at the end of each game, tell me how many scoring sounds there were. As soon as you have circled all of the special ships you can see, put a mark in this box. You don’t need to wait for the tape to finish.

Version A (record counting-game responses here ✔/✘)

Practice Test

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>7</td>
<td>11</td>
<td>6</td>
<td>9</td>
<td>4</td>
<td>10</td>
<td>8</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td>11</td>
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Version B (record counting-game responses here ✔/✘)

Practice Test

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</tbody>
</table>

Number of counting games correct (note: if 0, count as 1)

Number of counting games attempted

Proportion of counting games correct = M/N

Time taken in seconds

Number of correctly identified targets on Sky Search DT sheet

Time per target = P/Q

Weighted time per target = R/O

Re-enter C from Sky Search (Sky Search time per target) page 2

M
N
O
P
Q
R
S
C
Test of Everyday Attention for Children (TEA-Ch)
Subtest 1 Test Stimuli
Test of Everyday Attention for Children (TEA-Ch)
Subtest 3 Practice Stimuli #1
Test of Everyday Attention for Children (TEA-Ch)
Subtest 3 Practice Stimuli #2
Test of Everyday Attention for Children (TEA-Ch)
Subtest 3 Test Stimuli #1
Test of Everyday Attention for Children (TEA-Ch)
Subtest 3 Test Stimuli #6
Test of Everyday Attention for Children (TEA-Ch)
Subtest 3 Test Stimuli #7
Test of Everyday Attention for Children (TEA-Ch)
Subtest 4 Test Stimuli
Diagnostic Analysis of Nonverbal Accuracy (DANVA-2)
Sample Computer Images

○ Happy ○ Sad ○ Angry ○ Fearful

○ Happy ○ Sad ○ Angry ○ Fearful

○ Happy ○ Sad ○ Angry ○ Fearful

○ Happy ○ Sad ○ Angry ○ Fearful

○ Happy ○ Sad ○ Angry ○ Fearful

○ Happy ○ Sad ○ Angry ○ Fearful
Diagnostic Analysis of Nonverbal Accuracy (DANVA-2)
Sample Computer Images (continued)