PHYSIOLOGICAL RESPONSIVITY IN AGGRESSIVE AND NON-AGGRESSIVE PRE-PUBERTAL CHILDREN

by

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Abstract

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Numerous studies have investigated physiological arousal and responsivity to film stimuli in adults and children. However, much less attention has been given to the interactions between these types of stimuli and the physiological responses in children who have behavioral difficulties severe enough to warrant clinical referral. This study examined physiological responsivity to age-appropriate violent and non-violent videos by measuring changes in salivary cortisol (CORT), heart rate (HR), and alpha wave EEG asymmetry (EEG). The goal was to determine whether the videos have differential effects on aggressive (AGG) and non-aggressive pre-pubertal children (NAGG). Subjects were 30 nine to 11 year old boys divided into "aggressive" and "non-aggressive" groups based on parent and teacher ratings of aggression. Data across all three physiological measures provided support for the hypothesis that AGG and NAGG boys are differentially responsive to film stimuli. Yet the nature of this difference was not fully apparent. While viewing the films, AGG boys had a significantly greater CORT response and a more asymmetrical alpha EEG response in the temporal lobes. AGG boys' HRs to the violent and non-

violent films were less well differentiated than that of NAGG boys and in a different direction. Conversely, none of the physiological measures distinguished between the groups at baseline suggesting that unitary over- or under-arousal/activation hypotheses may not adequately characterize the biological distinctions between aggressive and non-aggressive children. Importantly, the two groups did not differ in overall amount of television or level of violence portrayed in their favorite television programs. Further, the groups did not differ in attentional capacity, impulse control, and overall motor activity. Therefore, the observed physiological differences between the AGG and NAGG cannot be attributed to these behavioral factors. These findings suggest that AGG and NAGG children differ in their physiological responsivity to environmental stimuli.

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I would like to dedicate this doctoral dissertation to my parents, Stanley and Joan Grayson and my sister, Wendy. Your unwavering love, support, and faith in my abilities have allowed me to make my dreams become a reality. A special dedication is also made in memory of my grandmother, Mary (Polly) Oppenheim. Your "little champ" finally made it. I will forget you not.

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CHAPTER I

INTRODUCTION

Data supporting a connection between neural dysregulation or dysfunction and aggressive behavior has consistently been shown since the late 1800's (Bard, 1928; Hess, 1981). While the nature of this neural dysfunction has not been fully elucidated, evidence of physiological under-arousal is one of the most robust and best-replicated findings in antisocial populations. Studies have demonstrated with relative consistency that aggressive individuals have reduced heart rate and skin conductance levels, and increased slow-wave EEG. Further support for this under-arousal is the fact that aggressive individuals have frequently been found to be physiologically less responsive to sensory stimuli, supporting the notion that they are under-aroused.

Conversely, data from some studies have suggested that aggressive people, who are characterized by high levels of impulsivity and affective lability, may be over-aroused and over-reactive to environmental stimulation. Thus, according to this hypothesis, aggressive individuals should show greater physiological arousal at baseline and increased responsivity to affectively charged stimuli.

One ecologically valid form of environmental stimulation comes in the form of media exposure to violent programs. Numerous studies have investigated physiological responsivity to film stimuli in adults as well as in children. Investigations of physiological responsivity to video clips in young adults and children have shown a significant increase in heart rate during exposure to violent but not prosocial scenes. However, the effect of viewing aggressive films has not been systematically evaluated in children characterized by high levels of aggressive behavior as compared to controls to determine whether this form of affective stimulation has a unique or specific affect on this subgroup of vulnerable children. If, as posited by the under-arousal hypothesis, aggressive children are under-responsive to environmental stimulation, then these "at risk" children should show a diminished physiological response to violent films as compared to their non-aggressive peers. In contrast, if aggressive children are "over-aroused," one would expect that they would exhibit an increased physiological response to aggressive films.

Specific Aims

The present study was designed to determine whether aggressive boys have a unique and differential physiological response to violent films as compared to their non-aggressive peers. Physiological responsivity was assessed in two groups of boys; one group was comprised of 15 boys who were clinically referred to a child psychiatry outpatient clinic for treatment because of aggressive behavior as measured by parent and teacher rating scales. The control group consisted of 15 boys recruited from a pediatrics clinic who were screened to rule-out a persistent or chronic pattern of aggressive behavior. Physiological responsivity was assessed twice in both groups of boys; once while viewing a 20-minute segment from a contemporary (PG)-rated motion picture depicting a boxing or prizefighting scenario ("Rocky III") and once while watching a non-violent situation comedy of equal length using a counterbalanced design. Both video segments were carefully screened for the presence of excessive violence, the presence of blood, and overall appropriateness for children in this age group.

Physiological responsivity in the children was measured using endocrine, cardiovascular and cortical measures of arousal and responsivity. Specifically, the primary dependent measures for this study were salivary cortisol, heart rate and coherence of alpha wave electroencephalography (EEG), respectively.

The goals of this study were to 1) evaluate the under- and over-arousal hypotheses of aggressive behavior by determining whether aggressive children have a differentially greater or lesser physiological response to film stimuli as compared to controls; 2) determine whether violent and non-violent films have differential physiological effects on children; and 3) determine whether a subgroup of children characterized by aggressive behavior are more susceptible or vulnerable to the stimulating effects of violent films.

Research Hypotheses

1. If the over-arousal hypothesis is correct, then:

   a) Aggressive children will show greater baseline cortisol levels and resting heart rate, as compared to control children.

   b) Aggressive children will show an enhanced cortisol, heart rate and EEG response to the film stimuli, as compared to controls.

2. If the underarousal hypothesis of aggressive behavior is correct, then:

   a) Aggressive children will show lower baseline cortisol levels and resting heart rate as compared to control children.

   b) Aggressive children will show a diminished cortisol, heart rate and EEG response to the film stimuli, as compared to controls.

3. All children, irrespective of group, will have a greater physiological response, as measured by cortisol, heart rate and EEG, during and following violent as compared to non-violent video.

4. If aggressive children are differentially sensitive to the effects of violent films, then there should be a significant group by film interaction such that aggressive children will have a differentially greater physiological response to violent as compared to non-violent film, whereas the controls will show less of a difference between the two videos.

A comprehensive review of the literature will address the following issues: 1) Environmental influences on child and adolescent violence, including the role of the media; 2) Prize fighting and its effects on aggressive behavior; 3) Neuroanatomical and neurophysiological underpinnings of aggression; and 4) Human models of aggressive behavior.

CHAPTER II

REVIEW OF THE LITERATURE

Youth Violence In Our Society

The dramatic increase in youth violence, documented by the current FBI statistics showing that one in every six violent crimes involves a juvenile (Reuters, 1999; Volz, 1999), have propelled the issue of increased child and teenage violence and its possible causes to the forefront of our collective consciousness.

Results of a seven-year (1990-1997) federally funded "Youth Behavior Risk Survey" consisting of a nationally representative sample of public and private high school students, produced mixed findings (Brener, Simon, Krug, & Lowry, 1999). Specifically, while overall rates of interpersonal violence decreased over this period, the number of children who reported feeling unsafe going to school and/or having been threatened or injured with a weapon remained unchanged. According to the latest survey (1997), approximately 20 percent of all high school students still reported carrying some type of weapon with them at all times and almost 40 percent had been involved in some physical altercation within six months prior to the survey. The reported rate of overall violent behaviors was two to four times greater in males as compared to females. For example, approximately 50 percent of all males surveyed reported having had physical altercations and a third reported carrying some type of weapon on a consistent basis. By comparison, females reported engaging in physical altercations at a rate of 25 percent and reported carrying a weapon only seven percent of the time. These numbers, while substantially lower than that of their male counterparts, were still considered by the authors to be excessively high. Nevertheless, results of this survey may be somewhat of an underestimation. One major limitation is that the data applied to only those students attending high school and, thus, did not take into account the five percent of adolescents who are not attending school (National Center for Educational Statistics, 1997). This factor is important in that these non-enrolled students frequently engage in more socially inappropriate and risky behaviors than do their in-school peers (Center for Disease Control and Prevention, 1994). Further, these numbers do not include information regarding the sporadic carrying of weapons. Finally, the overall analysis only included data up until 1997 and therefore does not include the multiple-victim and school related violent deaths that have occurred since the survey was completed. Thus, despite reductions reported over the seven years surveyed, the rates of youth homicides and non-fatal victimizations continue to remain at historically high levels (Brener, et al., 1999).

Considerable evidence indicates that aggressive behavior is relatively stable across the human life span (Eron & Huesmann, 1984; Eron, Huesmann, Lefkowitz, & Walder, 1972; Huesmann, Eron, Lefkowitz, & Walder 1984a; Loeber, 1991). Most researchers also acknowledge that there are numerous environmental, biological, and psychological factors that interact with one another in the development and expression of violent behaviors. One line of research has focused on environmental factors as a means of partially explaining violence and aggression.

Environmental Influences on Aggression

Several studies have identified major environmental risk factors for increased aggressive behaviors in children and adolescents (Farrington & Loeber, 2000; Geary, 1999; Kupersmidt, Griester, DeRosier, Patternson, & Davis, 1995). Some of the most widely accepted risk factors include family poverty, parental criminality and/or psychopathology, poor supervision, harsh discipline, and large family size. Peer delinquency, gang membership, urban residence, and living in high crime neighborhoods were also consistently found to be highly associated with increased youth violence.

One important environmental influence that has received considerable attention is exposure to media violence. Concerns regarding the impact of media violence on children has been expressed since the advent of television in the early 1950's.

Media Violence and Aggression

While the issue of media violence and aggression is of global concern, international investigations have shown that the amount, as well as the intensity of the violence portrayed on American television is consistently greater than that seen in most other countries (Mustonen, 1997; Sikorski, 1998). Only one country, Japan, surpassed the United States in the overall level of violence in their programs. Specifically, while Japanese and American programs had the same frequency of portrayed violence, Japanese violence tended to be more graphic in content and with more detailed suffering than did its American counterparts (Mustonen, 1997). Nonetheless, the overall amount of violence reported in Japan is significantly less than that seen in the United States. It is important to note that in typical American households, the television set is on for more than seven hours per day. Additionally, although levels do fluctuate, the viewer is, on the whole, consistently exposed to high levels of television violence (Signorielli, Gerbner, & Morgan, 1995).

The most significant findings come from the National Television Violence Study (NTVS), conducted by the University of California, Santa Barbara (Smith & Donnerstein, 1998; Kunkel et al., 1995, 1996; Wilson et al., 1997; Wilson & Smith, 1998). This study was designed to longitudinally examine the amount and context of violence on American television over a three-year period (1994-1997). Overall results from the first two years of this study indicated that 57 percent of television programs contained some measurable violence, with over 8,000 violent scenes and 18,000 violent interactions being reported. Additionally, of these interactions, 66 percent included some type of behavioral act of aggression, 29 percent contained threats of violence, and three percent included harmful consequences of unseen aggression. Furthermore, over half of the violent interactions displayed no pain and/or little harm to the aggressor (Smith et al., 1998). Importantly, 74 percent of all violent scenes did not feature any immediate punishment or condemnation for committing the violent act. In fact, only four percent of all violent programs assessed contained some type of anti-violence message (Smith et al., 1998). Additional analyses revealed that approximately 44 percent of all violence depicted on television consisted of perpetrators with attractive qualities worth emulating.

One major drawback of the NTVS was that it did not assess the levels of violence in non-fictional programs. However, according to the most recent figures from the Journal of Broadcasting & Electronic Media, a total of 2,126 antisocial acts were found within a composite week of 65.5 hours of non-fictional programming [i.e., local and national news, news magazines, and talk-interviews] (Potter, et al., 1997). Therefore results of the NTVS can likely be generalized to include many non-fictional programs as well.

While the effects of violence in the media is an overall concern in our society, many investigators have focused their attention on the amount of time children, especially young children, spend watching television and on the level of violent programming available to them. Children often begin watching television as toddlers and steadily increase their viewing through preadolescence. It is not uncommon for children between the ages of two to 11 years old to spend an average of 28 hours per week in front of the television (Andreasen, 1990; Liebert & Sprafkin, 1988). Of primary concern is the fact that violence tends to be at its highest during the times when children are most likely to be watching [e.g., Saturday morning programming]. This time period has on average 20-25 violent acts per hour (Gerbner & Signorielli, 1990). International review (Mustonen, 1997) has shown that the greatest disparity between the United States and other industrialized nations can be seen in the levels of cartoon violence (U.S. average =26.4 acts/hour versus 13.0 for European countries and 2.5 in Finland). Overall, cartoon programs present a very high-rate of antisocial activities that are far above real-life rates. These findings have led many to argue that children are becoming desensitized over time by the constant deluge of violent programming and as a result their psychological restraints (e.g., guilt, fear of retaliation) on violent behaviors are being significantly weakened (Doob and Wood, 1972; Hough & Erwin 1997). In addition, the lack of clear consequences and punishments may further encourage the increase of aggressive behaviors (Potter, et al., 1997).

Violence is often over-represented not only in television programming, but also in the advertisements, lead-ins, and promotions associated with this type of media. The majority of recent research in this area has been conducted in Finland. Results of one study indicated that advertisements for shows in which violence was the main feature of the lead-in were present in 45 percent of American, 33 percent of Finnish, and 20 percent of European programs (Mustonen, 1997). Similar numbers have been reported for children's television programming (Rajecki, et al., 1994). These very high numbers may be due in part to producer misconceptions regarding this type of marketing strategy and its effect on increasing viewership. However, previous studies have shown no evidence to support the view that violence is an effective marketing tool to increase viewership/popularity. Results of one programming/ratings survey of three major Finnish television stations, during a one-week period in 1991, revealed that high violence content or attractiveness (i.e., justified, glamorized, or profitable/effective) did not contribute toward larger audiences (Mustonen, 1997). In fact, the moderate correlation seen between the intensity of the portrayed violence and popularity was attributed primarily to the popularity of news programs, which tended to show graphic real-life events (Mustonen, 1997). This finding is along the lines of an earlier study that found no greater popularity for high versus low violent programs when other factors such as realism, conflicts, and humor were controlled (Diener & Woody 1981). However, this study, as well as others (Mustonen, 1997; Rajecki, et al., 1994), investigated the general population and it's viewing habits and preferences. Rarely have any studies investigated the possibility of differential effects of this type of promotional technique on specific vulnerable sub-populations.

Despite evidence supporting that the media may be partly responsible for increased violent and aggressive behaviors, the U.S. House of Representatives recently (1999) rejected a measure designed to stop minors from being exposed to violent games, movies, and music. The most frequently cited argument against censoring violence was that recently implemented measures, such as the recently revised and expanded media rating systems and "V-Chip" technology, allow for better monitoring and control of what children are viewing. However, results of a 1999 U.S. survey conducted by the Kaiser Family Foundation of 1,001 parents of children between the ages of two to17 years did not support this premise. Findings revealed, that although a large portion reported having "great concerns" about the amount of violence that their children are watching on television, only 44 percent, a 10 percent decrease from 1998, indicated that they were using the standard television rating system to monitor their child's viewing choices. Furthermore, despite the fact that all new televisions are equipped with the "V-Chip" as of January 1, 2000, less than 20 percent of parents surveyed had ever heard of the rating system and/or how to effectively use the device (Chetwynd, 1999).

In summary, while some researchers have failed to demonstrate a connection between television and actual violence, an impressive array of evidence supports the opinion that television violence may contribute to aggressive and violent behavior.

Gender Differences and Media Violence

Most published studies (Eron et al., 1971; Huessmann et al., 1984a, 1984b; Turner, Hesse, & Peterson-Lewis, 1986) have shown that viewing television violence causes a greater increase in aggression in boys as compared to girls. However, other investigations (Friedrich-Cofer & Huston, 1986; Heath et al., 1989; Huesmann, 1986; Huesmann, Moise, & Podolski, 1997; Moise, et al., 1994; Murray 1994) have shown that the deleterious long-term effects of watching violent television holds true for both genders. Nonetheless, the disproportionate number of young males involved in violent crimes and/or aggressive acts; especially in the U.S., continues to fuel this debate as to whether there is a more vulnerable gender-specific subgroup. Many possible reasons have been proposed in attempts to explain this phenomenon.

One recently posited theory (Murray, 1999) is that American boys are taught to forfeit sensitivity for bravado. Boys are taught to shut down their feelings, including empathy and sympathy, from multiple sources. Parents frequently expect their sons to act tough, strong, and protective. At the same time, it appears that peers often have the most detrimental effects. While peers often expose both genders to "ruthless" jeering and insults, these tauntings often do not cease for boys unless physical aggression is used. Unfortunately, these behaviors often earn the boy respect from the "gang" and are strongly reinforced. Consequently, these same factors, in combination with increased exposure to media violence and decreased supervision, often leads to tragic results (Murray, 1999). Additionally, while both genders watch, on average, the same amount of television, boys tend to prefer to watch more aggressive programs (Huesmann, 1986). Girls also tend to be less apt to approve of violent programs, see them as less realistic, and respond to them more emotionally than do boys (Van Evra, 1990).

Thus, while cross-gender comparisons may be advantageous in elucidating the negative effects of media violence on a broader scale, it is clear that males appear to be particularly vulnerable to such types of violent programs. Additionally, as mentioned, young males between the ages of nine and 13 who watched excessive amounts of television violence were at a significantly greater risk for responding violently to conflict or emotionally laden situations.

Field Studies

The majority of naturalistic and experimental field investigations assessing the relationship between aggression and television violence have reported moderate effect sizes [0.27 – 0.30] (Gadow & Sprafkin, 1989; Hearold, 1986; Hughes & Hasbrouck, 1996; Woods, Wong, & Chachere, 1991). According to the results of one study (Hearold, 1986), children who consistently watched violent programming were twice as likely to be deemed aggressive than those exposed to primarily neutral programs. Another study conducted by Williams (1986) revealed a significant increase in both verbal and physical aggression among primary school children after television was introduced into a small Canadian community that had been free of television until 1973 (Singer 1989).

Conversely, a comprehensive review of over 20 field experiments have yielded little support for an effect that is specific to the level of aggressive content in media programs (Gadow & Sprafkin, 1989). However, many of these studies did support the hypothesis that the children most affected by media violence are those who are more innately aggressive (Dorr & Kovaric, 1980; Hartmann, 1969; Huesmann et al., 1984a; Leyens, Camino, Parke, & Berkowitz, 1975).

Several investigations have focused on children labeled as emotionally disturbed (ED) and the possibility of differential vulnerability to viewing aggressive programs (Gadow & Sprafkin, 1987,1989,1993; Gadow, Sprafkin, & Ficarrotto, 1987; Gadow, Sprafkin, & Grayson, 1990; Sprafkin & Gadow, 1986, 1988; Sprafkin, Gadow, & Grayson, 1988). Overall, results indicated no difference in social aggression in ED children as a function of whether they watched aggression-laden as compared to non-aggressive programs. However, children with ED watched more hours of television with more aggressive content per week and were more likely to prefer aggressive characters as role models as compared to their non-ED classroom peers. ED children also comprehended less about the unreality of the portrayed behaviors, the use of special effects, and the truthfulness of commercials than their non-ED peers (Gadow & Sprafkin, 1993).

The ability to quantify and compare data from different field investigations is often made difficult by several methodological issues. These studies typically vary in their operational definition and measurement of aggression, the method of data collection, and the reliability of the measures used. Additionally, these investigations are characteristically short-term in duration. As a result, the less immediate and cumulative long-term effects of viewing violent programming are often not accurately assessed and, therefore, are often either under- or over-estimated.

Longitudinal Studies

Two major questions most frequently asked in longitudinal studies are: "At what age are children the most susceptible to television violence?" and "To what extent does the frequency of viewing aggressive programs affect later aggression?" These types of investigations allow for a more extensive examination of the relationship between aggressive and violent behavior, delinquency, and media violence by allowing for both the exposure and outcome effects to be assessed over longer periods of time. Some such studies have failed to find evidence that viewing television violence increases subsequent aggressiveness in adults (Hennigan et al., 1982; Milgram & Shotland, 1973) or in children (Friedrich & Stein, 1973). Nevertheless, the overall connection between media violence and later acts of aggression and delinquency has held up across numerous replications and across various paradigms (Friedrich-Cofer & Huston, 1986; Murray 1994).

Past research has suggested that the overall amount as well as the preferences for watching certain types of television programming may vary as a function of gender (Anderson, Lorch, Field, Collins, & Nathan, 1986), ethnicity of the viewer (Harris 1992; Tangney &

Feshbach, 1988), and socio-economic status (Huston et al., 1992; Kubey & Csikszentmilhalyi, 1990). Tangey and Feshbach (1988) reported that African American children watched approximately twice as much television per week as their Caucasian counterparts. Importantly, these results were independent of parents' overall level of education. Similarly, other studies have reported that children from low-income families watch significantly more television than children from mid- to high-income families. (Huston et al., 1992; Kubey & Csikszentmilhalyi, 1990). Thus, it appears that those children who come from the most vulnerable sections of society are the heaviest viewers of television, which, according to Eron, Walder, & Lefkowitz, (1971) may be primarily due to lack of other suitable alternatives.

These findings appear to only partially account for observed increases in aggressive behaviors in young children. Television violence continued to make a significant and independent contribution to later aggression even when possible confounding variables such as gender, ethnicity, maternal education, and previous aggression were controlled (Singer, Singer, & Rapaczynski, 1984). A similar relationship between viewing violent programming and aggressive behavior also holds true for adolescents (Heath, Bresolin, & Rinaldi, 1989; Hughes & Hasbrouck, 1996).

Results of a five-year investigation following children ages four to nine years old indicated that maternal reports of the amount of television watched along with the ways in which the children responded to provocation were relatively stable across this time span. Heavy television viewing during preschool years was moderately related to current and subsequent levels of aggression (Singer, et al., 1984). Additionally, children between the ages of nine to thirteen who were heavy viewers of television were more than twice as likely as light viewers to respond with aggressive solutions to conflict situations depicted in vignettes (Atkins, Greenberg, Korzenny, & McDermott, 1979).

A common criticism of such studies is that they have the disadvantage of weak casual inferences (Hughes & Hasbrouck, 1996). However, several longitudinal investigations, which directly addressed this issue, continue to support a moderate causal link between television violence and aggressive behaviors in children and adolescents (e.g., Eron & Huesmann, 1984; Eron, et al.,1972; Huesmann, Lagerspetz, & Eron, 1984b; Singer, et al., 1984).

An extensive and impressive ten-year longitudinal study was conducted by Eron et al., (1972). This investigation assessed the long term relationship between peer rated aggressive behavior and television viewing in 427, 19 year-old males and females from a predominantly middle class, upstate New York community. These subjects were all initially part of a group of 875 eight to nine years old studied by Eron in 1963. Overall results indicated that a preference for watching television violence between the ages of eight and nine years was the most useful variable for the prediction of aggression at age 19, after controlling for other potential contributors such as intelligence, socio-economic status, ethnicity, and, importantly, previous levels of aggression.

Similar findings were reported from a three-year longitudinal study of 750 Chicago inner city and suburban first and third graders (Eron & Huesmann, 1980). Later analysis of the data by Eron and Huesmann indicated that those children who were deemed less aggressive but watched more violent programs at age eight turned out to be more aggressive on follow-up than those deemed highly aggressive but who watched less violent programs.

These findings were further supported by the same authors in a 22-year follow-up study of the more aggressive children from the original 1960 study (Huesmann, et al., 1984a). The stability of aggression over the 22-year period was r = .50 for boys and r = .35 for girls, indicating a high level of stability in aggression. Similar to their 1980 study, Eron & Huesmann, using multiple regression analysis, again revealed a relationship between an early preference for watching television violence and later levels of aggression.

Another impressive and often cited longitudinal investigation followed 758 children in the United States and 220 in Finland from grades one through five (Huesmann, et al., 1984b). Results supported and expanded on the previous findings of Eron and collegues (Eron & Huesmann, 1980; Eron, 1963; Eron, et al., 1972) on an international level. In both countries, the level of aggression, while relatively stable for both genders, was more predictable for boys (US = .71; FIN = .58) during the three-year period than for girls (US = .57; FIN = .39). In addition, the relationship between viewing violent programs and aggression appeared to rely heavily on the regularity of the exposure to media violence. Specifically, regular exposure to mild violence was associated with higher reported aggression more often than in cases with infrequent exposure to severe violence. A recently conducted follow-up of those initially deemed aggressive at age eight to nine years old revealed that 47 percent had criminal records by ages 25-27. In fact, those with criminal records were more aggressive in childhood and watched more violence on television than those without criminal records. (Viemero, 1996). This particular finding supports previous indications that the ages of eight to nine years old may be an important period in child development when evaluating the television violence-aggression connection.

Another example documenting the relationship between television violence and aggression was a survey comparing men convicted of violent crimes with men with no history of violence from the same neighborhoods. Subjects were asked to retrospectively indicate the shows that they watched between the ages of 8-12 (Heath, Kruttschnitt, & Ward, 1986). Most significant were the interaction effects among physical abuse by the mother, physical abuse by the father, and exposure to television. Those men who scored high on any two of these factors were more likely to have been convicted of a violent crime. These findings suggest that physical violence in the home may alter the way children view violent images on television and are consistent with the view that certain children are more vulnerable than other to the effects of television violence.

Laboratory Studies of Environmental Influences on Aggressive Behavior

Some of the earliest laboratory investigations involving the effect of media violence and aggression in young children were the famous "Bobo Doll" experiments conducted by Bandura and colleagues (Bandura 1965; Bandura, Ross, & Ross, 1961, 1963a, 1963b). Children who had been exposed to television films in which the adult behaved aggressively toward the inflated dolls played more aggressively with the doll than did children who had not watched the adult model. Interestingly, the relationship between viewing aggressive behavior and acting aggressively was especially pronounced if the aggressor was rewarded for his/her actions. These effects, commonly attributed to modeling or observational learning, have been consistently replicated across numerous variations over the past 30 years (Huesmann, et al., 1984a).

Another frequently proposed hypothesis is that media violence may have differential emotional effects on people who chronically behave aggressively. One recently conducted study on the effects of violent movies and trait hostility on hostile feelings and aggressive thoughts in male and female college students has lent support to this hypothesis (Anderson, 1997). Trait hostility was assessed using a version of the Caprara's Irritability Scale (Caprara et al., 1985), which includes questions such as, "When I am irritated, I need to vent my feelings immediately." State hostility was assessed via a similar scale in which the subject indicated the extent of their agreement with such statements as, "I feel furious." Results indicated that viewing violent movie clips increased the level of reported state hostility in all subjects. Additionally, those subjects with high trait hostility ratings reported a greater level of state hostility in the violent movie condition than individuals with low trait hostility. As a result one would expect that these individuals would be more likely to exhibit increased aggressive behaviors both during and immediately following exposure to such stimuli. In fact, this premise has been supported by another study which showed that aggression-prone individuals display the greatest increase in aggressive feelings after viewing violent films (Bushman, 1995). Therefore the emotional effects of viewing a violent movie may be sufficient to alter those predisposed hostile individuals' perceptions of the material in such a way as to act as a "trigger", thus increasing the likelihood of an aggressive response (Anderson, 1997).

There is considerable evidence that standard laboratory paradigms effectively capture the affective aggression construct (Anderson & Bushman, 1997; Berkowitz & Donnerstein, 1982; Carleson, Marcus-Newhall, & Miller, 1990). In addition, research carried out in laboratory settings affords better methodological control over confounding variables, thus making such types of investigations more pragmatic and often more feasible.

Prize Fighting and Aggression

Prize fighting represents one of the most uniquely identifiable instances of media violence (Miller, Heath, Molcan, & Dugoni, 1990). Laboratory studies in which young adults were shown an aggressive boxing film clip under various aversive shock conditions were conducted by Geen and collegues in the late 1960's and early 70's (Geen & O'Neil, 1969; Geen & Stonner, 1972, 1973). The experimental paradigms in these studies consisted of male subjects who were either attacked (with mild to moderately painful electric shock) or treated in a neutral manner before watching a prizefighting movie. A varying percentage of subjects were primed with one of three situations prior to viewing the fight: 1) fighters were boxing for money as professionals; 2) fighters were motivated by a quest for vengeance; and 3) shown film without comment. It was found that previously attacked subjects tended to act more aggressively and to express lower restraints against violent acts after witnessing vengeful aggression than after seeing identical aggression deemed "professional." Additionally, those subjects who were not attacked were more aggressive and less restrained after observing "professional" violence than after seeing the "revenge" scenario. The authors concluded that the degree to which a person reacts aggressively toward a confederate is directly related not only to viewing the violent clips, but also to factors such as level of character identification, whether the violence was justified, and/or previous levels of arousal. Perry & Perry (1976) conducted a similar study in which 108 young males were initially angered using a variation of the paradigm used earlier by Geen and his colleagues. However, unlike previous studies, subjects were instructed to identify with either the winner or the loser of the prizefight prior to viewing. Those subjects who identified with the winner were more aggressive toward the confederates than subjects instructed to identify with the loser or who were not asked to identify with either fighter. These findings suggest that aggressive reactions of an individual appear to be related to whether or not the subject identified with the eventual winner of the fight and thus saw the aggressive behaviors receive positive reinforcement.

Further evidence supporting the connection between viewing prizefights and aggressive behavior come from a retrospective study by Phillips (1983). This investigation examined the impact of mass media violence on aggression by analyzing the daily homicide rates on days following heavyweight championship prizefights from 1973-1978. Results indicated a 12.5 percent increase in homicides on the third day following the fights. However, a more recent re-analysis of these data (Miller et al., 1990) addressed several theoretically important variables which were not adequately dealt with in the original study. Specifically, Miller analyzed the effects of fluctuations in unemployment, measure of publicity (e.g., day of the week the fight occurred, number of media outlets reporting fight), and the fight's relation to weekend holidays. Results indicated a more widespread effect in that an increase in homicides was actually seen over the third and fourth days following a fight. Further analysis using higher order auto-correlation and statistically controlling for chance probability, could not explain the increases in homicides on the third and fourth days following a fight as compared to other days. Interestingly, the rates of homicides were strongly related to the race of the losing boxer, that is, the homicide rates amongst white men rose after a major fight in which a white man lost and vice versa. The author suggested an imitative or modeling effect similar to that proposed by Bandura et al. in the 1960's, in that victims of these crimes may be selected due to their similarities (e.g., race, sex, and age) with the losing fighter. Thus, these results refute many of the critics of both field and laboratory investigations who have argued that no immediate change in aggressive behaviors following an aggressive/violent presentation equates to negative overall effects and that these relationship only occur after repeated, long-term exposure to violence. Importantly, there are no known studies that have investigated the effects of viewing such types of physical violence in children or adolescents.

There are convincing arguments supporting an important role for environmental influences in the manifestation of aggression. However, most agree that biological factors also play a pivotal role in the development and expression of violence. Twin and adoptive studies have provided evidence that childhood aggression increases significantly with the presence of both a genetic predisposition for aggressive behaviors and aversive environmental factors (Cadoret, Leve, & Devor, 1997; Cadoret, Yates, Troughton, Woodworth, & Stewart, 1995; Clark, Murphy, & Constantino, 1999; Lyons et al., 1996).

Biology of Aggression

Neural Mechanisms and Aggression

Central Nervous System

The limbic system, as currently defined, consists of a number of subcortical structures (i.e., cingulate gyrus, hippocampus, thalamus, amygdala, septum, and hypothalamus) that are reciprocally connected to cortical regions such as the prefrontal and temporal cortex. It is this integration that allows for cortical information to influence autonomic functions and is believed to be critical in the expression of emotion (Niehoff, 1999).

The hypothalamus has been acknowledged as playing an integral role in the neuroanatomy of aggression since Philip Bard's "sham rage" experiments in the 1920's (Bard, 1928). Sham rage was used to describe the unpredictable and uncontrollable aggressive behaviors seen in cats following the removal of the cerebral cortex. Sparing of the hypothalamus, however, effectively eliminated the sham rage response in these animals (see reviews: Finger, 1994; Kupfermann, 1991). Around the same time, Walter Hess, in an attempt to find the brain regions responsible for maintaining homeostasis, discovered that the hypothalamus was not only involved in influencing autonomic functioning (e.g., heart rate, respiration, blood pressure, and bladder control) but also aggression. Electrical stimulation of the hypothalamus in cats elicited what is now defined as "defensive aggression". These animals assumed a crouched position with arched back, flattened ears, raised fur, dilated pupils, bared teeth, and hissed as if poised to attack (Hess, 1981).

Two seminal studies conducted by Flynn and colleagues at Yale University in the 1960's and 70's can be used to help expand on Hess' original findings. Overall, electrical stimulation of specific regions of the hypothalamus elicited two distinct types of aggressive behaviors (Chi & Flynn, 1971; Wasman & Flynn, 1962). Specifically, stimulation of the medial hypothalamus (MH) produced the more affective, defensive type of aggression shown by Hess, whereas stimulation of the lateral hypothalamus (LH) created behaviors termed "predatory aggression" (i.e., stalk and kill sequence).

Siegel and colleagues have conducted numerous studies using enzymatic and radioactive tracers in an attempt to better understand the neuronal underpinnings of these two types of aggressive behaviors (Fuchs & Siegel, 1985; Mirsky & Siegel, 1994; Siegel & Edinger 1983; Siegel & Potts, 1988). Results indicated that LH and MH have extensive bidirectional connections with other limbic structures such as the amygdala and hippocampus as well as with the brainstem and higher cortical areas. The amygdala, found between the lateral edges of the hypothalamus and the temporal cortex, also contains numerous efferent and afferent pathways to the hippocampus and cortical areas responsible for all of the five senses (LeDoux, 1992, 1993). The hippocampus appears to play an especially important role by constantly comparing new/novel stimuli with past experiences. This information is first sent to the amygdala where it is given the appropriate emotional valence (e.g., anger, fear, affection) (Brodal, 1981) and then on to the hypothalamus for the processing and initiation of appropriate autonomic, endocrine, and behavioral responses. Animal studies have shown that complete or partial lesions to the amygdala consistently reduce aggressiveness, fear, and responsiveness to provocation (Krettek & Price, 1978; LeDoux, 1992, 1994). These extensive hippocampal-amygdaloid-hypothalamic connections appear play a critical role not only in the initiation, but also in the modulation of predatory and defensive aggressive behaviors by allowing for the constant exchange and monitoring of sensory and cognitive information (Amaral, et al., 1992; Brodal, 1981; Fuchs & Siegel, 1994).

Investigations using modern imaging techniques such as positron emission tomography (PET) and single photon emission computed tomography (SPECT) in humans have shown a connection between cortical dysfunction and increased aggressive behaviors. One such study conducted by Volkow and Tancredi (1987) used both computed tomography (CT) and PET to assess structural abnormalities and to measure regional blood flow and glucose metabolism in four recidivistic violent male offenders. Decreased blood flow and glucose utilization in the left temporal lobes was seen in all four of the violent subjects, as compared to normal age-matched controls. Decreased left frontal activity was also seen in those subjects who expressed minimal guilt or comprehension of the moral significance of their actions. No structural abnormalities were noted for any of the subjects in either group.

Another PET study compared the frontal metabolism of 22 convicted murders to that of non-violent offenders as they participated in a simple monitoring task in which they were required to press a button when the number zero appeared in a series of numbers and letters. Overall findings indicated significantly lower glucose utilization in the prefrontal and orbitofrontal cortex of the murderers during the task as compared to controls. These regions are thought to be related to the facilitation and inhibition of aggression (Raine, 1993).

Hypothalamic-Pituitary-Adrenal Axis (HPA).

Corticotropin-releasing hormone (CRH) is a 41-amino-acid peptide expressed in the medial parvicellular region of the paraventricular nucleus [mpPVN] of the hypothalamus (Swanson, Sawchenko, Lind, & Rho, 1988; Vale, Spiess, Rivier, & Rivier, 1981). CRH neurons in the mpPVN project to the external layer of the median eminence, where the peptides are transported via the portal bloodstream to the anterior pituitary. Corticotropes in the anterior pituitary have receptors, which, in response to stimulation, synthesize and release adrenocorticotropin hormone (ACTH). ACTH travels via the systemic circulation and binds and activates receptors on the adrenal cortex. In turn, adrenal cortical cells synthesize and release glucocorticoids as well as a large number of other steroids (Akil, et al., 1999). This complex system is termed the hypothalamic-pituitary-adrenal-axis (HPA).

Modulation of the HPA is believed to come about through negative feedback of the glucocorticoids on the pituitary, hypothalamic, and suprahypothalmic sites which differ not only in their sites of action but also in timing and mechanisms of action (Keller-Wood & Dallman, 1984). Removal of the adrenal gland, and thus glucocorticoids, has been shown to remove the negative feedback effects of these steroids (Sawchenko, 1987).

Steroid receptors are thought to mediate negative feedback by three methods. The first method is genomic feedback that involves inhibiting the transcription of the relevant genes need to encode CRH. While changes in transcription can occur promptly in response to stress or exogenous steroids (Roberts, et al., 1987), glucocorticoid-induced changes can take hours to days depending on the amount of mRNA present (Birnberg, Lissitsky, & Hinman, 1983). The remaining two methods of negative feedback operate on a shorter time frame and regulate moment-to-moment activation and termination of stress responses. One mechanism often referred to as the "fast feedback loop" establishes the magnitude and duration of the glucocorticosteroid response. While this mechanism is believed to involve neuronal rather than genomic regulation, the actual mechanisms remain unclear. Circumventricular organs (e.g., subfornical organs and vascular organ of the lamina terminalis) appear to be involved in HPA regulation by constantly monitoring the concentration of the circulating steroids. After the steroid levels have risen in response to a stressor, information from blood-born chemosensory signals are sent to the stress related mpPVN (Dallman, et al., 1991, Keller-Wood & Dallman, 1984). The other method is termed the "intermediate feedback loop" and involves a combination of both genetic and neuronal regulatory mechanisms, however its actual means of action are also unclear.

The HPA is not solely activated by either positive or negative stimuli. It appears that the basal secretions of the HPA oscillate in a circadian rhythm, which are controlled by the hypothalamus. In humans, glucocorticoid levels are highest around seven AM and decline gradually throughout the day with the lowest point being typically reached in the late evening (i.e., seven PM to midnight) after which levels begin to rise. Other factors such as food intake appear to also play a major role in the timing of these cycles and in the secretion of ACTH and glucocorticosteriods. Two studies involving rats found a systematic rise in the levels of ACTH that directly coincided not only with the animals' meal times but also the anticipation of receiving food (Krieger & Hauser, 1978; Szafarczyk, Izart, Malaval, Nouguier-Soule, & Assenmacher, 1979). Similar, yet less pronounced, fluctuations have been shown for circulating ACTH. Studies have shown that the daily rhythm of ACTH precedes that of the glucocorticoids by approximately one to two hours (Kwak, Morano, Young, Watson & Akil, 1993; Kwak, Young, Morano, Watson & Akil, 1992). These findings are consistent with ACTH being responsible for the synthesis and release of glucocorticoids from the adrenal cortex.

The overall sensitivity and responsiveness of the HPA to stress are also affected by diurnal rhythms. Studies in rats have shown the HPA to be most sensitive and show the clearest activation to stress stimuli at the lowest point of the rhythm. This time of peak sensitivity to inhibition and to negative feedback usually corresponds to when the animals were at rest as opposed to when the animals were most active and vigilant (Dallman, et al., 1991). This finding is important in that it gives evidence to suggest the system evaluates a stimulus not only in terms of its magnitude and context but also the organisms' readiness to meet it (Akil, et al., 1999).

Other neurochemical pathways that modulate physiological functions via neurotransmitters have been shown to also be important in the HPA activation and modulation of the autonomic nervous system.

Neurochemistry and the HPA

Catecholamines (CA). CA have been shown to be highly instrumental in early activation of the HPA in response to stress (Akil, et al., 1999) and the transmission of visceral information (Role & Kelly, 1991; Ungerstedt, 1971; Ungerstedt & Ljungberg, 1974). CA projections have been shown to originate in the brain stem and midbrain and then branch off in two directions: 1) the amygdala, hippocampus, hypothalamus and cortex, and 2) the cerebellum and spinal cord. Nearly all regions of the brain receive input from at least one CA projection.

One CA that has been shown to systematically increase in response to a stressor is dopamine (DA) (Akil, et al., 1999). DA cell groups can be divided into two broad groups, the nigrostriatal system and the mesolimbic and mesocortical systems, both of which have extensive projections to the neocortex (Anden, Dahlstrom, Fuxe, & Larsson, 1966; Dahlstrom and Fuxe, 1965; Lindvall, Bjorklund, 1974; Lindvall, Bjorklund, Moore, & Stenevi, 1974; Hokfelt & Ungerstedt, 1973). The nigrostriatal neurons originate in two midbrain regions, the substantia nigra (A9) and ventral tegmental area (A10). Neurons from the substantial nigra send projections to striatal areas such as the caudate-putamen, globus pallidus and the subthalamic nuclei (basal ganglia) that are thought to be responsible for voluntary movement. The mesolimbic and mesocortical pathways (A10 and parts of A9) have connections with the limbic system (brain stem, septum, amygdala, hypothalamus) and prefrontal cortex, areas known for being involved in emotional processing (Role & Kelly, 1991).

Another CA involved in the control of the stress response is norepinephrine (NE). NE is responsible for the activation of the adrenal gland, which in turn produces adrenaline, and thus triggers the symptoms of emotional arousal [e.g., increases in heart rate, respiration, and circulation] controlled in part by the HPA (Zigmond, Finlay, & Sved, 1995).

The majority of NE projections come from the locus coeruleus (LC) (Nemeroff, 1991). The LC is a compact cell group within the caudal pontine central gray that sends extensive projections throughout the brain including: 1) neocortex, 2) thalamus, 3) amygdala, 4) hippocampus and septum, 5) hypothalamus, and 6) brain stem nuclei (Foote, Bloom, & Aston-Jones, 1983). These NE tracts are thought to function as part of an active monitoring system by continuously screening incoming sensory information (Bjorklund & Nobin, 1973; Moore & Bloom, 1979). A small number of ascending pathways also relay visceral and interoceptive information from cranial nerves X (vagus) and XI (spinal accessory) to the PVN of the hypothalamus (Role & Kelly, 1991).

Pharmacological investigations have shown that prolonged exposure to pervasive stressful conditions can cause permanent sensitization of the CA system. One way is through the destabilization of auto-receptor feedback mechanisms. As a result, the basal firing rates of the neurons are reset at a higher value resulting in a hyper-sensitized alarm system that overreacts to the slightest provocation (Aston-Jones & Bloom, 1981; Gresch, Sved, & Zigmond, 1994; Southwick, Yehuda, & Morgan, 1995; Zigmond, et al., 1995). Another way that prolonged exposure to stressful situations can alter CA sensitivity is thought to be due to the inhibition in the transcription of mRNA for tyrosine hydroxylase and dopamine beta-hydroxylase, the rate-limiting enzymes responsible for converting l, tyrosine to either DA, NE, or epinephrine. The resulting decrease in CA production typically results in the up-regulation, or hypersensitivity of both the presynaptic and postsynaptic CA receptors and also results in animals who are hyper-responsive to future environmental or pharmacological challenges (Gresch, et al., 1994; Haney, et al., 1990; Modigh, 1973). Conversely, lesions of the noradrenergic projections from the LC have been shown to abolish the hypothalamic response to acute and chronic stress (Clow, Patel, Najafi, Evans, & Hucklebridge, 1997).

Indoleamines. Serotonergic projections from the midbrain raphe nuclei (RN) to the PVN have also been shown to be important in the regulation of CRH (Dinan, 1996) and the HPA. Serotonergic nerve terminals originating in the dorsal and median RN along with the ascending projections from the midbrain RN to the hypothalamus and limbic structures are also believed to be involved in the mediation of emotional expression (Clarke, Murphy, & Constantino, 1999; Meltzer, 1990) and anxiety (Charney, Woods, Krystal, & Heninger, 1990).

Investigations have indicated a strong link between serotonin and aggressive behaviors in animals (Higley, et al., 1992; Mehlman et al., 1994; Soubrie, 1986). Results of various human adult studies suggest that serotonin may modulate the expression of aggressive behaviors (Blumensohn et al., 1995) as well as impulse control (Cloninger, 1987; Coccaro et al., 1989; Virkkunen & Linnoila, 1990). Specifically, negative correlations have been reported between cerebrospinal fluid levels of 5-hydroxyindoleacetic acid (5-HIAA) the primary metabolite of serotonin, and impulsive-aggression in adults (Brown et al., 1982; Linnoila et al., 1983; Virkkunen, Goldman, Nielsen, & Linnoila, 1995; Virkkunen, et al., 1994). Similar findings have been reported in children (Clarke et al., 1999; Kruesi et al., 1990, 1992) and in infants with family histories of antisocial personality disorders (Constantino, Morris, &

Murphy, 1997). However, findings in aggressive children have been far less consistent than those reported in adults (Castellanos et al. 1994; Halperin et al. 1994; Pine et al. 1997).

Physiology and Aggression

Some of the most frequently used psychophysiologic measures in investigations involving aggressive and/or antisocial populations have been the measurement of cortisol, an adrenal steroid that purportedly indexes HPA arousal during stress, cortical brain activity (EEG), and resting heart rate (EKG).

Cortisol in Psychophysiological Research

The major glucocorticosteroid secreted by the HPA in humans is cortisol. Cortisol is synthesized from cholesterol through a number of enzymatic steps by cells of the zona fasciculata and zona reticularis in the adrenal cortex. Cortisol is then released into the circulation under the influence of ACTH. Normal adults typically secrete about 20 mg of cortisol daily (Golfien, 1989). The half-life of cortisol in the circulation is approximately 60-90 minutes (Miller, 1988).

The determination of cortisol levels in plasma and urine has long been used in the assessment of adrenocortical functions and in disturbances of the HPA (Aardal & Holm, 1995). The assessment of cortisol in saliva has recently become a valuable alternative to plasma and/or urine analysis. Studies comparing salivary with plasma cortisol in different populations, including newborns (Gunnar, Mangelsdorf, Larson, & Hertsgaard, 1989), children and adolescents (Woodside, Winter, & Fisman, 1991), geriatric (Reid, Intrieri, Susman, & Beard, 1992) and psychiatric patients (Harris et al., 1990), have all shown high correlations between these two measures. Importantly, salivary cortisol appears mainly as "free form" (i.e., unbound) which, according to some researchers (Carroll, Curtis, & Miendels, 1976; Harris et al., 1988; Riad-Fahmy, Read, Walker, & Griffiths, 1982), provides a more meaningful indicator of cortisol levels than either plasma or urinary sampling. Specifically, only free cortisol molecules that are not bound to globulins diffuse into the saliva and can cross the blood-brain barrier, suggesting that salivary levels may be more precise indicators of psychoactive concentrations of cortisol in circulation and are thus more accurate indicators of HPA functioning than that obtained from plasma (Carroll, et al., 1976; Harris et al., 1988; Kirschbaum & Helhammer, 1994; Mc Burnett et al., 1991; Riad-Fahmy, et al., 1982). Importantly, although urinary samples also contain primarily free-form cortisol, urinary cortisol levels reflect the integrated function of the HPA over a period of time, whereas salivary cortisol levels more accurately reflect the state of the HPA at a specific point in time (Schulz, Halperin, Newcorn, Sharma, & Gabriel, 1997). Furthermore, due to the non-invasive nature and laboratory independence of sampling, salivary cortisol can be measured at an almost unlimited frequency and under a variety of clinical settings. Finally, the use of salivary cortisol in the psychoneuroendocrine research literature has noted the ease of sampling and more importantly, the stress-free manner in which it can be obtained (Aardal et al., 1995; Hellhammer, Kirschbaum, & Belkien, 1987; Kirchbaum, Bartussek, & Strasburger, 1992; Kirschbaum & Helhammer, 1989,1994; Riad-Fahmy et al., 1982; Vining, McGinley, Maksuytis, & Ho, 1983). This non-invasive manner of sample collection significantly decreases the chance of stress-induced rise in cortisol concentrations, therefore making it particularly useful in investigations assessing physiological arousal and responsivity, particularly in children.

Cortisol and Aggression

The mechanism linking pervasive aggression and low cortisol concentrations is not fully understood. However, animal models have indicated that prenatal and early developmental stress (Levine 1994) can cause long-term or even permanent alterations in cortisol secretion and dysregulation of the HPA by affecting steroid receptors located in the frontal cortex and hippocampus (Meany, et al., 1985).

Reduced cortisol levels have been reported in habitually violent adult offenders (Virkkunen, 1985) and in aggressive children and adolescents (Lahey, 1993; McBurnett, Lahey, Rathouz, & Loeber, 2000; Susman et al., 1987; Tennes & Kreye, 1985; Tennes, Kreye, Avitable, & Wells, 1986). These lower levels of cortisol have been interpreted as indicators of underarousal, an over-regulation of the HPA axis, or an increased threshold for stress (Hennessy & Levine, 1979).

Virkkunen (1985) found that urinary cortisol was significantly lower in a group of habitually violent adult male offenders as compared to nonviolent offenders. Similar findings have also been reported in aggressive young children (Tennes & Kreye, 1985; Tennes, Kreye, Avitable, & Wells, 1986). Results from a study investigating the relationship between urinary cortisol levels and aggressive behavior in 29 second-grade children indicated that aggression towards both teachers and peers was negatively correlated with urinary cortisol secretion over a two-hour period. Further, the child's lack of popularity with peers and hostility toward the teacher accounted for approximately 69 percent of the group variance in cortisol level (Tennes & Kreye, 1985).

Additional evidence that low HPA activity is correlated with severe and persistent aggression comes from a recent two year follow-up investigation of 38 conduct disordered boys ranging in age from 7 to 12 years (McBurnett, Lahey, Rathouz, & Loeber, 2000). Research indicated that consistently low cortisol levels over the two sampling times were associated with both early onset and persistence of aggression. Further analyses indicated that those with lower overall cortisol levels exhibited three times as many aggressive symptoms and were more likely to be named as "most aggressive" by their peers than those with either variable or high cortisol levels.

These findings are consistent with an earlier investigation (Vanyukov et al., 1993) which reported a modest inverse correlation between basal salivary cortisol and the number of conduct disorder symptoms in the sons (ages 10-12 years) of alcoholic men. Corresponding results have also been reported in adolescents with conduct problems (Lahey, 1993; Susman et al., 1987).

In contrast, others have reported no relationships between resting urinary and/or salivary cortisol levels and disruptive behaviors in either children or adolescents (Kruesi, Schmidt, Donnelly, Hibbs, & Hamburger, 1989; Scerbo & Kolko, 1994) or young adults (Dabbs, Jurkovic, & Frady, 1991). Negative findings have also been reported in studies assessing plasma cortisol levels in aggressive prepubertal and adolescent boys with disruptive disorders (Schulz et al., 1997; Stoff et al., 1992).

The results of these studies should be viewed with some caution when attempting to rule out a possible association between aggression and cortisol secretion in children. In particular, the subjects in two of the five studies mentioned (Kruesi et al., 1989; Stoff et al., 1992) were chosen primarily on the basis of meeting criteria for any of the disruptive behavior disorders.

Thus, although the studies identified a variety of traits that included aggression, they did not specifically define the groups using aggression as the criterion factor. Additionally, while the remaining three investigations (Dabbs, et al., 1991; Scerbo & Kolko, 1994; Schulz et al., 1997) incorporated measured aggression for subject groupings, substantial variability was evident in their operational definitions of aggression and inclusion/exclusion criteria. Specifically, while Schulz et al.'s sample was limited to those children who were primarily physically aggressive, Scerbo & Kolko's subjects had an extremely large variance in their aggression scores (less than one standard deviation to over four deviations above the mean) on both parent and teacher measures of aggression. Dabbs et al.'s subject grouping was based solely on responses from a self-reported questionnaire that included 50 items from the delinquency scale of the 1986 National Youth Risk Survey. The overall validity of such self-report measures in children, especially when not done anonymously, has frequently been criticized, given the high incidence of under or over-reporting of certain past delinquent behaviors (Brener, Collins, Kann, Warren, & Williams, 1995). Substantial variability was also present in the overall age in many of the samples investigated. Given the fact that children characteristically secrete less urinary free cortisol than adults (Juselius & Kenney, 1974) the wide age range in the Kruesi et al. (7-16 years old) and Scerbo & Kolko studies (7-14 years old) makes the effects of age and/or puberty on cortisol somewhat questionable. Finally, only one of these studies (Stoff, et al., 1992) included a normal control group. Therefore it is possible that the overall cortisol of these children, while not different from one another, was relatively decreased as compared to the general childhood population.

Heightened levels of cortisol have also been reported in aggressive populations. Buydens-Branchey and Branchey (1992) compared plasma cortisol levels in adult alcoholics with and without a life-long history of violence. Overall, those individuals with a history of aggression had heightened levels of plasma cortisol throughout the four week period following cessation of drinking, as compared to those with no problems in mood or aggression control. However, these results may be tempered by the fact that, for the entire sample, not only were cortisol levels at their highest during the initial week following cessation of drinking, but the cortisol levels gradually decreased over the following three week period. Given that past investigators (Mendelson, Ogata, & Mello, 1971; Stokes, 1973) have observed an increase in corticosteriods in alcoholics during chronic drinking, the overall effect of chronic alcohol consumption and/or the mechanism underlying the elevated cortisol levels cannot be accurately delineated in this study. Despite this fact, the decrease in cortisol over time was more abrupt for those incarcerated for violent acts as compared to the nonviolent individuals. This finding suggests that aggressive individuals may possess a vulnerable HPA system that is more susceptible to dysregulation by mediating social/environmental factors such as alcohol or drug use.

Two studies assessed resting salivary cortisol levels in conduct disordered boys with or without co-morbid anxiety and in normal controls. Higher cortisol levels were reported in those with co-morbid symptoms as compared to either those individuals with pure conduct disorder or normal controls (McBurnett et al., 1991; Walker, et al., 1991). In both studies, the purely conducted-disordered groups had more incidents of school suspensions and police arrests, and were more likely to experience peer rejection than those with co-morbid anxiety or age-matched controls. In addition, the purely conduct disordered subjects with lower cortisol concentrations exhibited aggression at younger ages than those with higher cortisol levels. However, the heightened cortisol levels in the co-morbid sample may be explained on the basis of prior work which has shown increased salivary cortisol in inhibited/anxious children (Kagan, Reznick, & Snidman, 1988) as well as in adults with anxiety (Avery, et al., 1985; Copolov, et al., 1985) and mood disorders (Harris, et al., 1988; Saleem, 1984).

Despite the inconsistent findings linking aggression and cortisol secretion, the majority of investigators agree that a dysregulation of the HPA likely contributes to certain individuals being more "at risk" than others for antisocial and aggressive behavior problems in emotionally arousing situations.

Cortisol and Challenge Paradigms

Given the premise that some type of HPA dysregulation predisposes certain individuals to be differentially susceptible to emotionally arousing situations, a more able means than baseline arousal measurements to address this issue may be to assess changes in HPA function/output by challenging the system via psychological/emotional stressors.

Challenge paradigms typically involve exposing subjects to various types of psychosocial events, particularly those that are novel, stressful, cognitively demanding, or anxiety provoking, and then measuring associated physiological changes. These types of studies have the advantage of assessing physiological responsivity to a stressor as compared to those findings obtained via baseline or through pharmacologically induced reactivity (Granger, Weisz, McCracken, Ikeda, & Douglas, 1996). However, one often-cited disadvantage with these types of investigations is the inherent difficulty of quantifying and/or controlling for the degree of stress that a particular event may invoke in various individuals. As a result, the inter-subject reliability has been questioned when using such paradigms.

Notwithstanding these concerns, the HPA is sensitive to psychological stressors as measured by salivary, plasma, and urinary cortisol concentrations, as well as plasma catecholamine levels. Early studies have indicated that cortisol measurements obtained before and after a stressor reflect a systematic rise in cortisol in response to stressful or anxiety provoking situations in both animals (Hucklebridge & Nowell, 1974; Natelson, Trapp, Adamus, Mitler, & Levine, 1981) and in humans (Mason, 1968). Recent investigations have consistently reported moderate associations between HPA axis activation, as measured by elevated cortisol levels, and behavioral reactivity to physical, social and cognitive challenges in adults (Kirschbaum & Hellhammer, 1989) as well as children (Kagan, et al., 1987; Tennes & Kreye, 1985; Tennes, et al., 1986). These neurochemical indicators of HPA function/output have been shown to increase in a highly differentiated fashion that typically reflects the intensity of the stressful stimuli (Clow, et al., 1997; Kirchbaum, Pike, & Hellhammer, 1993). Thus, cortisol appears to represent an accurate physiological indication of emotional and/or psychosocial arousal.

The majority of the cortisol challenge studies conducted in adults and children have focused primarily on physiological responsivity to anxiety. However, only one study has examined HPA reactivity to an environmental stressor in an aggressive population. Moss, Vanyukov, & Martin (1995) found that sons of substance-abusing fathers were rated significantly more aggressive/delinquent relative to the sons of normal controls. They also found a lessened cortisol response to a mild “stressor” (i.e., counting high-pitched tones presented at variable rates with low-pitched tones). This lower response was associated with increased parent and teacher reports of aggression (CBCL). Overall impulsivity, as measured by the number of commission errors on a standard continuous performance test (CPT), was also elevated in those subjects with a blunted cortisol response. This study suggests an inverse correlation between lower HPA reactivity and impulsive aggressive behavior.

Electrophysiology and Aggression

EEG. Evidence over the past 50 years has indicated a strong relationship between electroencephalographic (EEG) abnormalities and aggressive behavior in adults (Fishbein, Herning, Pickworth, & Haertzen, 1989; Grober, Hartmann, & Coffman,1982; Mark & Ervin,1970). In addition, numerous studies have reported markedly high percentages of abnormal EEGs in children and adolescents with behavior disorders, and in particular in children with aggressive disorders, irritability and hyperactivity (Gunn & Bonn, 1971; Gunn & Fenton, 1971; Hendricks, Fitzpatrick, & Hartman, 1988; Lewis, 1990; Lewis et al., 1988; Lewis, Lewis, Unger, & Goldman, 1984; Lewis, Lovely, Yeager, & Della Femina, 1989; Lewis, Pincus, Feldman, Jackson, & Bard 1986; Lewis, Pincus, Shanok, & Glaser, 1982; Raine, 1996; Satterfield & Schell, 1984; Surwillo, 1980). A retrospective association between abnormal EEG and aggression has also been shown in juveniles incarcerated for murder (Lewis et al., 1982). Similar findings have been reported in aggressive children who later went on to commit murder (Lewis, et al., 1986).

A retrospective study examined the EEGs of 372 adult male patients from a maximum-security psychiatric hospital in relation to pre-admission violence ratings. Findings indicated a ten times higher rate of EEG abnormalities, localized primarily in the temporal lobe regions (specifics not reported), in the most violent group as compared to the least violent group (Wong, Lumsden, Fenton, & Fenwick 1994). Another study assessing resting EEG measures in overtly aggressive adult drug users found decreased localized alpha and greater delta activity in the fronto-central region. These EEG measures were positively correlated with self-reported history of aggressive behaviors (Fishbein, et al., 1989). One important methodological concern is that the investigators in these studies were not blind in regards to the patient profiles before reviewing the EEG data. As a result the overall interpretations may have been unknowingly biased.

Results of two separate prospective studies of non-referred children provide additional evidence that children who eventually become delinquent tend to exhibit cortical underarousal (Mednick, Volavka, Gabrielli, & Itil, 1981; Petersen, Matousek, Mednick, Volavka, & Pollack, 1982). The investigations compared childhood EEG recordings in subjects who became delinquent and those who did not. Specifically, Mednick, et al. (1981) conducted a six-year follow up of 129 males who were initially tested between the ages of 10-13 years old. Findings indicated that multiple criminal offenders at follow up (ages 16-19) had previously exhibited slower alpha wave activity than either the would-be one-time offenders or non-criminals. Similar findings were reported in a sample of 571 adults who had committed a crime and who had had EEG screening at some time during their childhood. Results from retrospective EEG exams found that those with criminal records had had more alpha activity and thus decreased cortical arousal as children than had non-criminals. Moreover, multiple offenders again showed the most pronounced alpha slowing of all the groups investigated (Petersen et al., 1982). These findings are consistent with results found in normal adolescents who later went on to have criminal records in young adulthood (Raine, Venables, & Williams, 1990).

Recent evidence from quantitative EEG analyses also lends support to the theory of cortical underarousal in aggressive children/adolescents. A quantitative EEG study (Graae et al., 1996) comparing resting state alpha coherence in 16 adolescent females with a history of suicide attempts with age matched controls indicated greater alpha asymmetry over the left hemisphere as compared to the right hemisphere in the suicidal group. The reverse was seen in the controls. A trend for relatively greater alpha power, and thus less activation, over the left posterior sites was also related to the lethality of the suicide attempts.

Although most of the available research has indicated that EEG abnormalities in violent individuals is characterized by a high amount of slow wave activity, other investigations in adults (Langevin, et al., 1987; Langevin, Paitich, Orchard, Handy, & Russon, 1982; Phillips, Drake, Hietter, Andrews & Bogner, 1993) and children (Hsu, Wisner, Richey, & Goldstein, 1985; Satterfield & Schell, 1984) have not supported these findings. However, negative findings may be due in part to factors such as sampling biases (e.g., the more violent criminals often are not approached or do not agree to participate in these studies), small sample size, and different methodologies used to qualify and quantify violent acts and their level of pervasiveness. The matter of medication and psychiatric history was also not adequately addressed in one of the investigations (Hsu et al., 1985). This is of relevance in that medications, particularly those used to treat mental illness, have been shown to have powerful effects on EEG depending on the type and the dosage (Volavka, 1990).

The majority of the literature supports the connection between EEG abnormality and violence/aggression. However many of the earlier studies used recordings which were manually scored via visual examination and thus less accurate than more objective computerized quantitative analyses. Nonetheless, despite the fact that some results obtained via manual scoring indicated that as many as 10 to 15 percent of the general adult population had abnormal EEG's, approximately 48 to 70 percent in aggressive psychopaths and 25 to 50 percent of violent criminals, especially those with a high rate of recidivism demonstrated some type of EEG abnormality (Mednick, Pollack, Volavka, & Gabrielli, 1982; Scarpa & Raine,1997; Surwillo, 1980). Additionally, in many of the studies reviewed, the foci and/or nature of the abnormalities were either quite diffuse or not explicitly stated. The often unclear pathology in conjunction with the methodological concerns mentioned have led to inconsistent findings.

Regardless of outcome, many studies using older children and adults have failed to control for mediating factors such as age, the effects of institutionalization, or drug use. In addition many investigations had no a priori hypotheses. As a result, the effects of these variables on EEG cannot be dissociated (Mc Burnett & Lahey, 1994; Volavka, 1990). While many of the confounding variables previously mentioned are more readily controlled in younger children than in adults, the plasticity of developing brains may make EEG results somewhat unstable in this population. As a result, the interpretation of the relationships between EEG and aggression in children of varying age ranges must be viewed with caution (Milstein, 1988). Finally, many studies did not investigate the EEG characteristics under the varying experimental conditions in which aggression and/or emotional factors were manipulated. Therefore the effects of varied emotional conditions on changes in behavioral and/or physiological responsivity is not known. Notwithstanding, the overall association between aggression and EEG abnormalities remains quite strong across varying methodologies when other possible co-factors such as history of major head trauma, mental retardation, and epilepsy are controlled.

Heart Rate

Heart rate has commonly been used to assess autonomic arousal and reactivity to both neutral and aversive events due to the fact that it accurately reflects both sympathetic and parasympathetic nervous system activity (Scarpa & Raine, 1997).

While some studies have failed to show a relationship between increased aggression and lower resting heart rate in children (Delamater & Lahey, 1983; Dwivedi, Beumont, & Brandon, 1984; Garralda, Connell, & Taylor, 1991; McBurnett & Lahey, 1994), an extensive review (Raine, 1996) of over 14 studies of predominately non-institutionalized, conduct disordered children and adolescents, has provided some of the strongest support for underarousal in aggressive children as indicated by lower heart rate. Overall, lower resting heart rates could accurately identify those individuals with either antisocial or aggressive tendencies. In fact, effect sizes of the studies reviewed averaged 0.84 (Raine, 1996), which is considered large according to Cohen's (1988)-categorization system. Similar findings have also been reported for institutionalized aggressive children and adolescents (Rogeness, Cepeda, Macedo, Fischer, & Harris, 1989). Given the fact that all of the studies reviewed produced fundamentally the same results despite the wide array of experimental measures, definitions of antisocial behavior, and variety of experimental settings, attests to the strength of these findings.

Longitudinal data have indicated that lower resting heart rate is a relatively stable measure which may be used as a predictor of current and later aggression (Kindlon et al., 1995;

Kruesi et al., 1992; Mezzacappa et al., 1996; Raine et al., 1990). Results from one of the largest follow-up studies, sampling more than 1,800 11-year old British boys, indicated that lower than normal resting heart rate measured at 11-years old significantly predicted delinquency at age 21 years. In fact, the differences were even more pronounced when the delinquent group was further subdivided to include only those who committed the most aggressive acts (Wadsworth, 1976).

Another line of thinking similar to that posited in the cortisol and EEG literature suggests that autonomic responsivity to a stressor may be more accurate measure of an underlying trait (Kindlon, et al., 1995). One such investigation (Hare and Craigen, 1974) involved measuring acceleratory heart rate responses to aversive stimuli in antisocial adults in which the subject's actions had clear-cut outcomes for both themselves and another unknown individual. The paradigm involved placing subjects at small tables on opposite sides of a screen. On the table was a panel consisting of two lights labeled "ready" and "select", and five buttons indicating the ratio of the intensity of shock given to themselves and to the other subject (e.g., 6:1). Each trial began with the "ready" light followed by "select", at which time subject A was to press the button indicating how much shock he himself would receive and how much was to be delivered to the other subject. Unbeknownst to the subjects, the shocks delivered to subject B were controlled by the experimenter in a pre-determined sequence. Significantly larger bi-phasic conditioned heart rate response – acceleration followed by deceleration, in anticipation of the shock were reported in aggressive adult psychopaths as compared to normal controls. Specifically, the psychopathic group exhibited larger accelerative responses on the first trial relative to controls. The groups did not differ on the subsequent trials. These findings suggest that while controls typically required a significant amount of actual experience with the stimuli and "rules" involved in the experiment before conditioned heart rate changes appeared, the psychopathic group was significantly primed by only the pre-experimental instructions.

Conversely, overall smaller electrodermal responses were reported in the psychopaths as compared to controls suggesting that aggressive individuals may experience little fear arousal prior to receiving or delivering aversive stimuli. These findings, along with the hyper-reactive anticipatory heart rate, reflect an adaptation that may serve to decrease the emotional impact of the situation. In other words, psychopaths may not be as readily influenced by threats of punishment or knowledge that their behaviors may have unpleasant consequences for themselves or others (Hare, 1982; Hare and Craigen, 1974). Similar results have been reported in studies in which loud tones were substituted for electrical shocks (Hare 1982; Hare, Frazelle, & Cox, 1978).

These earlier paradigms have frequently been criticized for their harshness as many past subjects typically described the stimuli as being either extremely painful or excessively loud. As a result, only one study (Davies & Maliphant, 1971) has attempted such a paradigm in aggressive adolescents. While results were similar to those seen in aggressive adults, this study did not adequately cue the onset of the stimuli, nor did every subject actually receive a shock. Therefore, no true inferences can be made about aggressive adolescents from studies. Given the obvious ethical concerns with these early studies, more recently conducted investigations have focused primarily on changes in aggressive children's heart rate via less invasive means such as orientation response paradigms.

Orientation response paradigms often use discrimination-reaction time tasks in which subjects are presented with a variety of auditory tones. It is the subject's job to press a device, typically a computer key, as quickly as possible whenever they hear a selected frequency (e.g., low or high tone). While smaller orienting responses in aggressive children/adolescents have been shown to significantly predict later criminal convictions or institutionalization (Raine et al., 1990), no group differences have been found in orientation/habituation paradigms between conduct and non-conduct disordered children/adolescents (Borkevec, 1970; Delmater & Lahey 1983; Dwivedi et al., 1984). Results from other studies using cognitive challenges (Garralda, et al., 1990, 1991; Maliphant, Hume, & Furnham, 1990; Rogeness, et al., 1989) and psychological stressors (Kagan et al., 1988, Matthews, Woodall, & Stoney, 1990) have also proven inconclusive.

Possible reasons for the observed discrepancies in the literature include such factors as varying methodology (i.e., type and intensity of stressor), developmental differences in cardiac responsivity as a function of age (Dwivedi et al., 1984), or quantitative differences in the operational definition of aggression pertaining to adults versus children (Maliphant, et al., 1990; Rogeness, et al., 1989).

Notwithstanding, two investigations of clinically referred emotionally or conduct disordered children (Garralda et al. 1990, 1991) have shown that changes in heart rate to mental activity tasks discriminates children with different types of psychiatric disorders. While no significant group differences were found in terms of overall heart rate reactivity, conduct disordered subjects were slightly more responsive to tasks with a positive emotional component as compared to normal controls and those with emotional disorders. These results are consistent with the hypothesis that these children may be unusually sensitive to reward (Douglas 1983;Garralda, et al., 1990). Those with conduct disorder also had more generalized deficits in the modulation of arousal responses as shown by reduced peripheral physiological reactivity, as measured by decreased skin conductance and heart rate changes, to intense stimuli (e.g., rock music). Conversely, the emotionally disturbed group showed greater heart rate acceleration to the aversive imagination task than either the conduct disordered or normal groups. Overall, these findings suggest the exceptionally high physiological responsivity seen with positive events and insufficient response to aversive ones may be one of the mechanisms involved in the psychopathology of childhood antisocial behavior. This dysregulation of autonomic arousal might also underlie the excessive activity, impulsivity, and sensation seeking often found in children and adults with antisocial symptoms (Cloninger, 1988; Garralda et al., 1991; Gorenstein & Newman, 1980; Zuckerman & Como, 1983).

Psychophysiological Responsivity and Films

Several adult cortisol studies (Brown & Heninger, 1975; Clow, et al., 1997; Hubert & de Jong-Meyer, 1992; Hubert, Mooler, & de Jong-Meyer, 1993) have demonstrated that the presentation of anxiety-provoking film clips is a useful measure for investigating changes in physiological responsivity. However, considerably less attention has been given to the affect of viewing such clips on physiological mechanisms in children.

Kirschbaum & Hellhammer (1989) compared the cortisol response to stressful and non-stressful films in anxious and non-anxious children. A significant difference between the two groups was reported. Highly anxious children demonstrated a similar increase in cortisol secretion to both film presentations irrespective of the emotional content. Conversely, normal controls showed no differential responsivity (i.e., increase or decrease in cortisol secretion) to either of the films. A similar study investigated changes in urinary cortisol levels to an exciting and partly violent movie in 12 year old boys who were grouped by their overall rating on the Sennton Neurotic Scale (Arnetz, Edgren, Levi, & Otto, 1985). This measure is a self-rating scale that contains 81 yes/no questions related to anxiety, somatic complaints and aggression. While no significant group differences were seen in urinary cortisol levels during the control and film periods, those scoring high on the scale showed an overall tendency to increased cortisol secretion during both conditions. Thus, it appears that changes in physiological responsivity are affected by the personality of the individual more than the nature of the stimulus. However, given the fact that the groups likely consisted of a heterogeneous population with varying pathology, the true nature of these finding cannot be adequately determined.

Numerous investigations have focused on the relationships between hemispheric EEG asymmetries and emotion in neurologically impaired, psychiatric and normal populations (Davidson, 1992; Davidson, Ekman, Saron, Senulis, & Friesen, 1990; Davidson & Tomarken, 1989; Gainotti, 1989; Silberman & Weingartner, 1986; Sutton & Davidson, 2000). Evidence from these studies indicated a greater involvement of the left anterior frontal hemisphere in the reporting of positive emotions (e.g., interest, happiness, and amusement), and a greater involvement of analogous right hemisphere region for certain negative emotions (e.g., anger, sadness, fear, and disgust). Individual differences in anterior temporal asymmetry have also been shown to be related to emotionally arousing film reactivity in the same direction as the frontal measures (Davidson et al., 1990; Wheeler, Davidson, & Tomarken, 1993 Wheeler, et al., 1993). According to Wheeler, et al., (1993) while the actual mechanisms are not known:

> "Individual differences in frontal asymmetry may be related to threshold differences for triggering an affective reactivity. A threshold mechanism would cause a subject with extreme right frontal activation to show a negative affective response to a very low intensity negative affect elicitor. Other mechanisms are also plausible... frontal asymmetry may primarily index the recovery function of an affective reaction. According to this mechanism, differences among subjects in the intensity of their affective reaction...would be primarily a function of the rapidity with which the emotional response was terminated, once triggered" (p. 88).

Reviews of the adult EEG literature focusing on affective responses to emotionally arousing films have supported the premise that resting frontal asymmetry appears to operate as a state-dependent marker of readiness to respond affectively (Tomarken, Davidson, & Henriques; 1990; Wheeler et al., 1993). Individual differences in affective reactivity are central components of both temperament and personality. One investigation (Wheeler et al., 1993) found that subjects with greater right sided resting frontal activation reported more intense negative affect following the presentation of negative film clips. Interestingly, a reverse profile (i.e., greater positive affect to the positive films) was seen for those subjects who showed greater left-sided frontal activiation.

These findings are comparable to those from a similar study of 43 right-handed females conducted by Tomarken, et al., (1990) that indicated an asymmetrical increase in relative right frontal alpha activity which was directly associated with heightened reports of negative affective responses to the negative films. Additionally, affect reactivity was assessed via an eight-point rating scale measuring both positive and negative reactions. Only resting asymmetry from frontal regions significantly predicted global affect ratings and affective valence independent of mood at baseline. Resting asymmetry from all other posterior regions failed to predict affective reactivity. The significant effects on global negative affect suggests that relative resting right frontal activation may be linked to lowered threshold for negative affective reactions to aversive stimuli. These findings are in contrast to others which suggested phasically aroused emotional asymmetry in the anterior temporal regions (T3/T4) related to film reactivity in the same directions as frontal measures (Davidson, et al., 1990). Specifically, there was greater involvement of the left temporal regions in certain reported positive emotions whereas homologous right temporal regions showed greater involvement with certain negative emotions.

Despite the relative consistency between affective responses and EEG asymmetry, some methodological issues must be addressed. Many of the earlier investigations measured only resting EEG as opposed to continuous activity during the film presentations when comparing groups. Furthermore, the studies that did assess phasic changes in response to emotionally arousing film clips often used stimuli that were exceedingly short in duration which likely limited the amount of artifact-free recordings. Finally, there have been no video-related EEG studies in children and/or adolescents. As a result, the generalizability of these effects to longer presentations and on varying populations is unclear and warrants further research to address these issues.

The few investigations of physiological responsivity, as measured by change in heart rate, to violent versus prosocial video clips in young adults (Langley, O'Neal, Edgar, Craig, & Yost, 1992) and children (Groer & Howell, 1990) have shown a significant increase in heart rate during exposure to the violent but not prosocial scenes. Results from a study investigating differential cardiovascular responsivity to viewing a prosocial program versus an age-appropriate violent cartoon in a group of 18 preschool children indicated a significant increase in heart rate with exposure to the violent program. Conversely, no changes were noted when viewing the prosocial program (Groer & Howell, 1990). Interestingly, children with a history of high exposure to television violence have been found to be significantly less autonomically aroused (i.e., lower heart rate) when shown a violent film than those with limited exposure, suggesting a measurable and possibly generalizable desensitization to film violence (Cline, Croft, & Courrier, 1973).

Many studies have investigated the relationship between aggression/violence and underarousal in a single physiological response system. However, few studies have investigated the possible relationship between aggression/violence in regards to multiple systems of arousal (Lewis, et al., 1989; Volavka, 1990). Additionally, among those studies that have assessed multiple factors, very little effort has been made to measure the interactions between EEG variables and other potential predictors of violence. Given the fact that these physiological systems generally do not correlate with one another in the general population, it would be advantageous to assess more than one psychophysiological system in aggressive individuals to evaluate possible differing profiles (Scarpa & Raine, 1997).

One of the first studies to provide clear evidence of under-arousal in more than one physiological response system in the development of criminal behavior was a prospective follow-up study assessing the relationship between central and autonomic measures of arousal (Raine, et al., 1990). Subjects were taken from a representative cross section of children based on academic and social background. Measures of psychophysiological systems at 15 years old were related to criminal status assessed at age 24. Significantly lower resting heart rate and lower levels of EEG arousal across all measures were seen in the adolescents who became criminals as compared to those who did not. Moreover, group differences tended to be the greatest for slow wave or low-frequency EEG bands with highly significant differences being seen in theta frequency ($P<.001$). Interestingly, discriminant function analysis indicated that 74.7% of the criminals could be correctly identified on the basis of arousal variables during adolescence (Raine, et al., 1990). Reanalysis of this sample by the same authors at a later date found that those considered "violent" (e.g., assault) had the lowest heart rate as compared to either the nonviolent offenders or normal controls. Moreover, while an association was seen between neighborhood crime rate, poor academic ability and later criminality, the correlation between these social factors and physiological variables did not account for the observed differences. However this study, although using non-criminal controls, did not include highly antisocial children/adolescents held in special schools, hospitals and detention centers.

Thus, despite the diverse theories as to the causes and/or implications of this differential physiological responsivity and aggression, most researchers acknowledge that violent aggression has numerous causative mechanisms that interact with one another. Most also agree that the physiological dysregulation seen in many aggressive individuals is likely associated with altered thresholds for behavioral reactions to environmental stimuli which results in an inappropriate or excessive arousal to real and/or imagined stressors. Some methodological and definitional concerns must be taken into account when reviewing these data. The term "arousal" typically refers to the psychophysiological activity that occurs during the resting state whereas "responsivity" is often used to describe activity or change in activity in relation to a stimulus. Thus, while many of the studies reporting over-arousal evaluated resting or baseline measures in their methodologies, most results were reported in relation to some type of stimulus or situation and thus more accurately reflect increased "responsivity" (Scarpa & Raine, 1997).

Human Models of Aggressive Behavior

Clear patterns regarding the relationship of aggression with some type of physiological dysregulation are present in the literature. However, many inconsistencies exist. Such inconsistencies should not be surprising in view of the fact that most investigators consider "aggression" to be a highly heterogeneous and multi-determined behavior. At least two different models of aggressive profiles have been postulated, each presumably having distinct neural underpinnings and behavioral presentations (Albert, Walsh, & Jonik, 1993; Mungas, 1983; Vitiello & Stoff, 1997). The first model is typically known as the "overactivation model". This model posits individuals who appear to feel unnecessarily threatened and thus consistently overreact to limited provocation characterize the first group. These individuals often react to such situations in an extremely emotional and impulsive fashion. The aggressive behaviors seen in this group are typically seen as being affectively driven or reactive in nature (Valzelli, 1981). As such, one would expect that these individuals would exhibit greater physiological arousal as measured by increases in cortisol secretion, heart rate, and EEG activity. Conversely, the second model, known as the "underactivation model", is typified by proactive aggression that is more planned, instrumental, or predatory in nature. These individuals tend to actively plan-out or engage in violent acts as a means of achieving some goal or need. Unlike the first group who typically later feel remorse and/or exhibit some insight into the negative consequences of their actions, this group does not appear to exhibit an appropriate emotional response when committing violent acts. As a result, these individuals would be expected to show blunted physiological arousal as compared to normals. Most of the recent aggression research has focused on investigating this latter group (Fowles, 1980; Gray, Owens, Davis, & Tsaltas, 1983; Simons, 1996; Raine, 1996, 1993; Raine, et al., 1990; Venables 1987).

Evidence of physiological under-arousal, as indicated by decreased cortisol levels, reduced heart rate and skin conductance, and increased slow-wave EEG, is one of the best-replicated findings in antisocial populations (Raine 1993). Moreover, autonomic under-arousal is frequently exhibited in infants and young children with a disinhibited temperament (Kagan, 1989; Kagan, et al., 1987,1988) and thus is thought by some to be a trait marker and possible indicator for later social difficulties.

One hypothesis (Simon, 1996) posits that that the low arousal seen in many aggressive/antisocial individuals may in fact represent an aversive physiological state which results in the active seeking out of stimulation to restore arousal levels back to optimal/normal levels. Raine and collegues (Raine, 1996, 1993; Raine, et al., 1990) have supported this hypothesis. Results of the Raine studies indicated a significantly lower overall emotional response, as measured by changes in skin conductance in aggressive individuals as compared to normal controls while being presented with emotionally laden images (e.g., car accident) and/or unpleasant auditory stimuli (e.g., loud tones). These findings suggest that while aggressive individuals may act-out quickly and severely, they are actually slower to emotionally respond than the general population.

Another hypothesis, first proposed by Gray in the late 1970's, suggests the presence of a norepinephrine (NE) driven circuit known as the "Behavioral Inhibition System". The primary role of this system is believed to be the suppression of negative behaviors following an unpleasant event (Fowles, 1980; Gray 1977; Gray, et al., 1983; Quay, 1988). According to this hypothesis, excessive amounts of circulating NE result in the desensitization and down-regulation of the NE receptors. This functional hypo-sensitivity, as defined by decreased sensitivity to NE, may render the individual less sensitive to signals of punishment and/or retaliation, less likely to experience anxiety, and therefore less likely to inhibit socially inappropriate behaviors (e.g., fighting and assaults). Support for this theory comes from findings that decreased noradrenergic functioning has been associated with increased aggression in both adults and children (Rogeness, et al., 1989; Rogeness, Javors, Maas, & Macedo, 1990).

Rational For Present Study

Many studies over the past 40 years have shown a moderate yet consistent association between media violence and increased aggression in children, adolescents, and adults even after such confounding variables as early aggression, total amount of television, socio-economic status, level of education and race are controlled. Nonetheless, while the relationship between early television violence viewing and later aggression has held up across numerous replications, the causal interpretation of these findings has been the subject of many debates. For example, path analyses of the more extensive longitudinal investigations suggest a bi-directional causal effect in which violence viewing engenders aggression, and aggression engenders violence viewing. Thus, it appears that aggressive children may actively select aggressive programs, which serves to maintain and increase initial aggressive tendencies (Huesmann, 1986; Huesmann

& Miller, 1994). However, this model may be too simplistic given that other psychological and social factors such as predisposition for violence, violent family environments, identification with characters committing the acts, and final outcomes or resulting consequences all play an important role in the final outcomes. Nonetheless, even small effect sizes (i.e., minimal increases in aggression/violence attributed solely to the media) are significant when results are viewed on a more global scale. Small effect sizes can and often do, translate into serious consequences when the resulting outcomes are homicides and other violent crimes (Anderson, 1997; Heath et al., 1989; Rosenthal, 1986).

While most agree that the relationship between aggression and media violence occurs, the essential precursors and intervening variables, as well as the processes through which they affect aggression, are not clearly delineated. The body of reported evidence available has shown that these types of media themes do not affect all people equally. In fact, while some debate continues as to the global effects of media violence, most research has indicated that young males constitute a particularly vulnerable subgroup. Therefore, to more accurately assess the impact of portrayed violence, researchers must begin to focus their efforts on the possible identification and/or characterization of a small group of vulnerable viewers and the relevant mechanisms.

The present study was designed to determine whether aggressive boys have a unique and differential physiological response to violent films as compared to their non-aggressive peers.

The goals of this study were to 1) evaluate the under- and over-arousal hypotheses of aggressive behavior by determining whether aggressive children have a differentially greater or lesser physiological response to film stimuli as compared to controls; 2) determine whether violent and non-violent films have differential physiological effects on children; and 3) determine whether a subgroups of children characterized by aggressive behavior as more susceptible or vulnerable to the stimulating affects of violent films.

If, as posited by the under-arousal hypothesis, aggressive children are under-responsive to environmental stimulation, then these "at risk" children should show a diminished physiological response to violent films as compared to their non-aggressive peers. In contrast, if aggressive children are "over-aroused," one would expect that they would exhibit an increased physiological response to aggressive films.

CHAPTER III

METHODS

Subjects

Subjects were recruited from the Child Psychiatry and Pediatric Outpatient Clinics of Mount Sinai Medical Center in New York. The participants included 30 boys between the ages of nine and 11 years old who were divided into "aggressive" and "non-aggressive" groups based on parent and teacher ratings of aggression. The groups were matched for age, IQ, and socioeconomic status (SES). Only children who were attending school, spoke and read English, had Full Scale IQs above 70, and were not receiving medication treatment were eligible for this study. Given the demographics and location of the center, the sample consisted primarily of African-American and Hispanic boys of lower to middle socioeconomic status.

Subject Recruitment

All male referrals to the Outpatient Clinic of the Division of Child and Adolescent Psychiatry of the Mount Sinai Medical Center who were between the ages of nine and 11 years-old were screened to determine their appropriateness for inclusion in the aggressive group. The Director of the Outpatient Clinic initially screened all potential candidates by chart review. Clinic evaluators and therapists were also made aware of the study and understood the inclusion/exclusion criteria. Patients that appeared to meet criteria for the study were identified, and either the Director of the Outpatient Clinic, evaluator, or therapist contacted the parent(s)/guardian(s) of the patients to determine whether they would be interested in participating in the study. The Director of the Child and Adolescent Psychiatry Clinic then gave a detailed explanation of the research protocol included in the consent form. If participants were still interested an informing interview and first session was scheduled.

Participants recruited from the Pediatric Clinic to serve in the non-aggressive control group were initially selected based on meeting the age requirements of this study. All non-aggressive participants followed the same recruitment procedure used for the aggressive group.

Upon arrival to the clinic, a copy of the consent form was given to parent(s)/guardian(s) to read and review with other family members and the identified child. The risks and benefits and the alternatives to participation were discussed with the participants. The Director of the Child and Adolescent Psychiatry Clinic then spoke to the child explaining the study and the tests and procedures that he would undergo. The child was then free to ask questions and indicate any concerns he had about participating in the study. Prior to signing consent, parent(s)/guardian(s), and children were asked to explain key points of the study to the coordinator and/or the investigator to ensure their understanding. Subjects were also informed that they were allowed to withdraw consent at any point during the study. If parent(s)/guardian(s) and the child agreed to participate after both the informing interview and reading the consent form, the consent form was signed by the parent(s)/guardian(s) and Session 1 commenced. A certification of assent was also completed for all children, regardless of age, in a separate location by an administrative member of the Department of Psychiatry, not associated with the study. Research material was not identified by subject's name and code numbers identified all subject data. The majority of subjects recruited from the outpatient clinic had completed the parent and teacher questionnaires prior to recruitment. Subjects recruited from the Pediatric Clinic as well as those who had not already completed one or both of these forms were asked to do so at the beginning the study.

Measures

Clinical assessment instruments

1) Wechsler Intelligence Scale for Children – Third Edition (Wechsler, 1991).
2) Wechsler Individual Achievement Test (Wechsler, 1992).
3) Child Behavior Checklist [CBCL] (Achenbach, 1991).
4) IOWA Conners Teacher Questionnaire [IOWA] (Pelham, Milich, Murphy, & Murphy, 1989, 1991; Loney, Milich, and Landau, 1982).
5) Continuous Performance Test [CPT] (Halperin, Sharma, Greenblatt, & Schwartz, 1991).
6) Television Preference Interview (design adapted from Harris, 1992).
7) Child Self-Report Questionnaire (design adapted from Arnetz et al., 1985)
8) Assessment of Gross Motor Activity [Actigraph] (Gaewiller, 1993).

1. Wechsler Intelligence Scale for Children - 3rd Edition (WISC-III). The WISC-III was used to assess overall cognitive abilities. It was standardized on 2,200 children, 100 boys and 100 girls in each of 11 age groups from six to 16 years. It contains 13 subtests, six in the Verbal Scale and seven in the Performance Scale. It yields separate Verbal, Performance and Full-Scale IQ scores using the deviation IQ (M = 100, SD = 15) along with scaled scores (M = 10, SD = 3) for the 13 independent subtest scores (Wechsler, 1991). Reliability for this measure is quite high. Average internal consistency reliability coefficients (r) across all 11 age groups are 0.96 for Full Scale IQ, 0.95 for the Verbal Scale IQ and 0.91 for the Performance Scale

IQ (Wechsler, 1991). Test – retest reliability (r) as assessed for three age groups (6-7, 10-11, 14-15 years) with a median time interval of 23 days were as follows: 0.92, 0.95, and 0.94 for Full Scale IQ; 0.90, 0.94, and 0.94 for the Verbal Scale IQ; and 0.86, 0.88, and 0.87 for the Performance Scale IQ, respectively (Sattler, 1992;Wechsler, 1991). A child was accepted into the study only if he received a Full Scale IQ of 70 or higher, which placed him above the Mildly Mentally Retarded range.

2. Wechsler Individual Achievement Test-Screener (WIAT). The WIAT is a comprehensive individually administered battery for assessing overall academic achievement. Three of the WIAT subtests - Basic Reading, Spelling, and Mathematical Reasoning were used as a brief screening instrument (Wechsler, 1992). The WIAT was nationally standardized on 4,252 children aged five years, 0 months to 19 years, 11 months. Importantly, the WIAT is co-normed with the WISC-III. Thus, both the WIAT and the WISC-III yield scores standardized such that their mean is 100 and the standard deviation is 15. Test – retest reliability for 367 children from five grades (one, three, five, eight, and ten) across two time intervals ranging from 12 to 52 days had stability coefficients (r) as follows: 0.97 for the total composite and a range from 0.81 to 0.92 for individual subtests. Co-normed data from ability and achievement have been shown to be important in the accurate assessment and diagnosis of learning disabilities (Reynolds, 1990; Berk, 1984). The WIAT-Screener (Wechsler, 1992) was used primarily to provide parents with a more complete evaluation of the child. It was not related to the key questions of this study.

3. Child Behavior Checklist- parent version (CBCL/4-18).

The CBCL/4-18 (Achenbach, 1991) is a 113 item list on which the parent or parent-surrogate is asked to rate a child across a broad range of behavioral dimensions. For each item, a three-point scale is used to rate the behavior of the child within the last six months. Twenty competency items are also obtained for the amount and quality of the child's participation in sports, hobbies, games, activities, jobs and chores, and friendships. Additionally, parents are asked to rate how well the child gets along with others, plays and works alone, and functions in school. The CBCL/4-18 generates separate standardized T-scores (T score mean = 50 SD = 10) for children ages four to five, six to 11 and 12 to 18 by gender. Within each age group, there are eight separate scales, developed on the basis of factor analysis: withdrawn, somatic complaints, anxious/depressed, social problems, thought problems, attention problems, delinquent behavior, and aggressive behavior. Validity, internal consistency, and mean test-retest reliability of this measure have been extensively documented (Achenbach, 1991). Specifically, the mean test-retest reliability for all problem scales is r = 0.89 and r = 0.87 for all competence scales. CBCL total problem score have also shown to be significantly correlated with other well-normed behavioral measures such as the Conners *Parent Questionnaire* (r = 0.82) and the Quay-Peterson *Revised Behavior Problems Checklist* (r = 0.81) (Achenbach, 1991). The Aggressive scale of the CBCL (Achenbach, 1991) was used for group classification such that aggressive group consisted of those children who were rated at least one and a half standard deviations above the mean. The non-aggressive group was rated at less than one standard deviation above the mean on both parent and teacher rating scales of aggression relative to normative data.

4. IOWA Conners Teacher Questionnaire (IOWA). The IOWA is a teacher rating scale consisting of two five-item subscales designed to assess Aggression (A) and Inattention/Overactivity (I/O) (Loney et al., 1982). Items for the scale were chosen from the Conners Teacher Rating Questionnaire (CTQ) (Conners, 1969) and correlated significantly with either the empirically derived Hyperactivity or Aggression factors (Pelham, et al., 1989). Thus, unlike the CTQ, which selects children with both hyperactive and aggressive disorders, the IOWA allows for a somewhat better distinction between these two closely related and highly overlapping behavioral deviations. Original norms obtained from Loney et al. (1982), were limited by sample size (n = 120), a relatively homogenous population in Iowa, and the fact that data on boys was included. Pelham et al., (1989, 1991) obtained IOWA ratings on 608 boys and girls from kindergarten to fifth grade in an ethnically and socioeconomically diverse area in Florida. The correlation between the I/O and A scales was r = 0.62. This number is significantly lower than the correlation between the full CTQ factors of Hyperactivity and Conduct Problems (r = 0.74), indicating that the IOWA measures are more independent than full-scale factors (Pelham, et al., 1989). Test-retest reliability was initially calculated by Loney et al. as r = 0.86 and 0.89 for the A and I/O scales respectively. The A score from the IOWA (Loney et al., 1982) was also used to classify participants into either the aggressive or non-aggressive group based on grade cutoff scores such that the aggressive group consisted of those children who were rated at least two standard deviations above the mean. The non-aggressive group was rated at less than one standard deviation above the mean on both parent and teacher rating scales of aggression relative to normative data.

5. Continuous Performance Test (CPT). CPT's are typically experimenter-paced tests that require subjects to monitor sequences of visually or aurally presented stimuli and to react whenever a previously specified target stimulus appears (Halperin, Sharma, Greenblatt, & Schwartz, 1991). CPT's have been widely used as objective measures of attention and impulsivity in a both psychiatric and normal childhood populations (Halperin, et al., 1991). The CPT version used in this study (Halperin, et al., 1988) was modeled after the "A-X" task of Rosvold et al., (1956). This well-normed version was programmed in Quickbasic to run on IBM-compatible computers. All participants were tested using a Toshiba T-2000 laptop computer, which had a backlit screen and produced blue letters on a gray background. The sequence of stimuli consisted of 11-letters presented individually for 200 milliseconds, with a 1.5-second interstimulus interval. The subjects were told to respond when they saw an "A" followed by an "X". A total of 400 letters were presented with a 10 percent target rate; each block of letters contained 10 targets (A-X), 17 "A's" not followed by "X", and 5 "X's" not preceded by an "A". The entire task lasted approximately 12 minutes.

The output from the program gave the total number of hits, misses, false alarms, correct rejections, very late correct responses, the mean hit reaction time, and the hit reaction time standard deviation for each block of 100 stimuli. Distinct inattention, impulsivity, and dyscontrol scores were then derived from the available data (Halperin, et al 1988).

6. Television Preference Interview (TPI). Parents/guardians were interviewed using the TPI. This semi-structured interview evaluated how many hours per week their child spends watching TV. The total number of hours was then coded as follows: 1 = (0 to 5 hours), 2 = (5 - 10 hours), 3 = (10 –20 hours), and 4 = (20 hours or greater). The child was then asked to identify his three favorite television shows. At a later date each of these shows was given a violence rating of 0 = (no violence), 1= (occasional mild violence) or 2 = (high violence), based on evaluations by the Network Television Ratings System (Mifflin, 1996). The majority of major broadcast and cable networks devised this content-based ratings system in 1996-1997 as a means of giving parents information about a show's content. This system was based on the Motion Pictures Association of America's code for movies (Mifflin, 1996). The labels range from TV-Y (appropriate for all children) to TV-MA (mature audiences only). Further information is given regarding the presence of sexual activity (S), Fantasy Violence (FV), Violence (V), and suggestive dialogue (D). Where show ratings were unavailable, two child/adolescent psychologists and one psychology graduate student independently rated the programs for the amount of visually portrayed physical aggression. A child's television violence rating score was then derived as the overall average of the three violent ratings for each program (design adapted from Harris, 1992).

7. Child Self-Rating Questionnaire. Subjects were asked to rate their own feelings of excitement, happiness, nervousness, anger, sadness, calmness, and fright on a 5-point ordinal scale with three anchor points: 1= (not at all); 3 = (a little); 5 = (a lot). Self-rating scales

were administered at the beginning and after the film presentations (design adapted from Arnetz et al., 1985). This questionnaire was used as a subjective assessment of the child's overall level of emotional arousal both before and after the video presentations.

8. Assessment of Gross Motor Activity. Motor activity was continuously recorded throughout the entire assessment using acceleration sensitive devices (Actigraph) with a solid state memory that stores data on the number of movements per 30-second epoch. The actigraphs, which weighed three ounces each, were worn around the wrist and ankle. These actigraphs were used only during the assessment periods in order to ensure that activity levels were measured from all children under similar situations (Gaewiller, 1993).

Determination of subject groups

Children were divided into aggressive and non-aggressive groups based upon parent CBCL aggression and teacher IOWA aggression ratings. All children in the aggressive group had parent and/or teacher ratings of aggression that were at least one and a one-half standard deviations above the mean relative to normative data. Children placed in the non-aggressive group all had parent and teacher ratings of aggression which were less than one standard deviation above the mean.

Table 1 depicts the identifying information obtained for all subjects in each of the two groups. Results of independent sample *t*-tests indicated that the groups did not differ significantly with respect to age, intelligence, or academic achievement.

The aggressive group exhibited significantly higher ratings on parent and teacher rating scales of aggression as compared to the non-aggressive group (See Table 2). Significant group differences were also found on four of six factors on the CBCL-parent form. Specifically the aggressive group showed significantly elevated scores on factors associated with thought problems, attentional problems, anxiety/depression, and social problems as compared to the non-aggressive group. No significant differences were found on factors of withdrawn behavior and somatic complaints as rated by parent. No significant group differences were seen on teacher ratings of inattention and overactivity.

There were no significant differences between the aggressive and non-aggressive groups on indices of inattention, impulsivity, and dyscontrol as measured by a continuous performance test [CPT] (See Table 3). These findings, which are consistent with teacher, but not parent ratings, suggest that variable attention and poor impulse control were not adequate means of differentiating the two groups. There was no significant difference in the amount of television watched by the aggressive and non-aggressive groups and the groups did not differ significantly on the overall level of violence in their three favorite television programs (See Table 4).

Dependent Measures

Physiological Measurements.

1) Salivary Cortisol
2) Quantitative EEG
3) Heart Rate (EKG)

1. Salivary Cortisol. Four samples of saliva were collected in "SALIVETTE" tubes (Sarstedt Ltd, Leicester UK) during each session (baseline, 15 minutes into the video, immediately following the completion of the video; and 15 minutes after the video). Subjects were

instructed to place a cotton swab in their mouths and chew on it for approximately 2.5 minutes which allowed the cotton to become saturated with saliva. Immediately after collection the cotton swabs were returned to the "SALIVETTE", capped and kept frozen at -20°C until analysis by radioimmunoassay (RIA).

2. Quantitative EEG (QEEG). A standardized 19 lead montage, using the International 10-20 system referenced to linked ears was used to obtain EEG recordings with eyes open and throughout the video presentations while each subject sat in a comfortable chair. In order to minimize possible ocular-motor artifacts, electrooculogram (EOG) was recorded on a separate channel from the supra-orbit of one eye. Electrodes were placed on the subject's head using a conductive jelly ($EC^2{}_{TM}$ Electrode Cream; Grass Medical Instruments). EEG was recorded from the frontal poles (Fp1, Fp2), left and right mid-frontal (F3, F4), inferior frontal (F7, F8), central (C3, C4), anterior temporal (T3, T4), posterior temporal (T5, T6), posterior parietal (P3, P4), and occipital regions (O1, O2). Similar to many investigations of hemispheric asymmetry, emotion, and cognition (Davidson 1989;Tomarkin, et al., 1990, for review), only the power asymmetry data for the alpha frequency band from the two homologous frontal and temporal inter-hemispheric leads (F3/F4, T3/T4) were used for these analyses. Raw data were collected on a Cadwell Spectrum 32 (Cadwell Laboratories, Inc.). Bandpass filters were set from 0.5 to 70 Hz, with a 60 Hz notch filter. All electrode impedance was below 5K. The EEG was digitized at a rate of 200 Hz with twelve-bit resolution. All raw EEG/EOG and selected epochs for data analysis were stored on a removable optical disk for later computer analysis. Notations were made to denote times of

salivary CORT samples and important video scenes (e.g., intense fighting).

3. Heart Rate (EKG). Resting heart rates (EKG) were measured at baseline following the placement of electrodes and throughout the video presentations. Electrodes were placed on the subject's sternum using a conductive jelly (EC^2 ™ Electrode Cream; Grass Medical Instruments). Raw EKG data was collected on a Cadwell Spectrum 32 machine (Cadwell Laboratories) and stored off-line on a removable optical disk for later analysis.

Film Stimuli

1. Violent Video. Rather than challenging children with a violent (R)-rated movie, which would raise ethical concerns, a 20-minute segment from a contemporary (PG)-rated motion picture depicting a boxing or prizefighting scenario ("Rocky III") was selected. These types of films have frequently been used in personality research involving the assessment of aggressive behaviors in children/adolescents (Eron, et al., 1971; Lefkowitz, et al., 1971, 1973), young adults (Eisenberg, et al., 1988; Geen & O'Neil, 1969; Geen & Stonner 1973; Perry & Perry, 1976) and in the general population (Phillips, 1983; Miller, Heath, Molcan, & Dugoni, 1990). This particular film segment was chosen for its moderate violent and aggressive content, as well as for the level of evoked anticipation both of which have been shown to elicit significant physiological changes in adults and children (Kirschbaum & Helhammer, 1989). The aggression video portion consisted of a 20-minute segment depicting a training scene followed by a boxing match. The chosen segment was carefully screened for the presence of blood as well as its overall appropriateness for children in this age group.

2. Non-violent video. This 20-minute video segment was from an age-appropriate television program, *Family Matters*. The segment contained mainly scenes of character dialog and/or non-aggressive, yet engaging, scenarios. All commercials were edited out to retain continuity.

Procedure

The approximate total time of this study was six-hours divided across two three-hour sessions. Each session was divided into morning and afternoon segments as follows:

Session 1 & 2 (Morning): Clinical/Behavioral Assessment

Upon arrival, children and their parents were interviewed regarding how many hours per week on average the child spends watching television, as well as the child's three favorite television shows.

Participants were asked to wear two acceleration sensitive devices to monitor motor activity throughout the sessions. Increased gross motor activity has been consistently shown to be highly correlated with aggression (Barkley, DuPaul, & McMurray, 1990; Raine & Jones, 1987), as well as being an accurate indicator of increased emotional arousal (Scerbo & Kolko, 1994).

Participants were administered cognitive and achievement tests as well as tests designed to measure inattention and impulsivity. All test measures were given in a standardized order for both groups. The WISC-III was administered during the morning of day 1, and the WIAT-

Screener, and CPT were administered on the morning of day 2. Following testing, the subjects took a lunch break. They were instructed not to drink any caffeinated beverages nor engage in any strenuous physical activity for at least one hour before returning for the afternoon session.

Session 1 & 2 (Afternoon): Film Presentations

Upon returning from lunch, subjects spent a two-hour period in a laboratory setting. Participants were allowed to play quietly for approximately five to ten minutes. During this time the children were asked to rate their own feelings of excitement, happiness, nervousness, anger, sadness, calmness, and fright on a five-point scale. The participants were again asked to wear the acceleration sensitive devices to monitor motor activity. Next, the child was asked to sit in a comfortable chair while the EEG/EKG electrodes were put into place. To keep the children occupied during the placement of the electrodes, they were allowed to watch commonly viewed, non-aggressive, television cartoons. Once the electrodes were in place an initial salivary sample (Baseline) and resting EKG were obtained. This allowed for the control of any emotional effects that the application of the electrodes might have on the child. The child was then shown either the 20-minute segment of *Rocky III* or of *Family Matters*. EEG and EKG recordings were obtained throughout the viewing of the video. Additional salivary samples were obtained 15 minutes into the video (Min +15), immediately following the video (Min +30) and 15 minutes after its completion (Min +45). Participants were again asked to rate their own feelings of excitement, happiness, nervousness, anger, sadness, calmness, and fright as well as allowed to play or read quietly for a brief period before leaving the sessions. Each of the groups were shown each of the films on separate occasions using a counterbalanced methodical design.

Data Analyses

All data were initially examined visually to ensure normality and to determine that outliers would not inordinately affect the results. CORT, EEG and EKG distributions were all found to have substantial skew. Thus, to meet the assumptions of analysis of variance (ANOVA), log transformations were conducted to normalize the data.

Salivary Cortisol (CORT)

Differences in CORT levels at the various sampling times were evaluated using a three-way mixed ANOVA with one between groups variable (Aggressive vs. Nonaggressive group), and condition (Violent video vs. Non-Violent video) and Time (BL, Min+15, Min+30, and Min+45) serving as repeated measures.

Quantitative EEG (QEEG)

Data analysis was carried out on artifact free EEG epochs (defined as 2.5 second segments) totaling 60 seconds. The Cadwell Spectrum 32 automatically calculated absolute power, relative power, power asymmetry and coherence for four frequency bands; delta (1.5-3.5 Hz), theta (3.5-7.5 Hz), alpha (7.5-12.5 Hz) and beta (12.5-25.0) for each of the 19 channels. As mentioned earlier, only the power alpha asymmetry data, calculated as the power difference between hemispheres [right – left] from the two homologous frontal and two temporal interhemiphere leads (F3/F4, T3/T4) were used for these analyses. To summarize the direction and magnitude of alpha asymmetry, an asymmetry index was calculated as the difference in power between hemispheres (right – left). This equation has been used extensively in the EEG asymmetry literature (Davidson, 1987, 1992,1998; Tomarken, etal., 1990; Wheeler, et al., 1993; Davidson & Hugdahl, 1995; Henriques & Davidson, 1997). Differences in anterior-asymmetry index were evaluated using a two-way mixed ANOVA with one between groups variable (Aggressive vs. Nonaggressive group), and condition (Violent video vs. Non-Violent video) serving as a repeated measure.

Heart Rate (EKG)

EKG data were manually analyzed from three separate time points during the video presentations. Each block consisted of four-minute increments (30, eight second epochs). The first block was taken prior to the start of the video (BL). The remaining two blocks were obtained four minutes prior to and four minutes after the initial video salivary sample (+15 minutes). This time point was selected because it corresponded with a highly arousing point in the aggressive video. Data for each block were then divided by four to give heart rate/minute. Differences in each block were evaluated using a three-way mixed ANOVA with one between groups variable (Aggressive vs. Nonaggressive group), and condition (Violent video vs. Non-Violent video) and Time (BL, Min+15, Min+30) serving as repeated measures.

Gross Motor activity

Motor activity for each location (Wrist, Ankle) was evaluated using a three-way mixed ANOVA with one between groups variable (Aggressive vs. Nonaggressive group), and condition

(Violent video vs. Non-Violent video) and Time (Testing, Movie) serving as repeated measures.

Subjective Emotional Experience

The seven subjective feelings (happy, sad, calm, angry, nervous, scared, and excited) were individually evaluated at baseline (BL) and at the end of the each video via independent sample t-tests. A Two-Way Repeated Measure ANOVA was used to compare changes (BL – end of video) in subjective feelings between the two groups during each of the video presentations.

CHAPTER IV

RESULTS

The primary dependent measures that were assessed to test the four key hypotheses central to this dissertation were salivary cortisol, heart rate, and EEG alpha asymmetry from homologous frontal (F4/F3) and temporal lobe (T4/T3) regions during each of the video presentations. Salivary cortisol was measured at four time points; prior to the onset of each video (BL), 15 minutes following the onset of each video (+15 min), at the end of each video (+30 min), and 15 minutes following the conclusion of each video (+45 min). Heart rate was evaluated during three four-minute blocks at BL, +15 min and +30 min. EEG was recorded continuously throughout each 20-minute video. As mentioned, given the prevalance in the EEG asymmetry literature (Davidson, 1987, 1992,1998; Tomarken, et al., 1990; Wheeler, et al., 1993; Davidson & Hugdahl, 1995; Henriques & Davidson, 1997) only the direction and magnitude of alpha asymmetry was calculated for the two frontal (F3/F4) and temporal sites (T3/T4). All data were log transformed to normalize the sample distribution. The following Results section is organized by dependent measure to determine the extent to which each measure provided data to support/refute the four hypotheses.

Salivary Cortisol (CORT)

The impact of group membership, video type and time on CORT was assessed using a 3-way mixed ANOVA with Group (Aggressive vs. Non-aggressive) serving as the between-group variable and Video (Violent vs. Non-violent) and Time (BL, +15 min, +30 min, +45 min) serving as repeated measures. Normalized means and standard deviations are provided in Tables 5 and 6. There was a significant main effect for Time [$F(3,22) = 8.62$, $p = .001$, $Eta^2 = 0.54$], but not for Group [$F(1,24) = 1.65$, $p > .10$] or Video [$F(1,24) = 0.24$, $p > .10$]. In addition, there was a significant Group x Time interaction [$F(3,22) = 3.41$, $p < .05$, $Eta^2 = 0.32$]. Neither the Group x Video [$F(1,24) = 0.32$, $p > .10$], Video x Time [$F(3,22) = 0.27$, $p > .10$], nor the 3-way Group x Video x Time [$F(3,22) = 0.91$, $p > .10$] was significant.

As shown in Figure 1, CORT within each group was remarkably consistent over the two sessions irrespective of Video type. In view of the non-significant Video effect, Figure 2 shows the Group x Time interaction collapsed across video. Post-hoc analyses examining the significant Group x Time interaction indicated significant ($p < .05$) changes in CORT levels over time in the aggressive group, but not in the non-aggressive group. Specifically, CORT levels decreased significantly in the aggressive group from BL to +15 min [$t(13) = 3.65$, $p = .003$], increased from + 15 min to +30 min [$t(13) = 2.72$, $p = .017$], and then decreased from +30 to + 45 min. [$t(13) = 3.92$, $p = .002$]. No significant changes in CORT levels occurred in the non-aggressive group (all $p > .10$). At the end of the video (+30 min) CORT was significantly higher in the aggressive as compared to the non-aggressive group [$t(12) = 2.76$, $p < .05$]. The two groups did not differ significantly at any other time point. Additional post-hoc analyses of the three way ANOVA (Group x Time x Video) were re-run using CBCL indices of anxiety/depression, thought problems, attention, and social problems as co-variates. As was the case without co-variates the Group x Time interaction remained significant ($p < .05$; $Eta^2 = 0.30$). All other non-significant main and interactions remained unchanged.

Overall, the CORT data do not support hypotheses 3 and 4, both of which posited differential video effects. The nature of the video did not differentially affect salivary cortisol (Hypothesis 3) and the two subject groups did not have a differential cortisol response to the violent and non-violent videos (Hypothesis 4). With regard to the over/underarousal hypotheses (1 and 2), there were no baseline differences between the groups with regard to CORT (Hypotheses 1a and 2a). However, consistent with part two of the overarousal hypothesis (Hypothesis 1b), the aggressive group as compared to non-aggressive children, demonstrated a significantly greater CORT response to the videos irrespective of content.

QEEG

The impact of group membership and video type on alpha EEG asymmetry was assessed using two 2-way mixed ANOVAs with Group (Aggressive vs. Non-aggressive) serving as the between-group variable and Video (Violent vs. Non-violent) as the repeated measure. EEG was recorded continuously throughout the presentation of each video. Separate analyses were conducted to examine frontal (F3/F4) and temporal (T3/T4) alpha asymmetry.

The ANOVA assessing frontal asymmetry yielded no significant main effects or interactions (see Table 7 and Figure 3). However, recordings from temporal regions yielded a significant main effect for Group [$F(1,27) = 5.45$, $p < .05$], but not Video [$F(1,27) = 0.07$, $p > .10$] (see Table 8 and Figure 4). The Group x Video interaction was also non-significant [$F(1,27) = 0.02$, $p > .10$].

Thus, similar to the CORT data, the EEG results provide no support for either hypothesis 3 or 4. Video type did not differentially affect alpha EEG asymmetry (Hypothesis 3) and the two groups did not have a differential response to the violent video (Hypothesis 4). However, again there was a significant group effect indicating greater temporal alpha asymmetry in the aggressive group as compared to non-aggressive controls. As shown in figure 4, temporal alpha EEG was relatively consistent across hemispheres in the non-aggressive controls. In contrast, the negative asymmetry index generated by the aggressive group indicates a greater left temporal than right temporal alpha output for that group. As such, the left temporal region in aggressive children is less aroused than the homologous right temporal region during video viewing.

Heart Rate (EKG)

The impact of group membership, video type and time on heart rate was assessed using a 3-way mixed ANOVA with Group (Aggressive vs. Non-aggressive) serving as the between-group variable and Video (Violent vs. Non-violent) and Time (BL, +15 min, +30 min) serving as repeated measures. Means and standard deviations are provided in Tables 9 and 10. The ANOVA generated no significant main effects [Group $F(1,23) = 1.37$, $p > .10$; Video $F(1,23) = 0.06$, $p > .10$; Time $(2,22) = 1.17$, $p > .10$]. However, there were significant Group x Video [$F(1,23) = 4.41$, $p < .05$, $Eta^2 = 0.16$] and Video x Time [$F(2,22) = 5.07$, $p < .05$, $Eta^2 = 0.32$] interactions, and the 3-way Group x Video x Time interaction fell just short of significance [$F(2,22) = 3.42$, $p = .051$, $Eta^2 = 0.24$]. The Group x Time interaction was not significant [$F(2,22) = 0.77$, $p > .10$].

Figure 5 depicts the significant Group x Video interaction. As can be seen, the two groups showed different heart rate patterns while viewing the two videos. The aggressive group exhibited a lower overall heart rate during the aggressive video as compared to the non-aggressive video. Conversely, the non-aggressive group had a higher heart rate during the aggressive as compared to the non-aggressive video. Further post-hoc analyses indicated that there was no significant within or between group differences across the data points (all $p > .10$).

Figure 6 shows the significant Video x Time interaction. Overall heart rate decreased over time (BL to +30 min) during the non-violent video, whereas it increased over time throughout the violent video. However, post hoc analyses did not yield significant time differences.

Finally, Figure 7 presents the data contributing to the nearly significant ($p = .051$) 3-way interaction. Further analysis using separate two-way repeated measure ANOVAs to compare group differences in heart rate over the course of the two videos, indicated that children in the non-aggressive group had a differential heart rate response to the violent and non-violent videos [Video x Time interaction: $F(2,11) = 14.71$, $p = .001$, $Eta^2 = 0.72$] such that their heart rate increased in response to the violent video and decreased during the non-violent video. In contrast, heart rate in the aggressive group did not differentiate the videos [Video x Time interaction: $F(2,10) = 0.27$, $p > .10$].

Additional post-hoc analyses of the three way ANOVA (Group x Time x Video) were re-run using CBCL indices of anxiety/depression, thought problems, attention, and social problems as co-variates. As was the case without co-variates the Group x Film interaction remained significant ($p < .05$; $Eta^2 = 0.25$). Conversely, the Film x Time interaction did not reach significance when co-varying out these factors ($p > .10$). All other non-significant main and interactions remained unchanged.

In contrast to CORT and EEG data, where all Video main effects and interactions were non-significant, heart rate data appeared to differentiate the two video conditions and provide support for hypothesis 4. Specifically, non-aggressive children's heart rate was found to vary as a function of video type, but aggressive children showed no difference in their response to the different videos.

Secondary Analyses of Additional Measures

Gross Motor Activity

Gross motor activity was assessed during testing and video portions of the sessions via actigraphs worn on the wrist and ankle. Results of Three-Way Repeated Measure ANOVAs revealed no significant differences between the aggressive and non-aggressive groups on measured motor activity for either body locations (Wrist, Ankle) during the testing and video sessions (See Table11). Thus, increased physiological responsivity could not be accurately predicted via differences in overall motor activity.

Subjective Emotional Experience

Results of independent sample t-tests indicated that the two groups did not differ significantly from one another with respect to the seven baseline feelings during either the aggressive and non-aggressive video segments (See Table 12). Since baseline differences were non-significant, Two-Way Repeated Measure ANOVAs were used to compare changes (BL – end of video) in each of the seven subjective feelings (happy, sad, calm, angry, nervous, scared, and excited) between the two groups during each of the video presentations. Results revealed no significant main effects for Video (happy [F(1,27) = 1.45, p = .24]; sad [F(1,27) = 2.00, p = .17]; calm [F(1,27) = 3.25, p = .94]; angry [F(1,27) = 0.87, p = .77]; nervous [F(1,27) = 0.20, p = .66]; scared [F(1,27) = 0.93, p = .34]; excited [F(1,27) = 3.25, p = .08] or Group (happy [F(1,27) = 0.01, p = .91]; sad [F(1,27) = 0.00, p = .96]; calm [F(1,27) = 0.47, p = .50]; angry [F(1,27) = 0.09, p = .77]; nervous [F(1,27) = 0.07, p = .79]; scared [F(1,27) = 0.93, p = .34]; excited [F(1,27) = 0.16, p = .21] for any of the seven emotional responses. Group by video interactions were also non-significant for each of the seven feelings (happy [F(1,27) = 0.27, p = .61]; sad [F(1,27) = 0.00, p = .96]; calm [F(1,27) = 0.28, p = .81]; angry [F(1,27) = 0.95, p = .34]; nervous [F(1,27) = 0.20, p = .66]; scared [F(1,27) = 0.93, p = .34]; excited [F(1,27) = 3.25, p = .29].

Finally, post-hoc analyses were used to dimensionally assess the degree to which CBCL anxiety/depression, social problems, attention, and thought problems were associated with physiological reponsivity during the two video conditions. Partial correlations were conducted controlling for baseline CORT and HR measures. Results indicated no significant correlations between any of the four CBCL indices and the two physiological measures (p > .10).

CHAPTER V

DISCUSSION

The results of this study indicate that aggressive and non-aggressive boys differ in their physiological response to videotaped films, raising the possibility that media stimulation has differential effects on these two groups of children and as such may differentially impact their behavior. Group differences in responsivity were found on all three physiological measures (i.e., cortisol, EEG and heart rate). However, it is notable that the nature of these differences was not consistent across the three measures. Therefore, the findings as a whole do not provide unequivocal support for any of initial hypotheses. Nevertheless, the data do provide partial support for some hypotheses and allow for the clear rejection of others.

Importantly, the two groups did not differ in the overall amount of television viewed or level of violence portrayed in their favorite television programs. Thus, prior exposure to television violence is unlikely to account for the observed group differences. Further, the two groups did not differ in attentional capacity, impulse control, and overall motor activity, as indicated by both teacher ratings and objective measures. Therefore, the observed physiological differences between the aggressive and non-aggressive pre-pubertal boys cannot be attributed to these behavioral factors. However, this possibility is tempered somewhat by the fact that parent ratings did suggest group differences in attentional capacity between the groups.

CORT

The salivary cortisol data were most consistent with the hypothesis that aggressive children would appear more responsive to the video stimuli as compared to their non-aggressive peers. Specifically, the aggressive group demonstrated significant changes in salivary cortisol while viewing the videos, whereas no significant changes in cortisol level were seen in the non-aggressive group. The non-aggressive children exhibited a relative decrease in salivary cortisol concentrations throughout both video sessions. These results are consistent with previous findings, which have indicated that normal cortisol concentrations continue to decrease during this time period (1pm to 4pm) due to circadian rhythms (Losonczy, Mohn, & Davis, 1984; Kafka, Benedito, Roth, Steele, Wolfe, & Catravas, 1986; Smith, Olson, & Justice, 1992). This suggests that the videos had no effect on cortisol secretion in these children. In contrast, the aggressive children had an initial decrease in cortisol secretion at the onset of the films, which significantly increased by the end of the film. Fifteen minutes following the film their salivary cortisol levels were virtually identical to that of the controls. Importantly, film type did not differentially affect cortisol levels. Both groups had highly consistent salivary responses across sessions, irrespective of the content of the film. Thus, the significant increase in cortisol seen in the aggressive group at the end of both videos suggests that activation of the HPA is likely occurring regardless of the nature of the stimuli. This indiscriminate hyper-activation of the HPA may result in an over responsivity in these children regardless of the content of the programs, possibly making them more vulnerable to images portrayed in the media.

It is also notable that the two groups did not differ significantly in baseline cortisol levels. While these findings do not support previously reported lower baseline cortisol levels in aggressive children and adolescents (Lahey, 1993; McBurnett, et al., 2000; Susman, et al., 1987; Tennes & Kreye, 1985; Tennes et al., 1986; Vanyukov, et al., 1993), they are in line with findings of others who have reported no such group differences (Dabbs, et al., 1991; Delamater & Lahey, 1983; Kruesi, et al., 1989; McBurnett & Lahey, 1994; Scerbo & Kolko, 1994; Schulz, et al., 1997; Stoff et al., 1992). Thus, the increased level of salivary cortisol seen in the aggressive children in response to the videos more accurately represents increased physiological responsivity as opposed to a more general state of over-arousal.

QEEG

Similar to the cortisol findings, EEG alpha asymmetry data from the frontal (F3/F4) and temporal leads (T3/T4) did not indicate a differential response to the violent and non-violent videos. However, significant differences in temporal asymmetry were seen between the groups during the two videos. In contrast to the non-aggressive group, in whom alpha activity was essentially equivalent across the two temporal leads, there was a striking hemispheric difference in the aggressive children. Specifically, results indicated a significant lateralization difference in the aggressive group such that there was greater alpha activity, and thus less cortical arousal, in the left as compared to the right temporal lobe. No differential change was seen between either video in the non-aggressive children. These findings suggest that aggressive children process video stimulation differently from controls. To the extent that left hemisphere processing is more associated with verbal mediation, as compared to the right hemisphere, which appears to be differentially associated with visual and emotional processing, these data suggest that non-aggressive children draw upon these cognitive and emotional resources in a balanced manner while viewing films. In contrast, aggressive children appear to differentially utilize right hemisphere visual/emotional modes of processing.

It is also possible that the observed group difference may be related to some trait rather than state condition (i.e., viewing the videos). Specifically, recent research has indicated that dispositional anger and aggression was associated with greater left than right alpha wave activity (Harmon-Jones & Allen, 1997, 1998; Sutton & Davidson, 1997).

Despite controversy over the relationship between hemispheric specialization and aggression, the present results are consistent with several studies that have indicated the temporal lobes to have an important role in relation to aggression (Bear, 1983; Graae, et al., 1996; Nachson, 1991, Saver, Salloway, & Devinsky, 1996; Tebartz van Elst, Woermann, Lemieux, Thompson, & Trimble, 2000; Wong, et al., 1994). The greater left-sided alpha wave activity seen in the aggressive boys suggests an overall under-arousal in the left temporal regions. Patients with left-hemisphere damage have also been shown to have greater arousal responses as compared to controls (Heilman, Schwartz, & Watson, 1978).

One could also view this asymmetry as an indicator of greater right-sided cortical arousal. The right temporal lobe has been shown to have extensive connections to many of the limbic structures, such as the amygdala, hippocampus, and hypothalamus as well as the prefrontal cortex. There has been an abundant literature documenting the fact that these areas are intricately involved in the interpretation and expression of emotion (Bear, 1979; Geschwind, 1965; Jones & Mishkin, 1972; Nauta, 1971; Weiskrantz, 1956). While the left hemisphere also has such connections, it is the right-sided connections that are thought to be responsible for the mediation and expression of aggression (Tebartz van Elst, et al., 2000). Specifically, the dominant role of the right-hemisphere has been shown to be in emotional surveillance and the search for threatening situations (Bear, 1983; Dimond & Farrington & Johnson, 1976, 1977). Further support for the hypothesis that the right hemisphere is dominant for the interpretation and expression of emotions comes from numerous studies showing the right hemisphere to be superior in detecting facial emotions (Borod, Haywood, & Koff, 1997; Borod, Kent, Koff, Martin, & Alpert, 1988, Borod, Koff, & White, 1983). Finally, another possibility is that the aggressive children may be processing stimuli differently. Lateralized lesion studies have shown the right hemisphere to be more sensitive to nonverbal auditory and visual cues of emotion (Benowitz, et al., 1980; Heilman, Scholes, & Watson, 1974). It has been shown that the right hemisphere is more involved in the affective processing and emotional quality of stimuli. Conversely, the left hemisphere is thought to be more cognitive, processing stimuli through verbal mediation. Therefore it is possible that without the cognitive input from the left hemisphere to modulate the appropriate reaction to a perceived stimulus and/or hyper-responsivity of the right hemisphere one would expect the more dramatic and indiscriminate physiological reaction to stimuli seen in the aggressive children. On the other hand, the non-aggressive group exhibited a balance between emotional and cognitive processing and thus no differential hemispheric asymmetry. Either way, these findings suggest some differential functioning in temporal lobe activity in this group of aggressive boys as compared to their non-aggressive counterparts.

In contrast, there were no significant differences seen between the two groups in frontal asymmetry (F3/F4). This finding is not consistent with previous EEG literature that has shown that frontal asymmetry predicts affective responses to emotionally laden films (Davidson, 1992; Davidson, et al., 1990; Davidson & Tomarken, 1989; Tomarkin, et al., 1990; Tomarkin, Davidson, Wheeler, & Kinney, 1992). The greater relative left-anterior activity has been related to subjective reports of greater positive reactions to positive films whereas relative greater right-anterior activity has been associated with more intense negative feeling to negative films (Tomarken, et al., 1990; Wheeler, et al., 1993). Therefore, it is not surprising that the present results did not follow along these lines given that the two groups did not report subjectively different emotional experiences to either video. In addition, frontal asymmetries from these regions using different types of psychometric measures have shown to correlate with hyperactivity and impulsivity (Lazzaro, et al., 1999; Niedermyer & Naidu, 1997). Thus, since CPT and actigraph measures did not distinguish the aggressive and non-aggressive groups, one might also expect to see no differential asymmetry in frontal regions.

Interestingly, the differential findings between the frontal and temporal regions may suggest a disconnection or dysregulation between the initial primary emotional processing involving the HPA and limbic system and higher cortical areas involved in the cognitive processing of emotionally laden stimuli.

EKG

Finally, in contrast to cortisol and EEG data, where all Video main effects and interactions were found to be non-significant, heart rate response did differentiate the two video conditions and did not provide support for the hypothesis of a differential video effect between the groups. Importantly, unlike the cortisol data, which supported the hypothesis of a global hyper-responsivity, heart rate data indicated a differential response of the two groups to the different videos.

The direction of heart rate changes to the violent and non-violent films differed across the two groups. Specifically, as compared to when viewing the non-violent film, the aggressive children viewing the violent film had a lower heart rate whereas the non-aggressive children had an elevated heart rate. Further, unlike the aggressive children, the non-aggressive controls had a highly differentiated response to the two films. Heart rates of the non-aggressive children increased throughout the violent video and decreased during the non-violent video. In contrast, the aggressive children showed no difference in their response to the different videos.

The overall interpretation of these heart rate results is unclear. Past research has suggested that co-activation of the sympathetic and vagal (parasympathetic) input to the heart occurs in response to noise and other stressors (Berntson, Cacioppo, & Quigley, 1991; Suls & Wan, 1993). In addition, given the possibility of either co-activation or separate sympathetic and parasympathetic activity it is likely that cardiovascular functioning may show no overall changes or in some instances hypo-responsivity in response to a stressor (Suls & Wan, 1993). Nevertheless, the hypo-reactivity seen in the aggressive boys during the aggressive video is consistent with overall smaller electrodermal responses reported in antisocial individuals as compared to controls. Further, this hypo-reactivity may also reflect an adaptation that may serve to decrease the emotional impact of the situation. Thus, the aggressive boys may not be as readily influenced by threats of punishment or knowledge that their behaviors may have unpleasant consequences for themselves or others (Hare, 1982; Hare and Craigen, 1974; Hare, Frazelle, & Cox, 1978). Future researchers may want to explore these issues further.

Taken together, these data cannot be used to conclusively support any of the proposed hypotheses, although some can be ruled-out. Further, the fact that consistent findings did not emerge across all three physiological indicators suggests that unitary over- or under-arousal/activation hypotheses may not adequately characterize the biological distinctions between aggressive and non-aggressive children.

Across physiologic indicators, the data do not support either the over- or under-arousal hypotheses. None of the physiological measures distinguished between the groups at baseline. These findings are consistent with an ever-growing literature which has failed to find baseline differences on measures of cortisol (Dabbs, et al., 1991; Kruesi, et al., 1989; Scerbo & Kolko, 1994; Schulz, et al., 1997; Stoff et al., 1992), heart rate (Garralda, et al., 1991; Maliphant, Hume, & Furnham, 1990; Suls & Wan, 1993), EEG (Hsu, et al., 1985; Langevin, et al., 1987, 1982; Philipps, et al., 1982) and skin conductance (see Raine, 1993 for review). Although some studies have found group differences on some of these indicators (Hendricks, et al., 1988; Kindlon et al., 1995; Lahey, 1993; Lewis, 1990; Lewis et al., 1982, 1984,1986, 1988,1989; McBurnett, et al., 1991, 2000; Raine, 1996; Rogeness, et al., 1989; Tennes & Kreye, 1985; Tennes et al., 1986; Satterfield & Schell, 1984; Surwillo, 1980; Susman, et al., 1987; Vanyukov, et al., 1993; Virkkunen, 1985), data suggest that these differences may be limited to a specific subgroup of children. For example, McBurnett et al., 1991 reported cortisol differences between children with conduct plus co-morbid anxiety disorders and controls. However, the finding did not hold-up among non-anxious conduct disordered children. In view of the well-know heterogeneity among aggressive children (Dodge, Lochman, Harnish, Bates, & Pettit, 1997), it is plausible, and perhaps even likely, that much of the variability across studies is due to differences in the nature of the aggressive group.

In contrast, the data across all three physiological measures do provide support for the hypothesis that aggressive and non-aggressive children are differentially responsive to environmental stimuli. Yet the nature of this difference is not fully apparent. While viewing the films, aggressive children had a significantly greater cortisol response and a more asymmetrical alpha EEG response in the temporal lobes. Further their heart rate response to the violent and non-violent films were less well differentiated than that of controls. Thus, aggressive children do appear to respond differently to environmental stimulation than non-aggressive children.

Only very limited data provided support for the hypotheses that children would have a differential response to the violent and non-violent films, and that the differential response would vary across the diagnostic groups. Only heart rate data provided support for this hypothesis. This limited difference may be due to the fact the "violent film" used in this study was not experienced by the participants as violent. This hypothesis is supported by the fact that behavioral/emotional ratings of the children did not differentiate the two films. This may be in part due to the fact that many of the regularly watched programs of the children are far more violent than that used in this study. Yet, human subject concerns limit the degree to which research investigations can expose children to highly violent material.

Nevertheless, the fact that heart rate did differentiate the films suggests that it may be a more sensitive indicator of emotional response than either salivary cortisol or EEG alpha asymmetry. The heart rate data are consistent with the hypothesis that aggressive and non-aggressive children have differential responses to violent and non-violent material. Whereas heart rate in non-aggressive children is highly discriminating of the two films, there is minimal differentiation among the aggressive children. Further, non-aggressive children appear to be aroused by the more violent film material, as indicated by an increase in heart rate as compared to the non-violent film. In contrast, the aggressive children have a reduction in heart rate. This "under-activation" finding is consistent with skin conductance data which also indicate decreased responsivity among aggressive individuals (Blackburn, 1979; Raine, 1988; Raine, Reynolds, & Sheard, 1991; Raine & Venables, 1984; Schmidt, Solant, & Bridger, 1985).

This lack of responsivity by aggressive children could potentially explain why these individuals appear to be so treatment resistant. Most treatments geared towards aggressive individuals apply behavioral methods based upon reinforcement and punishment. If, as suggested by these data, aggressive individuals are less responsive to environmental stimuli, they would be less likely than their non-aggressive peers to modify their behavior in response to reinforcement and punishment.

Limitations of the Study

This study must be considered in the context of several limitations. First, as alluded to above, one important limitation of this and other investigations that have assessed media violence and aggression, is the level of viewed violence being used as the independent measure. Institutional review boards (IRB) of most institutions have strict criteria for evaluating what is or is not appropriate for research protocols involving human subjects. These guidelines are frequently even more stringent when the research involves children. As a result, the level of viewed violence approved for use in such studies is often not an accurate representation of the types of programs being seen on an everyday basis. Furthermore, given the high levels of violence seen on television, it is a likely assumption that these children have been exposed to far more violence and aggression than that depicted in this and other such studies. Thus, it is not surprising that, despite the relative violent nature of the violent video, there were few differences seen in either physiological measures or subjective emotional ratings between the two video segments for either the aggressive or non-aggressive group. Future research may consider replicating these findings using independent measures that more accurately represent the level of violence currently being shown on television and/or in the movies. However, extreme caution must be used to ensure that children are not exposed to inappropriate material.

Another limitation is that the results of this study may not be broadly generalizable due the small number of subjects and the population used (all from inner city environments). Research has shown that such environmental influences as poverty, low SES, the level of neighborhood violence, and overcrowding can all play a significant role in the expression of aggressive behaviors.

Importantly, a large number of children who are referred to clinics and/or hospitals for disruptive behaviors commonly display what is often thought of as "reactive aggression" (characterized by an extremely low frustration tolerance, emotionally volatile reactions to perceive threat and impulsive acting out without provocation). This type of aggression is quite different from "predatory aggression" which is more planned and goal directed in nature and often done either covertly or at more opportune times. As a result, the reactive children are consistently getting into more trouble both at home and at school and thus more likely to be referred for treatment. This finding was also true in this study. Therefore it is not surprising that the aggressive sample demonstrated more hyper-responsivity to the video conditions as compared to their non-aggressive peers. Future researchers may want to use a larger sample size from multiple sites. This may help to correct this methodological issue of a skewed representation first, by allowing for more diversification and second, by increasing the power of the sample to allow for the separation of the two types of aggression. These methodological changes may lead to clearer differences between the groups and/or videos.

In addition, only males between the ages of nine and 11 years old were selected for this study. While males have been found to be differentially sensitive to violence in the media as compared to females, most agree that the effects of media violence also affect females as well. However, few known studies have been conducted to explore the possible effects of media violence in females. Therefore future research may consider using females in the same age range to elucidate this issue.

Given that female aggression has also risen, it would be interesting to conduct a similar study comparing the physiological arousal and responsivity of both males and females to assess the generalizability of the present findings across genders.

In addition, future researchers may want to consider using newer brain imaging methodologies to more carefully assess the differential response of aggressive and non-aggressive children to various types of environmental stimuli.

The role of the amygdala in the expression of aggression as well as its extensive connections with other areas of the limbic and the frontal and temporal cortices has been well documented. It may therefore be fruitful for future research to assess changes in amygdaloid functioning by measuring changes in regional brain activity using such real-time procedures as functional MRI or SPECT to elucidate any possible differing patterns of activity during the watching of aggressive and non-aggressive videos.

Conclusions

While keeping the limitations of this study in mind, the findings support the existence of physiological dysregulation in aggressive pre-pubertal boys. This physiological dysregulation may make them differentially susceptible to environmental stimuli and thus possibly lead to an increase in acting out behaviors. These findings may lead to future research exploring the mechanisms of this dysregulation and its overt effects on aggressive behaviors. Once these mechanisms are better understood, professionals and administrators may begin developing appropriate remediation and preventative measures to better aid this vulnerable sub-population of aggressive children.

Table 1

Means and Standard Deviations of Group Age, Intelligence, and Academic Achievement Measures

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
Age (months)	123.20	11.60	125.00	11.10	0.42	0.68
WISC-III						
FSIQ	83.50	7.50	85.60	12.41	0.55	0.59
VIQ	86.29	10.59	87.60	11.53	0.32	0.75
PIQ	83.14	9.21	86.00	15.21	0.61	0.55
WIAT						
READING	94.50	16.01	91.20	14.40	0.58	0.56
SPELLING	93.64	15.03	90.60	15.35	0.54	0.60
ARITHM	90.86	8.52	92.13	9.94	0.37	0.71

AGG = Aggressive, NAGG = Non-Aggressive. WISC = Wechsler Intelligence Scale for Children- 3rd Edition, FSIQ = Full Scale Intelligence Quotient, VIQ = Verbal Scale Intelligence Quotient, PIQ = Performance Scale Intelligence Quotient. WIAT = Wechsler Individual Achievement Test, ARITH = Mathematics Reasoning.

Table 2

Means and Standard Deviations of Group Behavioral Rating Scales Based on Child Behavior Checklist-parent version (CBCL) and Teacher Ratings (IOWA).

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
Parent CBCL						
AGGRES	74.21	13.21	52.53	3.02	6.19	0.00**
DELIN	71.64	6.15	54.80	5.43	7.83	0.00**
WDRAWN	65.79	13.23	59.40	8.50	1.56	0.13
SOMATIC	64.79	12.43	59.13	6.99	1.52	0.14
ANXDEP	67.39	14.73	58.00	6.01	2.25	0.03*
SOCPRB	61.29	10.63	54.53	6.65	2.07	0.04*
THOUGHT	67.00	11.45	55.20	8.22	3.21	0.00**
ATTENTN	70.29	10.39	60.00	8.49	2.93	0.01*
Teacher-IOWA						
IOWA-AGG	10.46	4.84	2.29	1.86	5.87	0.00**
IOWA-I/O	8.54	3.93	6.50	5.05	1.16	0.25

AGG = Aggressive, NAGG = Non-Aggressive. AGGRES = Aggressive Behavior; DELIN = Delinquent Behaviors, WDRAWN = Withdrawn, SOMATIC = Somatic Complaints, ANXDEP = Anxious/Depressed; SOCPRB = Social Problems, THOUGHT = Thought Problems, ATTENTN = Attentional Problems. IOWA-AGG = Aggressive behavior, IOWA-I/O = Inattention/Overactivity.

* $p < .05$, ** $p < .01$

Table 3

Means and Standard Deviations of Group for CPT Measures of Inattention, Impulsivity, and Dyscontrol.

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
INATTENTION	5.29	4.32	5.93	4.46	0.40	0.70
IMPULSIVITY	4.36	5.27	2.73	3.24	1.00	0.32
DYSCONTROL	6.36	8.70	2.87	2.83	1.43	0.15

AGG = Aggressive, NAGG = Non-Aggressive.

Table 4

Means and Standard Deviations of Group for Amount of Television Viewed and Level of Violence Portrayed in Favorite Television Programs.

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
TPI	3.86	0.36	3.60	0.51	1.56	0.13
VRATING	4.00	1.57	3.07	1.75	1.51	0.14

AGG = Aggressive, NAGG = Non-Aggressive. TPI = Total amount of television watched per week coded as follows: 1 = (0 to 5 hours), 2 = (5 - 10 hours), 3 = (10 –20 hours), and 4 = (20 hours or greater). VRATING = Overall violence ratings of the subjects three favorite television programs. Coding was as follows: 0 = (no violence), 1= (occasional mild violence) and 2 = (high violence). Cumulative scores were calculated to give a total overall violence rating.

Table 5

Means and Standard Deviations of Group Baseline Salivary CORT Levels for the Violent and Non-violent Videos.

	GROUP					
	AGG n = 14		NAGG n = 14			
	M	SD	M	SD	t	p
V-VIDEO	5.21	0.38	4.99	0.47	1.27	0.22
NV–VIDEO	5.26	0.46	5.05	0.58	1.13	0.27

Data were log transformed to normalize distribution. AGG = Aggressive, NAGG = Non-Aggressive. V-VIDEO = Violent Video, NV-VIDEO = Non-Violent Video.

Table 6

Means and Standard Deviations of Group Salivary Cortisol Levels Over Time Collapsed Across Videos.

	GROUP					
	AGG n = 13		NAGG n = 13			
	M	SD	M	SD	t	p
BL	5.24	0.38	5.02	0.38	1.95	0.08
+ 15 MIN	5.04	0.33	4.92	0.39	1.68	0.12
END	5.22	0.33	4.90	0.25	2.76	0.02*
+15 MIN PV	4.89	0.32	4.89	0.32	0.76	0.94

Data were log transformed to minimize group variance. AGG = Aggressive, NAGG = Non-Aggressive. BL = Baseline, + 15 MIN = 15 minutes into the video, End = Immediately following the end of the video, +15 MIN PV = 15 minutes post video.

* $p < .05$

Table 7

Two-Way Repeated-Measures Analysis of Variance for Frontal Hemispheric Asymmetry (F4/F3) While Viewing Violent and Non-violent Videos

Source	df	F	p
		Between subjects	
Group (G)	1	0.02	0.89
Within-group error	27	(0.01)	
		Within subjects	
Video (V)	1	1.18	0.29
V X G	1	0.01	0.93
V X G within-group error	27	(0.01)	

Values enclosed in parentheses represent mean square errors.

Table 8

Two-Way Repeated-Measures Analysis of Variance for Temporal Hemispheric Asymmetry (T4/T3) While Viewing Violent and Non-violent Videos

Source	*df*	*F*	*p*
	Between subjects		
Group (G)	1	5.45	0.03*
Within-group error	27	(0.02)	
	Within subjects		
Video (V)	1	0.07	0.79
V X G	1	0.02	0.89
V X G within-group error	27	(0.02)	

Values enclosed in parentheses represent mean square errors.

* $p < .05$.

Table 9

Means and Standard Deviations of Group Baseline Resting Heart Rates For The Violent and Non-violent Videos

	GROUP					
	AGG n = 12		NAGG n = 13			
	M	SD	M	SD	t	p
V-VIDEO	4.29	0.15	4.39	0.11	1.33	0.20
NV-VIDEO	4.34	0.12	4.37	0.15	0.66	0.52

Data were log transformed to normalize distribution. AGG = Aggressive, NAGG = Non-Aggressive. V-VIDEO = Violent Video, NV-VIDEO = Non-Violent Video.

Table 10

Means and Standard Deviations of Group Heart Rate Levels Over Time Across Violent and Non-Violent Videos.

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
Violent Video						
BL	4.29	0.15	4.36	0.13	1.33	0.20
+ 15 MIN	4.32	0.14	4.38	0.11	1.35	0.19
+30 MIN	4.31	0.13	4.39	0.14	1.60	0.12
Non-Violent Video						
BL	4.34	0.12	4.38	0.15	0.66	0.52
+ 15 MIN	4.34	0.11	4.34	0.14	0.20	0.85
+30 MIN	4.33	0.11	4.32	0.16	0.22	0.83

Data were log transformed to normalize distribution. AGG = Aggressive, NAGG = Non-Aggressive. BL = Baseline, + 15 MIN = 15 minutes into the video, +30 MIN = Immediately following the end of the video.

Table 11

Means and Standard Deviations of Group Motor Activity During Testing and Viewing of Violent and Non-violent Videos.

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
Testing Sessions						
Violent-W	12.42	7.36	11.49	6.08	0.37	0.71
Nonviolent-W	9.52	4.48	9.59	4.11	0.44	0.97
Violent-A	8.51	6.12	13.30	10.86	1.45	0.16
Nonviolent-A	7.26	4.92	7.97	7.02	0.36	0.72
Video Sessions						
Violent-W	6.23	3.51	6.04	3.23	0.15	0.88
Nonviolent-W	5.48	2.75	5.01	3.09	0.43	0.67
Violent-A	6.12	2.86	7.81	6.14	0.94	0.36
Nonviolent-A	6.26	4.06	7.90	5.84	0.90	0.37

AGG = Aggressive, NAGG = Non-Aggressive. Violent-W = Wrist motor activity during aggressive sessions, Nonviolent-W = Wrist motor activity during non-aggressive sessions, Violent-A = Ankle motor activity during aggressive sessions, Nonviolent-A = Ankle motor activity during non-aggressive sessions.

Table 12

Means and Standard Deviations of Group Subjective Baseline Feelings Prior to Violent and Non-violent Videos Conditions.

	GROUP					
	AGG n = 14		NAGG n = 15			
	M	SD	M	SD	t	p
AGG VIDEO						
HAPPY	4.14	0.95	3.87	1.41	0.62	0.54
SAD	1.00	0.00	1.00	0.00	-[a]	·
CALM	4.21	1.25	4.20	1.21	0.03	0.98
ANGRY	1.00	0.00	1.00	0.00	-[a]	·
NERVOUS	1.29	0.73	1.27	0.70	0.07	0.94
SCARED	1.00	0.00	1.13	0.52	1.00	0.33
EXCITED	3.57	1.65	3.13	1.77	0.69	0.50
NON-AGG VIDEO						
HAPPY	4.50	0.85	3.87	1.64	1.32	0.20
SAD	1.14	0.53	1.07	0.26	0.48	0.63
CALM	4.14	1.51	4.47	1.06	0.67	0.51
ANGRY	1.14	0.53	1.00	0.00	1.00	0.34
NERVOUS	1.29	0.73	1.27	0.70	0.94	0.94
SCARED	1.14	0.53	1.00	0.00	1.00	0.34
EXCITED	4.00	1.52	4.20	1.42	0.72	0.72

AGG = Aggressive; NAGG = Non-Aggressive. AGG VIDEO = Aggressive Video, N-AGG VIDEO = Non-Aggressive Video. Child Self-Rating Scale coded on a continuum from 1 to 5 (1 = not at all; 3 = a little; 5 = a lot).

[a] t-scores could not be computed because the standard deviations of both groups was 0.

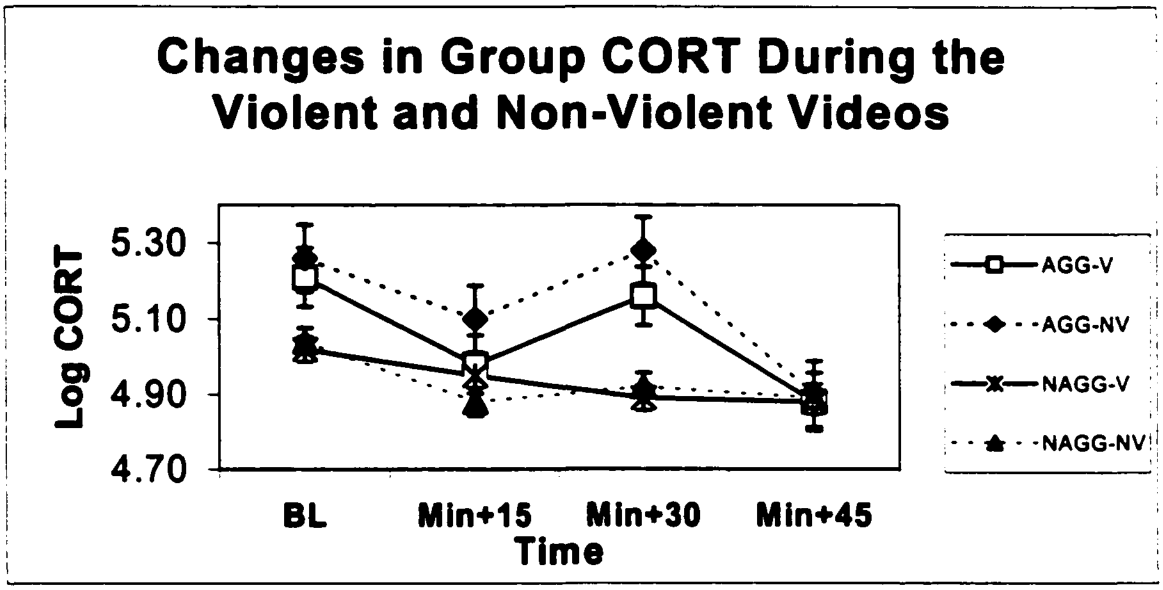


Figure 1. Changes in salivary cortisol (CORT) in the Aggressive (n = 14) and Non-Aggressive (n = 15) groups across the violent and non-violent videos. CORT levels were remarkably consistent for each group irrespective of video type.
AGG-V = Aggressive group-violent video, AGG-NV = Aggressive group-nonviolent video; NAGG-V = Non-aggressive group-violent video and NAGG-NV = Non-aggressive group-nonviolent video. BL = baseline, Min+15 = 15 min. into video, Min+30 = End of video, and Min+45 = 15 min. post video. Vertical lines depict standard Errors of the means.

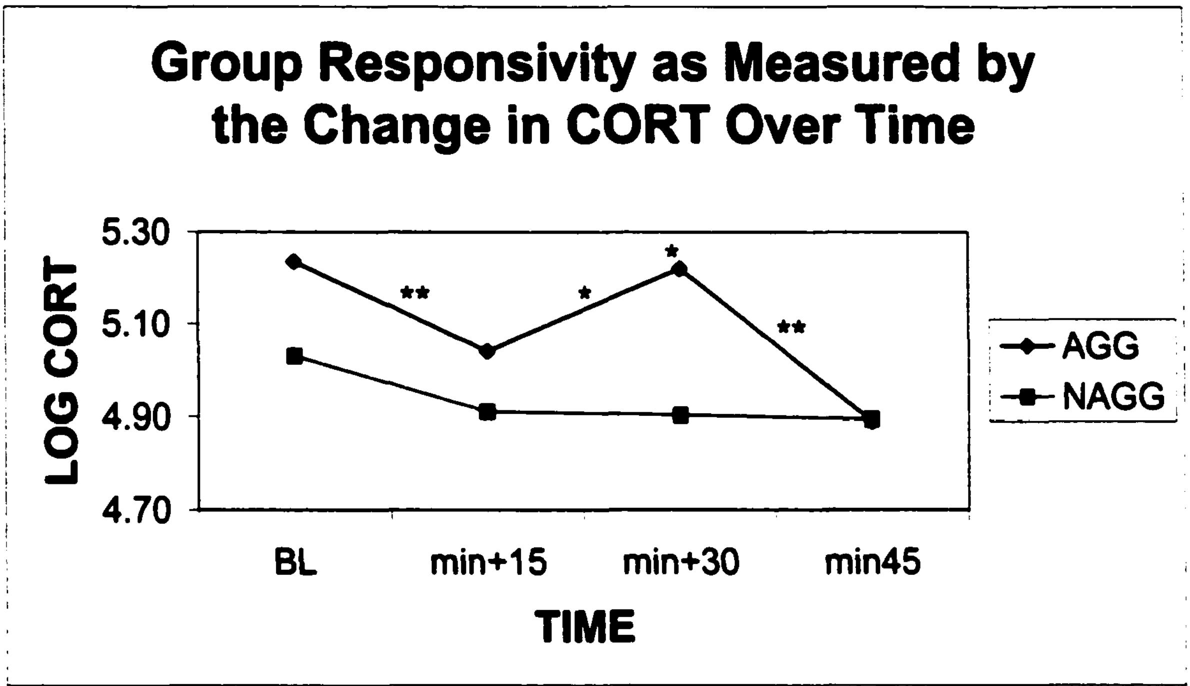


Figure 2. Changes in group salivary cortisol (CORT) levels were measured over time collapsed across video type. Overall, results indicated a significant group by time effect ($p < .05$) for the aggressive group (AGG) only. No significant changes were seen in the Non-aggressive group (NAGG).

* $p < .05$ ** $p < .01$

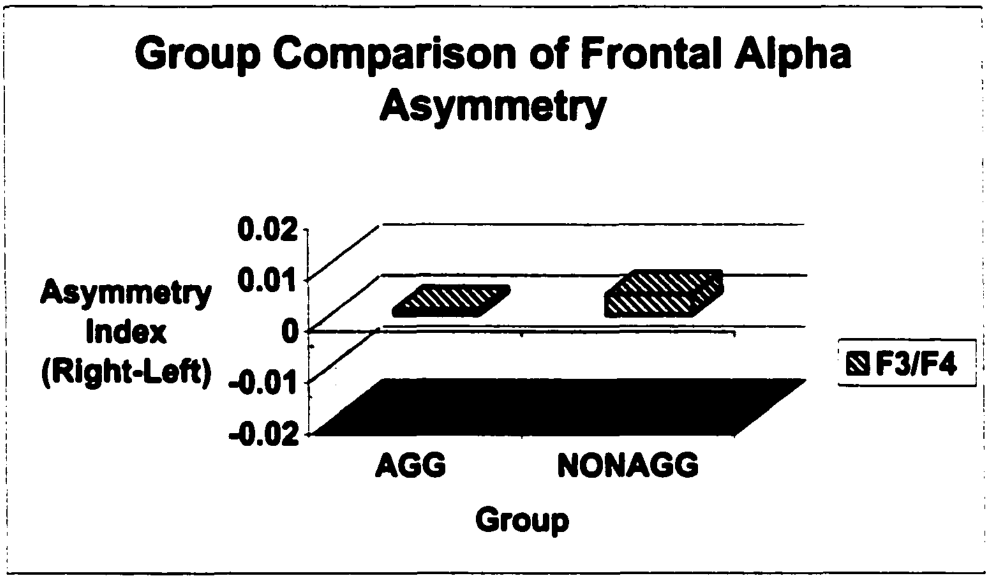


Figure 3. AGG = Aggressive group (AGG), NAGG = Non-Aggressive group. No significant group differences was seen in alpha wave asymmetry over the frontal regions (F3/F4) [p >.05].

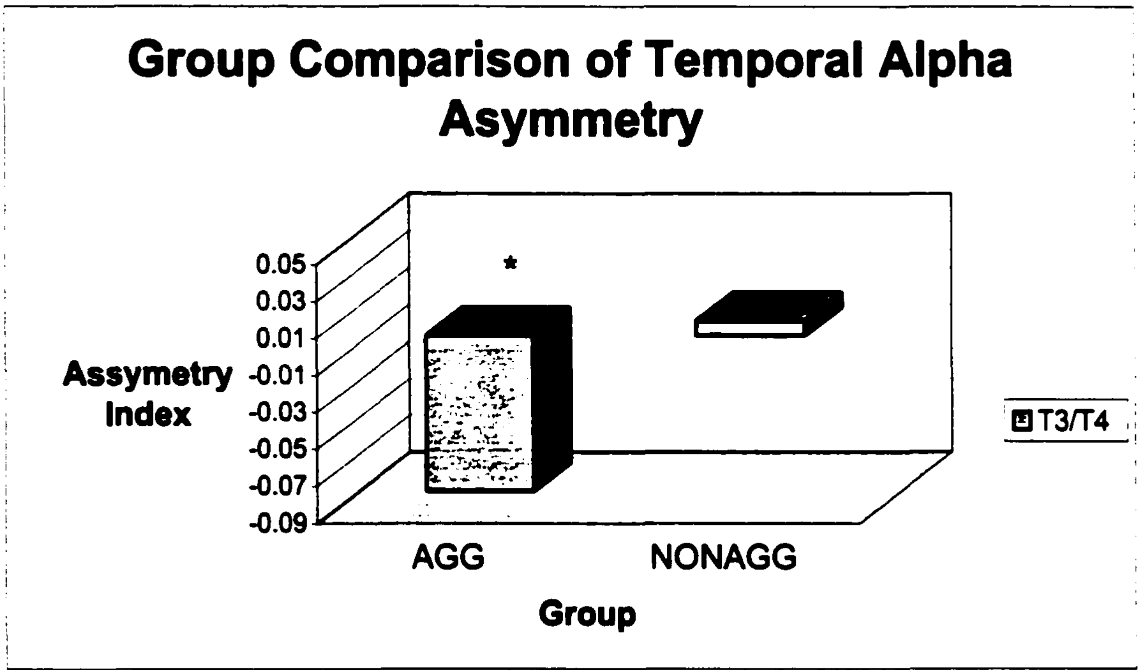


Figure 4. The Aggressive group (AGG) showed significantly greater alpha wave asymmetry over the temporal regions (T3/T4) as compared to the Non-aggressive group (NAGG) [$p < .05$]. Overall, greater left- versus right-sided temporal activity was seen in the AGG as compared to NAGG. Conversely, NAGG showed relatively consistent alpha activity across both hemispheres.

* $p < .05$

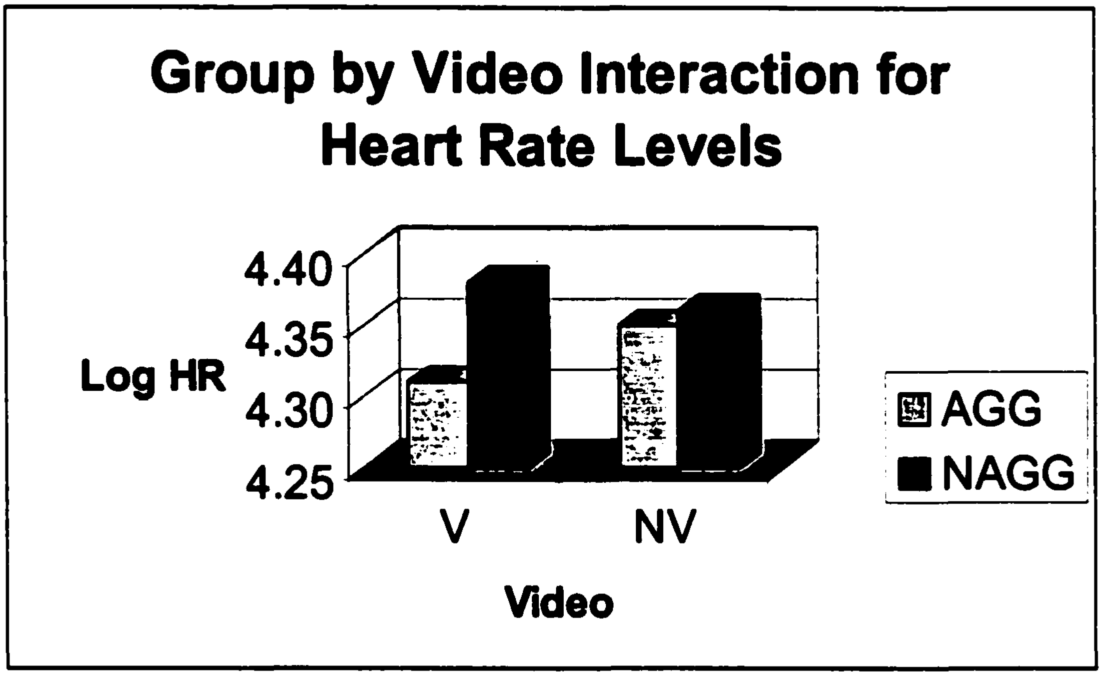


Figure 5. A significant group by video interaction was seen for the Aggressive group (AGG) and the Non-aggressive group (NAGG) [p <.05]. AGG exhibited a lower overall heart rate during the violent video (V) as compared to the non-violent video (NV). Conversely, NAGG demonstrated increased heart rate during (V) as compared to (NV).

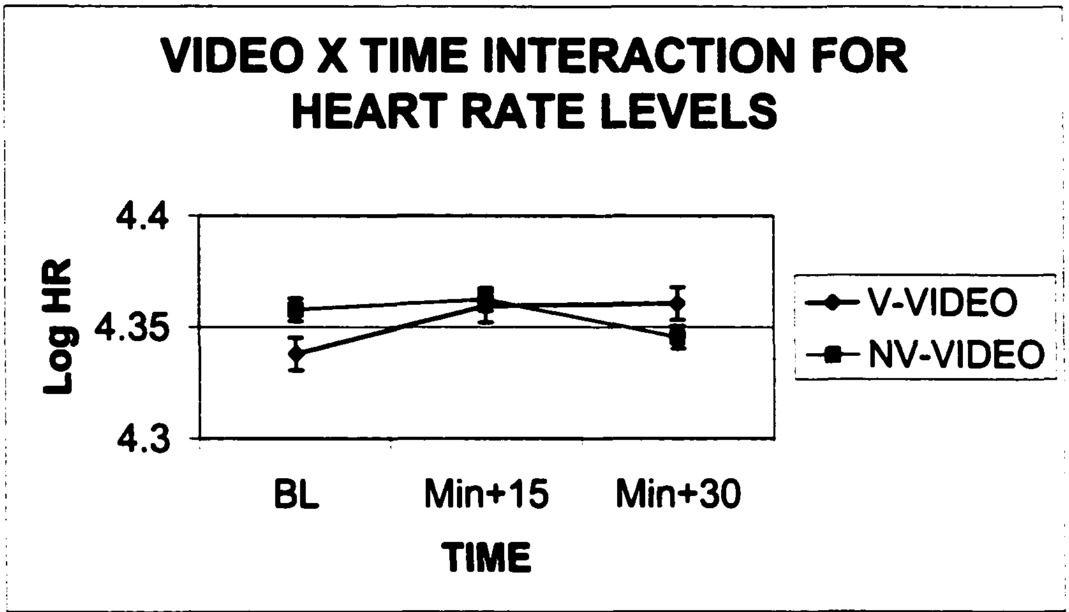
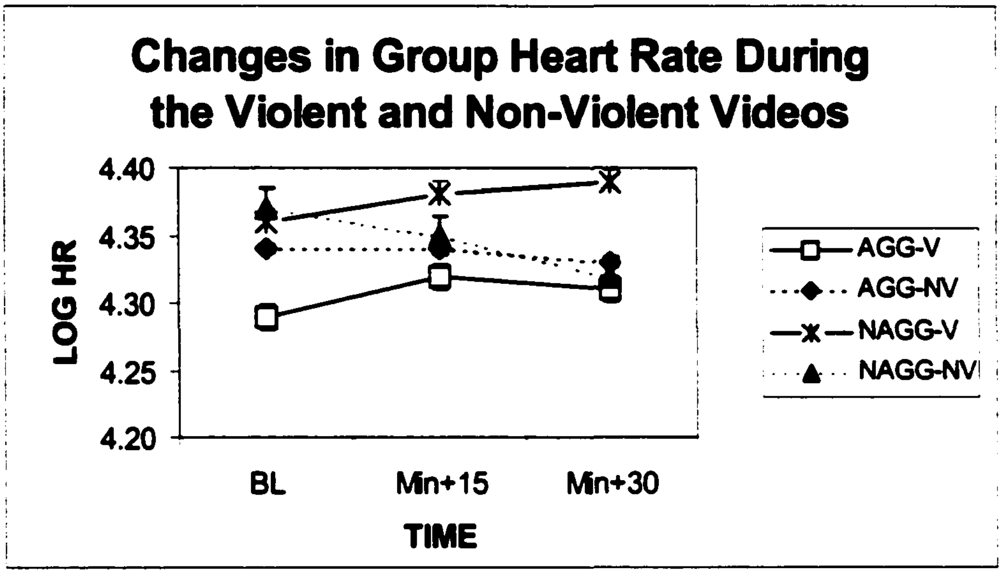


Figure 6. Depicts the significant Video by Time interaction [$p < .05$]. Overall heart rate decreased over time during the non-violent video (NV-VIDEO). Conversely, heart rate increased over time throughout the violent video(V-VIDEO). BL = Baseline, Min+15 = Middle of Video, Min+30 = End of Video.



<u>Figure 7.</u> Depicts the Nearly significant 3-way interaction (Group by Video by Time) interaction [p =.051]. Non-aggressive group (NAGG) exhibited a significantly differential heart rate response to the violent (V)versus non-violent videos (NV) [p<.01]. Specifically NAGG heart rate increased during the (V) but decreased during the (NV). No significant changes in heart rate were seen in the (AGG) during the two videos (p>.10). BL = baseline, Min+15 = 15 min. into video, and Min+30 = End of video. Vertical lines depict standard errors of the means.

APPENDICES

MOUNT SINAI SCHOOL OF MEDICINE
CONSENT FOR RESEARCH

GCO# 98-186PS

Part I- Research Participant Information Sheet

Physiological Responsivity in Aggressive and Non-Aggressive Prepubertal Children

PURPOSE OF STUDY:

You and your child are invited to participate in a research study. You qualify for participation in this study because your child is between the ages of 9 –11 and has been referred for evaluation in the Child Psychiatry Outpatient Clinic at the Mount Sinai Medical Center.

The purpose of the study is to examine the relationship between how the body reacts to different types of videos and behavior problems in children. This will be determined by measuring various behaviors in children, such their ability to pay attention, control their behavior such as not calling out in class or waiting their turn, and level of activity; by measuring Cortisol, a stress hormone often used to measure changes in feelings, in their saliva; measuring heart rate by electrocardiogram (EKG); and by measuring brain activity by electroencephalogram (EEG) from their scalp.

DESCRIPTION OF THE RESEARCH:

Only children who are not receiving medication treatment are eligible for this study. Children participating in this study will be placed into one of three groups. Two of the groups, referred to the Child Psychiatry Outpatient Clinic of Mount Sinai Medical Center, will be divided based on the presence or absence of aggressive behaviors. A control group of non-psychiatrically referred children will be recruited from neighborhood schools. You and your child can participate in this study because you sought out evaluation/treatment in the Child Psychiatry Outpatient Clinic. The approximate total time of this study will be six hours divided across 2 three hour sessions. For some children who require breaks, they will be allowed to take a 15 minute break during the sessions.

<u>Clinical/Behavioral Assessment.</u> As part of the study, your child will receive intelligence and educational testing and tests designed to measure their ability to pay attention and control their behavior, such as not calling out in class or waiting their turn. These procedures will take about 2 hours. You and your child's teacher will be asked to answer

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From: 5/1/00 To: 2/3/01

questions describing your child's behavior. In addition, you and your child will be administered a questionnaire regarding approximately how many hours per week he/she spends watching television as well as his/her three favorite television shows.

Physiological Challenge. For this test, your child will spend two 2-hr. periods in which he/she will be watching a video or playing/resting quietly. Your child should not drink any caffeinated beverages (e.g., soda or hot chocolate) or engage in any strenuous physical activity for at least 1 hour before session. Upon arriving, your child will be allowed to play or read quietly for a brief period. During this time your child will be asked to rate his/her own feelings of aggression, happiness, tensions, anger, sadness, calmness, and fright. Afterwards your child will then be shown either a 20-30 minute video depicting a training scene and boxing match from a contemporary (PG)-rated motion picture or an age-appropriate non-aggressive television program. EEG and EKG will be recorded throughout the viewing of the video. In addition, approximately six samples of saliva will be collected in salivary tubes from your child using a non-invasive procedure throughout this period. Your child will be instructed to place a cotton swab in his/her mouth and chew on it for approximately 3 minutes. Immediately after collection, the swabs will be placed in the salivary tubes for later analysis. All saliva samples will be tested for levels of cortisol. Immediately after the video, your child will again be asked to rate his/her own feelings of aggression, happiness, tensions, anger, sadness, calmness, and fright as well as being allowed to play or read quietly for a brief period. The second session will be identical to that of the first with the exception that your child will be shown the video not seen during the first session.

COSTS/REIMBURSEMENTS:

You and your child will not receive payment for participation nor will you or your child incur any costs.

POTENTIAL RISKS AND DISCOMFORTS:

Most of the behavioral tests and scales, the EEG and EKG measures, as well as the procedure for salivary collection that will be used in this study are well-known and often used for evaluating children. None of these tests or procedures are dangerous or pose any risk to your child, although there is a slight chance that the jelly used for the placement of the EEG/EKG electrodes could cause a mild allergic skin reaction. In addition, the placement of the electrodes as well as viewing the aggressive film may cause some anxiety.

POTENTIAL BENEFITS:

There are no significant benefits for participation in the study. However, as participants in this study, you and your child will receive a written report of the psychological and educational evaluation. These may be useful for future educational planning. This study is also likely to add to our knowledge about television violence and behavior disorders in children. Thus, your participation may be helpful to families who have children with behavioral difficulties.

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From: 5/11/00 To: 3/21/01

ALTERNATIVES TO PARTICIPATION:
The following are possible alternatives to participation in this study: You and your child may receive an evaluation with the Division of Child and Adolescent Psychiatry of the Mount Sinai Medical Center as a non-research participant or at a child psychiatric clinic or hospital elsewhere. Evaluations comparable to that being proposed in the context of this study are not available outside such a study because several of these tests are specific to this research.

CONFIDENTIALITY:
Every effort will be made to keep all information about your child confidential. Your child's identity as a participant in this research study will be kept confidential in any publication of the results of the study. Your child's medical record in connection with this study will be kept confidential to the extent permitted by law.

COMPENSATION/INJURY:
If you believe that you have suffered an injury related to this research as a participant you should contact Dr. Greenblatt at 212-241-6134.

VOLUNTARY PARTICIPATION:
You and your child's participation in this study is voluntary. If you decide not to participate or your child discontinues his or her participation at any time during the study this will not affect your ability to receive medical care at Mount Sinai Medical Center or to receive any benefits to which you are otherwise entitled. Even after signing this consent form, you are free to withdraw your consent and discontinue your child's participation at any time. Any new information that develops during this study, which might relate to your child's safety or affect your decision to participate, will be given to you immediately.

A signed copy of this consent form will be given to you.

TERMINATION OF PARTICIPATION:
Your participation may be terminated by the investigator if it becomes clear that your child does not meet criteria for the disorders being studied in this research. You and your child may withdraw from this study at any time without jeopardizing any present or future services at Mt. Sinai Hospital.

PERSONS TO CONTACT:
If you have any questions, at any time, about this research, please contact Dr. Greenblatt at 212-241-6134. If you still have questions about your child's rights as a research subject, you may discuss them with a member of the Institutional Review Board (the committee which oversees research at Mount Sinai School of Medicine) at 212-659-8980.

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From: 5/11/00 To: 3/2/01

MOUNT SINAI SCHOOL OF MEDICINE
CONSENT FOR RESEARCH

Part II - Authorization to Participate in Research

This form must be signed by the participant/surrogate and the investigator/delegate

Participant_______________________ _______________________
(Print Name) (Unit #)

1. I hereby volunteer to participate in a research program under the supervision of Dr. Greenblatt and his associates at Mount Sinai School of Medicine.
2. I acknowledge that I have read, or had explained to me in a language I understand, the attached consent document and that Dr. Greenblatt has explained to me the nature and purpose of these studies. This explanation included a description of the parts of the study that are experimental, the possible discomforts, symptoms, side effects and risks that I might reasonably expect, and the possible complications, if any that I might reasonably experience from both known and unknown causes as a result of my participation in these studies. I have had the opportunity to ask questions I had about the study and all the questions I asked were answered to my satisfaction.
3. I understand that I am free to withdraw this authorization and to discontinue my participation in these studies at any time. The consequences and risks, if any, of withdrawing from the study while it is ongoing have been explained to me. I understand that such withdrawal will not affect my ability to receive medical care to which I might otherwise be entitled.
4. I confirm that I have read, or had read to me, this entire authorization and that all blanks of statements that require completion were, in fact, properly completed before I signed this authorization.

Research Subject/Surrogate:_______________________ Date:__________
(signature)

Name:_______________________________________ Time:__________
(print)

Relationship:_______________________
(if signed by surrogate)

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From: 5/11/00 To: 3/21/01

MOUNT SINAI SCHOOL OF MEDICINE
CONSENT FOR RESEARCH

Authorization to Participate in Research (continued)

For subjects who are not able to read this consent document themselves, the following must be completed:

I confirm that I have accurately translated and/or read the information to the subject.

Witness: ______________________________
(signature)

Name: ______________________________
(print)

Address: ______________________________
Number and street City State Zip Code

ATTESTATION OF PRINCIPAL INVESTIGATOR/DELEGATE:

I have fully explained to the above volunteer/relative/surrogate the nature and purpose of the above-mentioned research program (including the extent to which the studies are experimental), the possible complication which may arise from both known and unknown causes as a result thereof and the consequences and risks, if any, if the subject decides to discontinue participation. I believe that he/she understands the nature, purposes, and risks of these studies. I have also offered to answer any questions relating to these studies and have fully and completely answered such questions.

____
(Signature of Principal Investigator/Delegate) (Date)

____
(Print Name) (Title)

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From: 5/11/00 To: 3/21/01

Queens College/CUNY
IRB APPROVED:
5/18/00 to 5/17/01

MOUNT SINAI SCHOOL OF MEDICINE
CONSENT FOR RESEARCH

GCO# 98-186PS

Part I - Research Participant Information Sheet

Physiological Responsivity in Aggressive and Non-Aggressive Prepubertal Children

PURPOSE OF STUDY:
You and your child are invited to participate in a research study. You qualify for participation in this study because your child is between the ages of 9 -11.

The purpose of the study is to examine the relationship between how the body reacts to different types of videos and behavior problems in children. This will be determined by measuring various behaviors in children, such their ability to pay attention, control their behavior such as not calling out in class or waiting their turn, and level of activity; by measuring Cortisol, a stress hormone often used to measure changes in feelings, in their saliva; measuring heart rate by electrocardiogram (EKG); and by measuring brain activity by electroencephalogram (EEG) from their scalp.

DESCRIPTION OF THE RESEARCH:
Only children who are not receiving medication treatment are eligible for this study. Children participating in this study will be placed into one of three groups. Two of the groups, referred to the Child Psychiatry Outpatient Clinic of Mount Sinai Medical Center, will be divided based on the presence or absence of aggressive behaviors. A control group of non-psychiatrically referred children will be recruited from neighborhood schools. You and your child can participate in this study as part of the control group because your child is currently at the same age as those referred to the clinic. The approximate total time of this study will be six hours divided across 2 three hour sessions. For some children who require breaks, they will be allowed to take a 15 minute break during the sessions.

Clinical/Behavioral Assessment. As part of the study, your child will receive intelligence and educational testing and tests designed to measure their ability to pay attention and control their behavior, such as not calling out in class or waiting their turn. These procedures will take about 2 hours. You and your child's teacher will be asked to answer questions describing your child's behavior. In addition, you and your child will be administered

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From: 5/11/00 To: 3/31/01

a questionnaire regarding approximately how many hours per week he/she spends watching television as well as his/her three favorite television shows.

Physiological Challenge. For this test, your child will spend two 2-hr. periods in which he/she will be watching a video or playing/resting quietly. Your child should not drink any caffeinated beverages (e.g., soda or hot chocolate) or engage in any strenuous physical activity for at least 1 hour before session. Upon arriving, your child will be allowed to play or read quietly for a brief period. During this time your child will be asked to rate his/her own feelings of aggression, happiness, tensions, anger, sadness, calmness, and fright. Afterwards your child will then be shown either a 20-30 minute video depicting a training scene and boxing match from a contemporary (PG)-rated motion picture or an age-appropriate non-aggressive television program. EEG and EKG will be recorded throughout the viewing of the video. In addition, approximately six samples of saliva will be collected in salivary tubes from your child using a non-invasive procedure throughout this period. Your child will be instructed to place a cotton swab in his/her mouth and chew on it for approximately 3 minutes. Immediately after collection, the swabs will be placed in the salivary tubes for later analysis. All saliva samples will be tested for levels of cortisol. Immediately after the video, your child will again be asked to rate his/her own feelings of aggression, happiness, tensions, anger, sadness, calmness, and fright as well as being allowed to play or read quietly for a brief period. The second session will be identical to that of the first with the exception that your child will be shown the video not seen during the first session.

COSTS/REIMBURSEMENTS:
You and your child will not receive payment for participation nor will you or your child incur any costs.

POTENTIAL RISKS AND DISCOMFORTS:
Most of the behavioral tests and scales, the EEG and EKG measures, as well as the procedure for salivary collection that will be used in this study are well-known and often used for evaluating children. None of these tests or procedures are dangerous or pose any risk to your child, although there is a slight chance that the jelly used for the placement of the EEG/EKG electrodes could cause a mild allergic skin reaction. In addition, the placement of the electrodes as well as viewing the aggressive film may cause some anxiety.

POTENTIAL BENEFITS:
There are no significant benefits for participation in the study. However, as participants in this study, you and your child will receive a written report of the psychological and educational evaluation. These may be useful for future educational planning. This study is also likely to add to our knowledge about television violence and behavior disorders in children. Thus, your participation may be helpful to families who have children with behavioral difficulties.

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From: 5/11/00 To: 2/31/01

ALTERNATIVES TO PARTICIPATION:
The following are possible alternatives to participation in this study: You and your child may receive an evaluation with the Division of Child and Adolescent Psychiatry of the Mount Sinai Medical Center as a non-research participant or at a child psychiatric clinic or hospital elsewhere. Evaluations comparable to that being proposed in the context of this study are not available outside such a study because several of these tests are specific to this research.

CONFIDENTIALITY:
Every effort will be made to keep all information about your child confidential. Your child's identity as a participant in this research study will be kept confidential in any publication of the results of the study. Your child's medical record in connection with this study will be kept confidential to the extent permitted by law.

COMPENSATION/INJURY:
If you believe that you have suffered an injury related to this research as a participant you should contact Dr. Greenblatt at 212-241-6134.

VOLUNTARY PARTICIPATION:
You and your child's participation in this study is voluntary. If you decide not to participate or your child discontinues his or her participation at any time during the study this will not affect your ability to receive medical care at Mount Sinai Medical Center or to receive any benefits to which you are otherwise entitled. Even after signing this consent form, you are free to withdraw your consent and discontinue your child's participation at any time. Any new information that develops during this study, which might relate to your child's safety or affect your decision to participate, will be given to you immediately.

A signed copy of this consent form will be given to you.

TERMINATION OF PARTICIPATION:
You and your child may withdraw from this study at any time without jeopardizing any present or future services at Mt. Sinai Hospital.

PERSONS TO CONTACT:
If you have any questions, at any time, about this research, please contact Dr. Greenblatt at 212-241-6134. If you still have questions about your child's rights as a research subject, you may discuss them with a member of the Institutional Review Board (the committee which oversees research at Mount Sinai School of Medicine) at 212-659-8980.

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From: 5/11/00 To: 2/8/01

MOUNT SINAI SCHOOL OF MEDICINE
CONSENT FOR RESEARCH

Part II - Authorization to Participate in Research

This form must be signed by the participant/surrogate and the investigator/delegate

Participant________________________ ____________________
(Print Name) (Unit #)

1. I hereby volunteer to participate in a research program under the supervision of Dr. Greenblatt and his associates at Mount Sinai School of Medicine.
2. I acknowledge that I have read, or had explained to me in a language I understand, the attached consent document and that Dr. Greenblatt has explained to me the nature and purpose of these studies. This explanation included a description of the parts of the study that are experimental, the possible discomforts, symptoms, side effects and risks that I might reasonably expect, and the possible complications, if any that I might reasonably experience from both known and unknown causes as a result of my participation in these studies. I have had the opportunity to ask questions I had about the study and all the questions I asked were answered to my satisfaction.
3. I understand that I am free to withdraw this authorization and to discontinue my participation in these studies at any time. The consequences and risks, if any, of withdrawing from the study while it is ongoing have been explained to me. I understand that such withdrawal will not affect my ability to receive medical care to which I might otherwise be entitled.
4. I confirm that I have read, or had read to me, this entire authorization and that all blanks of statements that require completion were, in fact, properly completed before I signed this authorization.

Research Subject/Surrogate:__________________________ Date:__________
(signature)

Name:____ Time:__________
(print)

Relationship:__________________________
(if signed by surrogate)

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From: 5/1/00 To: 2/3/01

MOUNT SINAI SCHOOL OF MEDICINE
CONSENT FOR RESEARCH

Authorization to Participate in Research (continued)

For subjects who are not able to read this consent document themselves, the following must be completed:

I confirm that I have accurately translated and/or read the information to the subject:

Witness: ______________________________
(signature)

Name: ______________________________
(print)

Address: ______________________________
Number and street City State Zip Code

ATTESTATION OF PRINCIPAL INVESTIGATOR/DELEGATE:

I have fully explained to the above volunteer/relative/surrogate the nature and purpose of the above-mentioned research program (including the extent to which the studies are experimental), the possible complication which may arise from both known and unknown causes as a result thereof and the consequences and risks, if any, if the subject decides to discontinue participation. I believe that he/she understands the nature, purposes, and risks of these studies. I have also offered to answer any questions relating to these studies and have fully and completely answered such questions.

____
(Signature of Principal Investigator/Delegate) (Date)

____
(Print Name) (Title)

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From: 5/11/00 To: 3/31/01

TOTAL P.13

CERTIFICATION OF ASSENT OF MINOR

GCO # 98-186 PS

Project Title: Physiological Responsivity in Aggressive and Non-Aggressive Prepubertal Children

I hereby certify that ______________________ has fully explained to ______________________ the nature of the study and its potential risks and benefits in a language that he/she could understand. I also certify that the child was given the opportunity to ask questions and was informed that he/she could refuse participation in the study. I further certify that the child freely gave verbal assent and has, without coercion, agreed to participate in this study.

I also certify that I have no personal relationship to the child or the research study in which the child has been asked to participate.

Signature	Typed or printed name
Title	Date

Television Preference Interview

Subject ID#:_____________ **Date:__________**

Group:____________

How many hours per week does your child spend watching TV?

0 - 5 hrs. **5 - 10 hrs.** **10 - 20 hrs.** **More than 20 hrs.**

Please list your child's three (3) favorite TV shows.

Name	Channel	Time	Day/week	Rating

Total Hours watched per week: ____________

Total violence rating: ____________

Child Self-Rating Questionnaire

Subject ID#:______________ **Date:____________**

Group:______________ **Session:__________**

Before/After Movie:____________

How do you feel right now ??

On a rating scale of 1 to 5.
Please circle how you are feeling at this time with:

1 (not at all)---------3 (a little)---------5 (a lot)

Happy	1	2	3	4	5
Sad	1	2	3	4	5
Calm	1	2	3	4	5
Angry	1	2	3	4	5
Nervous	1	2	3	4	5
Scared	1	2	3	4	5
Excited	1	2	3	4	5

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