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**THE ROLE OF ALCOHOL AND STEROID HORMONES
IN HUMAN AGGRESSION**

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ACADEMIC DISSERTATION

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To Janne and William

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ORIGINAL PUBLICATION

ABBREVIATIONS

AD	Androstenedione
AGG-	Men without a history of alcohol-related aggression
AGG+	Men with a history of alcohol-related aggression
ASPD	Antisocial personality disorder
AQ	Buss-Perry Aggression Questionnaire
CTS1	Conflict Tactics Scale
CTS2	Revised Conflict Tactics Scale
DHEA	Dehydroepiandrosterone
DHT	Dihydrotestosterone
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders
HPG	Hypothalamic-pituitary-gonadal
IPV	Interpersonal partner violence
MAST	Michigan Alcoholism Screening Test
Md	Median
RIA	Radioimmunoassay
SD	Standard deviation
S.e.m.	Standard error of mean
S.E.S	Socioeconomic status

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals:

- I Lindman, R., von der Pahlen, B., Öst, B., and Eriksson, C.J.P. (1992). Serum testosterone, cortisol, glucose, and ethanol in males arrested for spouse abuse. *Aggress. Behav.* **18**, 393-400.
- II von der Pahlen, B., Öst, B., Lindfors, B., and Lindman, R. (1997). Early antecedents of spouse abuse. *Aggress. Behav.* **23**, 239-243.
- III von der Pahlen, B., Lindman, R., Sarkola, T., Mäkisalo, H., and Eriksson, C.J.P. (2002). An exploratory study on self-evaluated aggression and androgens in women. *Aggress. Behav.* **28**, 273-280.
- IV von der Pahlen, B., Sarkola, T., Seppä, K., and Eriksson, C.J.P. Testosterone, 5 α -dihydrotestosterone, and cortisol in men with and without a history of alcohol-related aggression. *J. Stud. Alcohol* (in press).
- V von der Pahlen, B., Sarkola, T., Seppä, K., and Eriksson, C.J.P. Estradiol and human male aggression (*submitted*).

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ABSTRACT

The present thesis consists of five studies in which the aim was to investigate human aggression from a multidisciplinary perspective. Conflict tactics, childhood victimization, alcohol intake, and steroid hormones were studied in altogether 175 male (n=142) and female (n=33) subjects as possible determinants of aggressive behavior. The aggressive males included arrested spouse abusers and males with a self-reported history of alcohol-related aggression (AGG+). The female sample consisted of healthy students (study III). The controls (n=84) were age-matched male volunteers gathered either from the same police precinct (studies I and II) or in studies IV and V from the Finnish population register (AGG-).

The aggressive males resorted to verbal aggression, and physical assault and injury significantly more often during interpersonal partner violence (IPV) than male controls. The aggressive males also recalled significantly more inter-parental violence in their family of origin than did the controls. In addition, the spouse abusers recalled significantly more paternal alcoholism in their family of origin. Abuse of alcohol was significantly more common in the aggressive males compared to controls.

The cortisol level in the spouse abusers was high during police intervention and significantly higher than that of controls. In the AGG+ men, the cortisol level was negatively associated with both physical aggression and anger while testosterone was positively linked to physical assault and injury. In the female sample a significant positive link was found between free testosterone and physical and verbal aggression. 5 α -dihydrotestosterone correlated positively with the feeling of anger in both the AGG- men and in the female sample. A negative association was found between estradiol and violent aggression in AGG+ men, while a positive link was found between estradiol and emotional negotiation in both groups of men. Furthermore, estradiol was linked to psychological aggression in both AGG+ and AGG- groups.

In general, the results indicate that ineffective conflict resolution strategies in aggressive males increase the risk for IPV. The influence here of childhood victimization (e.g. witnessing abuse in the family of origin) supports not only social learning theories but may also indicate a genetic predisposition. In addition, the genetic contribution to alcoholism may partly explain the significant link between paternal alcohol abuse and spouse abusers' present drinking. The effects of modeling and context specific learning could account for why physical violence was admissible in IPV situations in an intoxicated state. The spouse abusers elevated sober state cortisol level might reflect chronic effects of hangover and stress. The spouse abusers excessive drinking and engagement in IPV indicates insufficient coping mechanisms. It is suggested that the etiology of aggression and alcohol abuse might derive from common biological and/or social factors. The negative association between cortisol, physical aggression, and anger in the AGG+ group may indicate a possible two-way mechanism for cortisol. The metabolite of testosterone, DHT, was associated with anger in both the AGG+ men and the female subjects, indicating the importance of other hormones in aggression. Finally, the female sex hormone, estradiol, may counterbalance violent, aggressive behavior and distinguish male from female aggression.

1. INTRODUCTION

There are many different human behaviors that may be called aggressive. Aggressive behaviors are exhibited in a variety of context, and for different purposes, and through different mechanisms (Goldman, 1996). Several theories have been suggested in an attempt to understand and explain the occurrence and maintenance of aggression in humans. In the DSM-IV by the American Psychiatric Association (1994), aggression is associated not with only several psychiatric disorders, such as antisocial personality disorder (ASPD), but also with alcohol intoxication. Acute ethanol intoxication produces marked behavioral changes (Barros and Miczek, 1996) and is frequently associated with violent and aggressive behavior in humans (Chermack and Giancola, 1997; Graham and West, 2001). Approximately half of all violent crimes are committed under the influence of alcohol (Roizen, 1997) and there is evidence that alcohol use often precedes or accompanies acts of marital aggression (Leonard, 1993). Analogous to the association between alcohol and aggression, an influence of steroid hormones on aggressive behavior has emerged. Testosterone, in particular, has been evaluated and re-evaluated for its part in aggressive and violent behavior, while some attention has been given to the metabolite of testosterone, 5α -dihydrotestosterone (DHT), especially in aggressive female behavior. Although a few intervention studies have reported that the administration of the female steroid hormone, estradiol, attenuates dementia-related aggression in elderly men (Kyomen et al., 1991; Shelton and Brooks, 1999), almost nothing beyond this is known about the possible role of estradiol in human male aggression. In the subtle balance of hormones, cortisol may also play an important part as a regulator in the occurrence and expression of aggressiveness. In addition, alcohol consumption seems not only to modulate aggressive behavior but also affect the hormone levels in various ways.

In the present thesis, a multidimensional approach was used in the attempt to reveal some of the mechanisms involved in human aggressiveness, and especially to explore the role of childhood victimization, alcohol intake, and steroid hormones in interpersonal violence.

2. PRESENTATION OF THE LITERATURE

2.1 Definitions of violence and aggression

Gelles and Straus (1979) defined violence as “an act carried out with the intention of, or perceived as having the intention of, physically hurting another person.” Aggression in turn is a more general concept referring to any malevolent behavior “directed toward the goal of harming or injuring another living being who is motivated to avoid such treatment” (Baron, 1977). Violence is a term that often attracts greater than normal social disapproval (Brain, 1994) while the precursor to aggression, the emotion of anger, can be described as an inner state (Björkqvist, 1997). In animal and human studies, the terms aggression and violence are used with enormous flexibility, and in most reviews both violence and anger are used interchangeable with aggression (Björkqvist, 1997; Brain, 1994).

For the purposes of this presentation, the term of interpersonal partner violence (IPV) is given preference and refers to an act or acts of aggression perpetrated against current or former intimate partner, whether spouse or cohabitant.

2.1.1 Gender differences in aggression

Males have committed the majority (85%) of all recorded crimes (Steffensmeier and

Allan, 1991). Males of all age groups have been reported to use physical aggression more than females (Björkqvist and Niemelä, 1992; Maccoby and Jacklin, 1974), while the gender difference in the use of verbal aggression has been more inconclusive (Maccoby and Jacklin, 1974; Österman et al., 1994).

Archer (2000) concluded that when specific acts were measured, women were found to be significantly more likely than men to have used physical aggression toward their partner and to have done so significantly more often. When the physical consequences of aggression, e.g., injuries requiring medical treatment, were measured, however, men were more likely than women to have injured their partner. These results are in line with an earlier finding suggesting that measures based on acts produce different results than measures based on consequences (Nazroo, 1995). Women's self-defense has been suggested as the reason for the small gender differences: that men are basically more aggressive but their female partners defend themselves, making the total number of acts similar. As Archer (2000) points out, however, there are studies indicating that more women than men initiate an attack (Bland and Orn, 1986; DeMaris, 1992) or that they are at least equally likely to do so (Straus, 1997).

Significant gender differences were found in physical and verbal forms when assessing self-reported aggression. Gladue (1991a) found men to score higher on impulsiveness and lack of patience, while women were more likely to avoid confrontation. On the Buss-Perry (1992) Aggression Questionnaire (AQ), men scored significantly higher on physical and verbal aggression although verbal aggression distinguished them less than physical aggression (Archer et al., 1995). On the anger subscale, on the other hand, significant sex differences were more difficult to find (Archer et al., 1995; Buss and Perry, 1992). Gender differences in aggressive behavior could be due more to the escalation in the actions following anger than to the frequency with which males and females become angry or

initiate aggression. Archer et al., (1995) found pronounced differences between the sexes for the more escalated forms of aggression, especially in young adults. Although a group of female prisoners scored higher than male prison inmates on all four AQ scales, significantly so on the anger subscale (Archer and Haigh, 1997), this result was explained by the inclusion of younger females than males, since the instrumental scores decreased with age. In sum, gender differences are clearest in the more escalated forms of aggression leading to injury while gender differences are smaller, or the roles are even reversed, on initiating attacks on each other. In addition, the state of anger, which can be described as a precursor to aggression, is reported equally often in men and women.

2.1.2 The genetics of aggression

Biological factors have been found to play a part in aggressive behavior in both animal experiments (Kalin, 1999) and human studies (Baron and Richardsson, 1994). An overall consensus that there is some genetic influence on aggression and antisocial behavior has been suggested (Carey, 1994). Studies indicate that the biological parents of adopted, antisocial children also have an antisocial disorder more often than controls (Bohman, 1996; Cadoret et al., 1997). Miles and Carey (1997) reported a strong overall genetic effect that may account for up to 50% of the variance in aggressive behavior. In a Swedish twin study on the development of antisocial behavior, Lichtenstein (2001) found that the genetic factors in antisocial behavior were more important in girls than boys especially among older children and on measures of aggression. A wide range of heritabilities have been reported in monozygotic and dizygotic twin experiments, and in adoption studies, ranging from nearly 0 (Loehlin et al., 1987) to 0.85 (Rende et al., 1992). More recently, Vernon et al., (1999) demonstrated again that individual differences in aggressive behavior have a

substantial genetic component although high heritability does not preclude the influence of environmental variables in the development of aggressive behavior. Overall, distinguishing between genetic and environmental influences is challenging, but it appears clear that a genetic component is present and may account for roughly half of the variance in aggressive behavior depending upon how aggression is defined and measured.

2.1.3 Extent of interpersonal violence and aggression

Male-to-female physical aggression is one of the most studied forms occurring in the family unit. The associated violence has been widely recognized as a serious public health problem, but the estimates of lifetime prevalence vary depending upon how violence was measured and defined, and upon the method of sample selection (Schumacher et al., 2001). Over 60% of the men in marital samples and more than 12% of men in normative samples have been physically aggressive towards their female partner during the prior year (Cascardi et al., 1992; Straus et al., 1980). Consistent with the latter value, Straus and Gelles (1990) found that 11.6% of women in a normative sample reported being physically abused by their partners during the preceding 12 months; 3.4% reported severe victimization. Serious and recurrent violence is a serious problem in Finland, too, and almost always is targeted toward women. Based on a victim survey, 25% of the participants in 1980 reported IPV; 17% in 1993; and 18% in 1997. IPV leading to injury has decreased during the last 20 years, from 3013 reported cases in 1980 to 2147 in 1997 (Kivivuori and Aromaa, 2001). Still, the number of women who have died annually from intentional violence in Finland has remained between 31 and 61 in each of the last ten years (Kivivuori and Aromaa, 2001). Men seldom report being the victim of IPV, but the rate of female-to-male aggression is increasing (Aromaa and Heiskanen, 1994; Aromaa

and Heiskanen, 2000; Kiviaho and Heiskanen, 1994), perhaps partly because the rate of reporting the assaults has increased.

2.2 Theories on interpersonal aggression

Numerous theories and models have been proposed, based on both scientific and theoretical frameworks, in the effort of explaining the occurrence and persistence of IPV (e.g. Dutton, 1995). Gelles and Straus (1979) divided the theories into three levels based upon the type of causal factor essential to the theory. One level of theories focuses on individual characteristics. Aggression is seen as being caused by the biological features (e.g., genes) and/or personal qualities of the perpetrator (e.g., aggressive personality, psychological defects). This class contains theories about psychopathology and alcohol.

The second level, social psychological theories, locate the source of aggression in the interaction between the individual and the social environment. In this class are the frustration-aggression theory of Dollard et al., (1939), Bandura's social learning theory (1973), Palmer's "A Clockwork Orange" theory (1972) derived from Burgess's book (1962) locating the cause of violence in boredom and thrill-seeking, and Kaplan's (1972) self-attitude theory.

The third level, sociocultural theories, focus on the social structure or arrangements that include norms, values and attitudes. Included in this level are Dahrendorf's conflict theory (1968), an extension of social learning concepts by Wolfgang and Ferracuti called the culture of violence theory (1967), Gelles' structural theory of violence (1974), and Good's resource theories (1971).

Several narrower models of IPV have been proposed focusing on variables from one or two of the theory classes. Schumacher et al., (2001) examined potential risk factors for

male-to-female physical partner violence. Included were demographic variables such as the age, socioeconomic status, and education of the perpetrator, the perpetrators' personal history variables e.g., childhood victimization and the perpetrators' psychological variables such as personality disorders, stress, and the use of alcohol and drugs.

It has become increasingly common to combine biological and psychosocial factors in behavioral models (Booth and Osgood, 1993; Dabbs and Morris, 1990). Soler et al., (2000) argued that a biosocial model, integrating social and biological factors, would be particularly well suited for the understanding of violent behavior, including IPV. The following is a closer presentation of potential risk factors for aggressive behavior.

2.2.1 Age

An important demographic variable in assessing the likelihood of aggression is the perpetrator's age. Criminal behavior is systematically related to age. Most serious crimes are committed by young adults, with a peak between 16-18 years, after which there is a steady decrease with age (Archer and Haigh, 1997; Petersilia, 1980). Earlier studies have found that aging decreases the probability of male-to-female aggression (Kantor et al., 1994; Pan et al., 1994), and that more domestic violence has been documented among younger couples (Wilt and Olson, 1996). This inversely related link between age and violence has also been documented in one of the largest studies (N=11,870) on physical aggression against partner (Pan et al., 1994).

2.2.2 Childhood victimization

Inappropriate learning conditions are suggested to form one of the most important

variables in “guiding” a child to aggressive problem solving (Huesmann et al., 1984), although both genetic factors and physiology surely have their own impact. These learning conditions consist of opportunities to witness aggression, be the target of aggression, or to experience reinforcement from one’s own aggressive behavior. The intergenerational transmission of violence (Spinetta and Rigler, 1972) and the social learning theory (Bandura, 1973) suggest that aggression is in fact learned by observation. These theories presume that practice and acceptance of aggression within the family offers a model for the child through which the child can learn aggressive behavior and achieve a goal. Experiencing physical abuse or witnessing violence in the family of origin as a child, increased the risk of later involvement in IPV either as a perpetrator (Bergman and Brismar, 1994a; Else et al., 1993; Huesman et al., 1984) or as a victim (Bergman and Brismar, 1992; Bitler et al., 1994; Hotaling and Sugarman, 1986). In fact, witnessing inter-parental violence has been more strongly related to later spouse abuse than being physically abused as a child (Hotaling and Sugarman, 1986; Kalmuss, 1984; Tolman and Bennett, 1990). It is noteworthy that once these aggressive patterns have been learned, there is relative stability in their persistence throughout adulthood (Huesman et al., 1984; Olweus, 1979). Huesman et al., (1984) suggests that each individual develops a characteristic level of aggressiveness that remains relatively stable across situations, decades and generations. The stability of aggression, especially spouse abuse, across generations, was studied in more than 600 subjects between the ages of 8-30 for over 22 years. The stability for boys was higher (0.50) than for girls (0.35) (Huesmann et al., 1984).

Choice et al., (1995) demonstrated that men who had witnessed inter-parental violence were more likely to use ineffective conflict resolution strategies which increased their likelihood of encountering marital distress and engaging in wife battering. Abusive men

have also been found to view their relationships with their father more negatively and to have witnessed more conflict between their parents as children (Beasley and Stoltenberg, 1992). Schumacher et al., (2001) concluded in a comprehensive review on aggression and violence that men's recollection of childhood aggression in the family of origin, including both experiencing and witnessing, were related to male-to-female aggression later in life. The effects seem to be small-to-medium but more importantly, consistent.

2.2.3 Stress

Farrington (1975) suggested that there is an optimum level of stress under which an individual performs best. When an individual experiences a significant change between demands and capabilities, the probability of violence increases. Farrington (1980) applied this stress model to predict intra-family violence. The nuclear family, with its unique structure, is the object of constant change and considerable amount of emotional investment. The family may, therefore, experience more stress and be less efficient in dealing with stressful situations than most other groups in society.

Lazarus (1993) defined life stress as discrete life events or experiences that are perceived as exceeding the individual's resources and perceived as negative: threat or harm. Based on an extensive review, in 13 out of 17 studies a significant link was found between Lazarus' life stress and husband-to-wife violence (Cano and Vivian, 2001). Husbands' stress has been found to correlate significantly with both physical and emotional violence (Margolin et al., 1998) while Pan et al., (1994) found no significant link between stress at work and IPV. Significant life experiences that are perceived as stressful, e.g., measured by the Life Experiences Survey (Sarason et al., 1978), appear to be more of a risk factor for IPV than day-to-day stress.

2.3 Alcohol use and abuse

2.3.1 The extent of the alcohol-aggression relation

There is strong correlational evidence for a link between alcohol intoxication and aggression and violent crimes. Many studies suggest that alcohol is involved in a large percentage of all violent crimes (Bushman, 1997; Graham and West, 2001; Murdoch et al., 1990; Pernanen, 1991). Roizen (1997) reviewed the percentage of violent offenders who were drinking at the time of the offense: 86% of the homicides, 60% of the sexual offenders, 37% of the assault offenders, 57% of the men involved in marital violence, and 27% of the female victims. In incidents of marital violence, at least one of the participants had been drinking in 24% of the cases (Kaufman Kantor and Straus, 1990). Pan et al., (1994) found the husband's alcohol intake to be related to marital aggression in an extensive sample of military personnel. There are also studies indicating that problem drinking is most predictive of IPV (Leonard et al., 1985; Van Hasselt et al., 1985). Both frequent binge drinking and severe alcohol abuse have been associated with male-to-female partner violence (Fagan et al., 1983; Leonard and Senchack, 1993). Excessive alcohol use was found to be consistently related to marital aggression (Barnett and Fagan, 1993; Leonard, 1993), and spouse abusers have often been found to have alcohol problems (Kaufman Kantor and Straus, 1989; Leonard et al., 1985). In Bergman and Brismar's (1994a) study on male alcoholics, almost 60% reported a history of violent behavior often directed towards women. Rodriguez et al. (2001) reported alcohol abuse to remain an important predictor of domestic violence even after adjustment for income, education, and age.

2.3.2 Explanations of alcohol-related aggression

Among contemporary explanations of violence and aggression, few factors have been more prevalent than the presumed pharmacological effects of alcohol (Fagan, 1990). When examining the extensive literature on alcohol and aggression, one may form the idea that aggressive behavior is a more or less predetermined consequence of an intoxicated state (Bushman, 1993; Else et al., 1993; Murdoch et al., 1990; Straus and Gelles, 1986, 1990; Quigley and Leonard, 2000). However, the underlying biological mechanisms behind alcohol-induced aggression have remained complex. Alcohol abuse and aggressive behavior may derive from common causes such as ASPD with violent and criminal behavior or from an early-onset type II alcoholism characterized by high heritability from father to son. Parental alcoholism has been found to be a strong and consistent predictor of later development of alcoholism in children (Chassin et al., 1991; Cotton, 1979; Goodwin, 1988; Hill et al., 1992). Persons with type II alcoholism and ASPD overlap in their tendencies toward aggressive behavior and excessive drinking, and may have the same genetic basis (Virkkunen et al., 1995).

Experiments in controlled settings have concluded that alcohol intoxication increases aggressive behavior (Bushman, 1997; Bushman and Cooper, 1990; Lipsey et al., 1997). Meta-analytic studies have agreed that alcohol seems to play a causal role in the expression of aggressive behavior (Bushman and Cooper, 1990; Steele and Southwick, 1985). Laboratory experiments have usually reported that intoxicated individuals become more aggressive than those who receive placebo (Chermack and Taylor, 1995; Taylor et al., 1977). In addition, intoxicated subjects administer higher levels of shock and for longer periods as punishment to alleged subjects compared to those receiving placebo beverages (Giancola and Zeichner, 1997; Gustafsson, 1985).

Provocation was found to be a stronger elicitor of aggression than either gender or alcohol (Giancola et al., 2002). Men were more aggressive than women under low provocation but equally aggressive under high provocation except in the case of extreme aggression, in which the men again exhibited higher levels than the women. Moreover, alcohol increased aggression in men but not in women. These results indicate that provocation appears to be an effective aggression-elicitor for women whereas provocation and alcohol are effective in lifting inhibitions against the expression of aggression for men (Giancola et al., 2002). Although laboratory paradigms have been useful, allowing control of dosage, procedure, and ambience, they are constricting and artificial compared to the diversity of real life situations.

The amount of alcohol consumed prior to violent crimes is highly variable, indicating that a simple, direct dose dependent, pharmacological effect on aggressive behavior is unlikely (Graham and West, 2001). The relation between alcohol and aggression is most likely affected by multiple factors (Chermack and Giancola, 1997) such as personality (Giancola and Zeichner, 1995), provocation (Taylor et al., 1979), and threat (Zeichner et al., 1994). Learned alcohol expectancies (Lang et al., 1975), situational factors (Pernanen, 1991), and biochemical factors (Virkkunen and Linnoila, 1993) might also play an integral role.

The majority of the explanations proposed for alcohol-related aggression can be divided into one of following three categories depending upon the role assigned to alcohol: (1) physiological disinhibition; (2) deviance disavowal and social learning theory or; (3) integrated theoretical models (Bushman, 1997).

2.3.2.1 Physiological disinhibition

Alcohol is thought to release inhibition and alter judgment (Kaufman Kantor and Straus, 1987) by disrupting or weakening normal functions in the brain. People usually try to inhibit and restrain inappropriate, e.g. aggressive, behavior but alcohol intoxication increases the likelihood for aggressive responses supposedly by anesthetizing the brain center that normally inhibits aggressive responding (Bushman, 1997). Even though the disinhibition theory has been one of the main theories for almost a century, disinhibition is today regarded as a combination of a complex pharmacologically related cognitive disruption (Leonard, 1984) interacting with various personal alcohol expectancies (Sher, 1985). According to these expectancy theories, aggressive and violent behavior under intoxication is based upon learned beliefs and attitudes about the “supposed” effects of alcohol. In controlled research situations subjects that believe that they have consumed alcoholic beverages start to act more aggressively regardless of beverage composition (Bushman, 1997).

2.3.2.2 Deviance disavowal and social learning

In many societies, intoxication is considered as “time-out” behavior during which a person is not responsible and accountable in the same sense as under sober conditions (MacAndrew and Edgerton, 1969). Based on data of over 2000 families, Coleman and Straus (1983) suggested that deviance disavowal theory and social learning theories could best explain alcohol-violence relationship within the family. They suggest that people learn by observing individuals being excused and forgiven for aggressive behavior under intoxication. On the other hand, people that intend to become violent or aggressive might

drink to “speed up” or bolster courage or use the intoxicated state as an excuse for possible later punishment.

Retrospective studies have found an association between childhood violence and adult alcohol problems (Hill et al., 1992). Hastings and Hamberger (1988) found alcoholic spouse abusers to be more likely to have witnessed inter-parental violence (father-to-mother) as children than non-alcoholic batterers. An association was also noted between those adult batterers that had either experienced or witnessed abuse and concurrent alcohol problems. Alcoholic men who reported being physically abused in the family of origin had higher scores on the Michigan Alcoholism Screening Test (MAST) than non-abused alcoholics. The combination of alcohol problems and a history of childhood victimization resulted in greater problems in alcoholic men (Schafer et al., 1988).

2.3.2.3 Integrated theoretical models

Alcohol is also believed to increase aggression by causing cognitive, emotional, and physiological effects and changes that increase the probability of aggressiveness. Examples of cognitive changes are reduced self-awareness and impaired intellectual functioning as proposed in the theories by Hull (1981), Pernanen (1976), and Steele and Joseph (1990).

A spurious association between alcohol and aggression might be more caused by an underlying third factor or factors on an individual, structural or even cultural level (Kaufman Kantor and Straus, 1987). Spurious association may occur by chance or coincidence, with no direct common cause. The probability is higher for violent criminals who abuse alcohol to be caught and consequently they may be over-represented in samples of arrested individuals than less intoxicated offenders (Cook and Moore, 1993).

2.4 Endocrinology of aggression

There is increasing evidence that biological factors such as different androgens should be taken into account in assessing aggressive behavior (Soler et al., 2000). The following is a closer look at those steroid hormones, as well as estradiol and cortisol, all of which fall within the scope of the present thesis.

2.4.1 Testosterone

The ancient practice of castration as a way to control both sexual and aggressive behavior in animals reflects the recognition that there is a relationship between androgens and behavior (Seidman and Walsh, 1999). A number of convergent results suggest that gonadal steroid hormones significantly shape at least some aspects of aggressive behavior in subhuman primates (Rejeski et al., 1988). In contrast to the amount of data suggesting an important role of androgens in a variety of behaviors in animals, relatively little is known about the ultimate behavioral effects of androgens in humans (Rubinow and Schmidt, 1996). In humans, particularly aggression is one of the behaviors that have been linked to the testosterone level. It is generally believed that there is a modest positive association between testosterone and aggressiveness and violent behavior in men (Archer, 1991; 1994; Brooks and Reddon, 1996; Christiansen and Knussman, 1987; Ehrencranz et al., 1974; Dabbs et al., 1987; Räsänen et al., 1999; Soler et al., 2000). In general, this positive association has been based on three types of studies: (1) group comparison studies, in which the groups are selected for the presence or absence of a particular characteristic; (2) correlational studies that examine the degree of association between androgen levels and a particular behavior; and (3) intervention and treatment studies in which the

behavioral consequences of manipulation of the androgen concentrations are observed. In the group comparison studies, men selected for atypically high violence such as prison inmates have been found to possess higher testosterone levels than less violent controls (Bergman and Brismar, 1994b; Dabbs et al., 1987; Ehrenkranz et al., 1974; Kreutz and Rose, 1972). Additionally, higher levels of testosterone have been reported in female psychiatric patients and in female prisoners with histories of both provoked and unprovoked violent behavior (Dabbs et al., 1988; Ehlers et al., 1980). In correlational studies, a significant link between testosterone levels and verbal aggression as well as physical violence has been documented in samples of spouse-abusing men (Dabbs et al., 1991; Soler et al., 2000). Self-reported aggression has also been found to be associated with testosterone in healthy men (Christiansen and Knussman, 1987), in male and female university students (Harris et al., 1996), and in male adolescence (Olweus et al., 1980; 1988). Olweus et al. (1980) reported a relation between testosterone and verbal as well as physical aggression on Olweus Aggression Inventory. Closer analysis of the verbal and physical aggression items showed a clear testosterone correlation with those items consisting of a response to provocation (Olweus et al., 1980).

Studies administering moderate doses of exogenous testosterone for both contraceptive and clinical purposes, e.g. to hypogonadal men (O'Carroll et al., 1985; Skakkebaeck et al., 1981; Wu et al., 1982), have revealed small effects of increased aggressive behavior. In a double-blind randomized crossover design, increased aggressive responding (punitive button pushes) was reported in eight men after administration of increasingly higher doses of testosterone cyprionate (Kouri et al., 1998), while another study failed to find an increase of anger with comparable doses (Tricker et al., 1996). Correspondingly, no increased ratings of aggressive feelings were found during 8 weeks of injections of testosterone enanthate in 31 healthy men (Anderson et al., 1992). In another double-blind

placebo-controlled crossover trial of low and high doses of methyltestosterone, increased euphoria and sexual arousal as well as irritability, hostility and violent feelings were reported (Su et al., 1993). On the other hand, an intriguing placebo effect was revealed in a double-blind low-dose experiment in which human males were given testosterone, placebo or no treatment. After treatment, the placebo group scored highest on self-evaluated anger, irritation, and frustration indicating possible expectancy factors (Björkqvist et al., 1994). Although attempts have been made to evaluate the behavioral changes in prisoners treated with chemical androgen suppressers or castration (Brain 1984; 1994; Heim and Hursch, 1979), the small samples and the difficulties in separating the effects of testosterone reduction and mutilation have made the assessment of possible reductions of violent behavior difficult. A summary of studies on the effects of testosterone on aggressive responding is presented in Table 1.

Table 1. Changes in aggressive behavior following testosterone administration.

Study	Subjects (N)	Changes in aggressive behavior	Compound, dose, and duration
Su et al., (1993)	healthy men (N=20)	irritability, violent feelings, hostility	methyltestosterone 40mg-240mg/day; for 2 weeks
Tricker et al., (1996)	eugonadal men (N=43)	no increase of angry behavior	testosterone enanthate 600mg/day; for 10 weeks
Kouri et al., (1998)	healthy men (N=8)	increased aggressive responses	testosterone cypionate injections; 150mg-600mg /day; for 2 weeks
Pope et al., (2000)	healthy men (N=56)	increased aggressive responses	testosterone cypionate 600mg/day; for 6 weeks

In sum, studies indicate a more consistent positive association between testosterone and aggressive predisposition in particularly violent groups, while the results in laboratory settings have been more inconclusive.

2.4.2 5 α -dihydrotestosterone

Little is known about the role of 5 α -dihydrotestosterone (DHT) in human aggression. DHT, a metabolite of testosterone, has been found to correlate significantly with spontaneous aggression and dominance in men (Christiansen and Knussman, 1987). The same laboratory also found a significant correlation between the frequency of physical violence in bushmen and DHT (Christiansen and Winkler, 1992). On the other hand, Gray et al., (1991b) did not find an association between DHT and either dominance or anger in a sample of 1709 men.

2.4.3 Estradiol

In contrast to androgens, much less attention has been paid to endogenous estrogens in male aggressive behavior. Androgens and estrogens are responsible for most of the observed differences between males and females in brain structure and function (Rubinow and Schmidt, 1996). Estrogen has been related to aggression in animals (Hilakivi-Clarke, 1996; Simon and Whalen, 1986), while human studies on estrogen and aggressive behavior have been more inconclusive (Beatty, 1992). In a study of men suffering from dementia-related aggression, the subjects receiving transdermal estradiol treatment decreased their physical and sexual aggressiveness but verbal aggression remained unchanged (Kay et al., 1996). In another small case study, conjugated estrogens reduced physical and sexual aggression in elderly demented men (Shelton and Brooks, 1999). Bulimia, which has been associated with increased aggressiveness in women, was found in one study of 33 women to be related to decreased levels of 17 beta-estradiol and increased concentrations of cortisol and testosterone (Cotrufo et al., 2000).

2.4.4 Cortisol

Studies on the role of cortisol as a mediator in aggressive behavior have yielded conflicting results. Basal cortisol levels have been observed to correlate positively with aggression in control populations (Gerra et al., 1998; Westrin et al., 1998). Increased cortisol levels have also been found in men with violent and suicidal behavior (van Heeringen et al., 2000) and in alcoholic men with a history of aggressive behavior (Buydens-Branchey and Branchey, 1992). However, lower levels of cortisol have also been reported in abusive and suicidal alcoholics (Bergman and Brismar, 1994b), in men with aggressive and antisocial behavior (Dolan et al., 2001; Virkkunen, 1985), and in boys referred for disruptive behavior (McBurnett et al., 2000). In Banks and Dabbs (1996) study, the cortisol level did not differ between men and women of delinquent and violent nature in comparison to college students of same age.

The link between aggression and cortisol has been explained by both direct and/or indirect effects of stress (Lindman et al., 1997). Stress may lower the threshold for aggressive actions which then increase cortisol levels. Alternatively, stress may increase alcohol intake that causes both cortisol levels and aggression to rise. The positive association between cortisol and aggression has also been related to an overactive hypothalamic-pituitary-adrenal (HPA) function revealed by excessive alcohol drinking (Buydens-Branchey and Branchey, 1992) and/or to over-sensitivity to stress produced by social factors (van Heeringen et al., 2000). The negative correlations between cortisol and aggression are supported by several earlier results (Bergman and Brismar, 1994b; Dolan et al., 2001; McBurnett et al., 2000; Virkkunen 1985) and partly explained by the ability of cortisol to lower testosterone levels (Cumming et al., 1983). Dabbs et al. (1991) proposed on the basis of a prison study that cortisol may inhibit violence in high-testosterone males.

Changes in cortisol may also be a biological consequence of social withdrawal that moderates testosterone levels (Dabbs et al., 1991).

2.5 Glucose

Impulsive behavior and aggression have also been related to low glucose levels. Virkkunen et al., (1994) suggest that it is during episodes of low glucose levels caused by inebriation that alcoholic, impulsive offenders are most likely to exhibit unprovoked, interpersonal violent behavior. Glucose tolerance tests on 56 violent offenders with antisocial personalities showed extremely rapid increases and decreases in the blood glucose levels with a tendency towards reactive hypoglycemia with a slow return to basal values (Virkkunen and Huttunen, 1982). Part of the glucose relation may be affected by the hypoglycemic effect of alcohol (Ylikahri, 1980). In addition, alcohol consumption can be considered as a stress factor influencing glucose metabolism by simulating the hypoglycemia induced by insulin (Sereny et al., 1975).

2.6 Effect of alcohol on hormones

Overall, the effect of alcohol on steroids is of importance since aggressive behavior is not only associated with androgens but also strongly correlated with alcohol intake. In the following, the effects of alcohol on steroid hormones and cortisol are briefly discussed.

2.6.1 Effect of alcohol on testosterone and DHT

Alcohol consumption has been found to have both short and long term impacts on testosterone levels in men (Mendelson et al., 1977; Van Thiel and Lester, 1979; Ylikahri, 1974). A large intake of alcohol leads to an acute decrease in the testosterone concentration in males (Mendelson et al., 1977; Ylikahri et al., 1974). An alcohol intake of 1.5 g/kg per body weight decreased blood testosterone level by 20 to 40 percent from baseline within 10 to 16 hours from drinking onset in healthy men (Välimäki, 1990). Chronic intake of alcohol has also been found to suppress testosterone levels of male alcohol abusers (Eagon et al., 1983; Irwin et al., 1988; Van Thiel and Lester, 1979). In women, however, the blood plasma testosterone level seems to increase very quickly even with low alcohol doses. Thus, Eriksson et al., (1994) and Sarkola et al., (2000) reported acute elevations in the testosterone concentrations in premenopausal women in the midphase of the menstrual cycle and in women using oral contraceptives during the whole cycle. Little effects of alcohol on DHT have been found (Sarkola et al., 1999).

2.6.2 Effect of alcohol on estradiol

Estradiol levels have been found to increase in current male alcoholics (Muti et al., 1998) and female alcohol abusers (Handa et al., 1997; Reichman et al., 1993). The alcohol-mediated estrogen elevations may be a result of increased aromatization (Couwenberg, 1988) or decreased catabolism in the liver (Sarkola et al., 2000).

2.6.3 Effect of alcohol on cortisol

Higher doses of alcohol intake elevate the cortisol level, especially in the hangover phase, in normal healthy men (Ylikahri et al., 1978). In response to alcohol intake, both normal and decreased levels of cortisol have been found in men with a family history of alcoholism compared to controls (Gianoulakis et al., 1996; Schuckit et al., 1996). On the other hand, studies have also indicated an absolute increase in corticosteroids in alcoholics during chronic drinking (Mendelson et al., 1971; Prinz, 1980; Stokes, 1973) followed by a decrease during abstinence (Stokes, 1973). Another study (Buydens-Branchey and Branchey, 1992), however, showed that cortisol was highest during the week after cessation of alcohol intake after which a decrease could be seen for the following three weeks in the entire sample of depressed or violent alcoholics. The decrease in cortisol over time was more abrupt in alcoholics incarcerated for violent behavior than in the depressed alcoholics. During withdrawal and detoxification, both normal and elevated cortisol levels have been found in alcoholic men (Wand and Dobs, 1991). Individuals displaying severe forms of violence could have dysregulated HPA function revealed by exposure to excessive amounts of alcohol (Buydens-Branchey and Branchey, 1992).

3. AIMS AND HYPOTHESES OF THE PRESENT THESIS

The aim of the present thesis was to study the role of alcohol intake, steroid hormones, and cortisol in human aggression. Conflict tactics and childhood victimization were also included in the attempts to investigate aggressive behavior from a multidisciplinary perspective in men and women. The first two studies focused on intoxicated violent spouse abusers and their hormone levels, conflict strategies and family histories of violence and alcohol abuse. The third study examined healthy women's aggressiveness on the AQ (Buss and Perry, 1992) in relation to their hormone levels. The last two examined men with a history of alcohol-related aggression and their aggressiveness on the AQ and their conflict tactics in relation to their steroid hormone levels. The specific aims and hypothesis were the following:

- I to study the hormonal levels in arrested intoxicated spouse abusers in comparison to their own sober state levels as well as to equally intoxicated but nonviolent control men. In addition, the spouse abusers sober-state hormonal levels, alcohol intake and conflict resolution strategies were expected to differ from a second, sober and non-violent control group on all variables.
- II to study the relative importance of family histories of alcoholism and/or paternal violence in violent spouse abusers. Paternal drinking was expected to correlate with present drinking and paternal violence with the spouse abuser's present aggressiveness and abuse. The inter-parental violence witnessed by the spouse abusers as children was expected to predispose subjects to repeated violence under intoxication.

- III to study the association between self-reported aggression (AQ) and steroid hormones in healthy women. Dehydroepiandrosterone (DHEA), androstenedione (AD), free and total testosterone, and DHT were assessed. A positive association between testosterone and aggression proneness was expected in healthy women.
- IV to investigate the role of testosterone, DHT and cortisol in men with a history of alcohol related aggression and in a cross-sectional sample of control men. The men with a history of alcohol-related aggression were expected to have higher testosterone, DHT, and lower cortisol levels as well as higher alcohol consumption. They were also expected to be more aggressive on the self-reported sober-state aggression measures compared to the cross-sectional control population.
- V to study the interaction between testosterone and estradiol in terms of conflict tactic strategies in men with a history of alcohol-related aggression and age-matched male volunteers. The testosterone level was expected to be higher and estradiol level lower in the men with a history of alcohol-related aggression.

4. SUBJECTS A METHODS

4.1 Experimental protocols

Table 2. Description of study designs.

Subjects	N	Main variables	Methods	
I	Male spouse abusers Sober controls Intoxicated controls	16 19 20	Aggression (CTS1), Alcohol, Testosterone, Cortisol, Glucose,	Blood samples Questionnaires Interviews
II	Male spouse abusers Sober controls	19 19	Aggression (CTS1), IPV in family of origin, Alcohol intake	Retrospective data Questionnaires Interview
III	Healthy women	33	Aggression (AQ), Testosterone, DHT, AD, DHEA	Blood sample Questionnaires
IV	Males with alcohol-related aggression Age-matched controls	40 44	Aggression (AQ), Alcohol, Testosterone, DHT, Cortisol	Blood sample Questionnaires
V	Males with alcohol-related aggression Age-matched controls	40 44	Aggression (CTS2), Alcohol, Testosterone, Estradiol	Blood sample Questionnaires

4.2 Study subjects

4.2.1 Ethical aspects

The present studies (I-V) were all based on informed consent and approved by the police authorities (I, II), a local ethical committee (III), or by the National Public Health

Institute's ethical committee (IV, V). All studies were conducted according to the guidelines proposed in the Declaration of Helsinki.

4.2.2 Serum testosterone, cortisol, glucose, and ethanol in males arrested for spouse abuse

In study I, three separate groups of men were studied. The first group consisted of men taken into police custody for reported spouse abuse (N=16). A voluntary blood sample was taken within one hour of the violent incident. A second sober-state blood sample was obtained together with a semi-structured interview at spouse abuser's home, usually within one week of the incident. The spouse abusers served as their own controls. Semi-structured interviews included self-reports on alcohol intake (frequency and amount per occasion) and aggressive behavior. The Conflict Tactics Scale (CTS1) questionnaire was given to assess habitual use of violence (Straus, 1979). The second group of men consisted of randomly selected age-matched controls (N=19) recruited outside a shopping center in the same district. The sober control men received the same instructions as the spouse abusers and a blood sample was taken at the end of an almost identical interview. The third control group included intoxicated male controls (N=20) at comparable intoxication levels with the spouse abusers. A blood sample was taken on the spot usually at a pub, bar, or restaurant in the same district. The intoxicated controls received the CTS1 to fill out at home, when sober. The spouse abusers had been previously arrested (median = 8.5 times; range 1 to 72) during the last 18 months based on official police records. This was the first arrest for eight of the spouse abusers, while seven had ten or more arrests during this period. None of the sober or the intoxicated controls had been arrested for spouse abuse during the same period (von der Pahlen and Öst, 1991).

4.2.3 Early antecedents of spouse abuse

The subjects in study II are identical to those in study I, except for the intoxicated controls, consisting of men arrested for spouse abuse (N=19) and sober controls (N=19). A semi-structural interview was conducted in which the subjects answered the CTS1, reported retrospective data on paternal drinking habits, and described their current use of alcohol. In addition, subjects were asked to recall the amount of inter-parental spouse abuse and violence they had witnessed and experienced during childhood.

4.2.4 An exploratory study on self-evaluated aggression and androgens in women

Study III consisted of healthy, premenopausal female volunteers (N=33) recruited by advertising in newspapers and a bulletin board at the University of Helsinki. All female subjects included had a history of regular menstruation, no record of hirsutism, none were using any medication. In addition, subjects were interviewed by phone to exclude those with alcohol abuse. Subjects answered a modified version of the Buss and Perry (1992) Aggression Questionnaire (AQ). A blood sample was taken at the mid-phase of the menstrual cycle.

4.2.5 Testosterone, DHT, cortisol and estradiol in AGG+ and AGG- men

The same subjects were used in study IV and V: men responding to newspaper advertisements searching for subjects with a history of alcohol-related aggression (N= 40) and a cross-sectional sample of age-matched controls (N=44) obtained from the Finnish Population Register. A questionnaire package was sent to the subjects including the AQ,

Selzer's (1971) Michigan Alcoholism Screening Test (MAST), and the CTS2 (Straus et al., 1996). Questions about the subject's demographics, alcohol intake (frequency of drinking occasions and amount consumed), and violent behavior in family of origin were also gathered. When questionnaires were returned a blood sample was taken.

4.3 Standardized questionnaires

4.3.1 CTS1 and CTS2

The CTS1 (Straus, 1979) is a widely used standardized measurement for IPV. CTS1 measures the extent to which partners in a dating, cohabiting, or marital relationship engage in physical attacks on each other. Each item describes an abusive act, ranging from reasoning to verbal aggression to severe acts of violence. Subjects are instructed to respond on a scale between 0-5 on each item, indicating whether or not the subject himself and the partner have ever engaged in each behavior described. A revised and enlarged version of CTS1 was presented 1996 by Straus and colleagues in response to disagreement as to which scale items should be included and to requests for revising and enlarging the original CTS1 (Straus 1979; 1990). The new test was called the Revised Conflict Tactics Scale (CTS2). The theoretical basis is the same despite the differences between CTS1 and CTS2. Straus et al. (1996) assumed that conflict is an inevitable part of all human association whereas violence, as a tactic to deal with conflict, can often generally be avoided. The revised CTS2 consists of 39 items and differs in several aspects from CTS1. "Reasoning" was replaced with a new scale composed of items measuring actions taken to settle a disagreement through discussion. Two new scales were included in CTS2 – "Sexual coercion" and "Injury" – and the original three scales were renamed "Negotiation"

(Reasoning), “Psychological aggression” (Verbal aggression) and “Physical assault” (Violence). The negotiation scale can be divided into cognitive and emotional subscales and the other four scales into minor and severe degrees. The most frequent application has been to obtain data on physical assault on a partner (Straus et al., 1996).

4.3.2 The Aggression Questionnaire and MAST

The AQ (Buss and Perry, 1992) was originally derived from the widely used Buss Durkee Hostility Inventory from 1957 (Buss and Durkee). The AQ has shown significant reliability, both for internal consistency and test-retest correlations, as well as convergent validity with other self-report measures of aggression (Harris, 1997). The AQ is also thought to be useful for examining the association between biological and psychosocial factors and aggressiveness (Archer et al., 1995).

Previous research has revealed that the MAST has significant validity, with good sensitivity and specificity, as a screening instrument for the detection of alcoholism (Else et al., 1993; Hirata et al., 2001; Maisto et al., 1995; Teitelbaum and Mullen, 2000). In addition, the MAST has been successfully used in different countries and age groups (Hirata et al., 2001). The MAST can, however, be criticized for not distinguishing between past and current cases of alcoholism (Hirata et al., 2001). All standardized questionnaires were given in translated form.

4.4 Analytical procedures

4.4.1 General procedures

In study I, the first blood sample was obtained at the police station approximately between 6 p.m. and 2 a.m. The second blood sample was roughly matched to the subject's first sample with respect to the time of day. In this study serum testosterone, cortisol, glucose, and ethanol levels were determined from all male subjects. In study III, blood samples were taken at the mid-phase of the menstrual cycle at 6 p.m. to assess the levels of total and free testosterone, DHT, AD, and DHEA. In study IV and V, blood samples were collected in tubes containing 22.5 mg of sodium fluoride and 22.5 mg of potassium oxalate as anticoagulants for a volume of 10 ml blood at 8 a.m. Plasma samples were prepared within 2 hrs and stored at -70°C until determinations. In addition to ethanol, plasma free and total testosterone, DHT, estradiol, and cortisol were assessed.

In studies III to V, plasma samples were used while in study I serum was used. Serum and plasma can be used equally well in hormonal determinations. Plasma is more easily separated and gives larger quantities than serum from the same quantity of whole blood.

All subjects (except the intoxicated spouse abusers and intoxicated controls in study I) were advised to abstain from alcohol 24 hours prior to the blood sampling, but no instructions or restrictions were given regarding meals or snacks in studies I-III. The abstaining from alcohol was measured in study III. In studies IV and V, information was gathered about meals, smoking, and medication, but no restrictions were made.

4.4.2 Biochemical determinations

Serum testosterone levels and cortisol (study I) were determined by standard radioimmunoassay reagent sets (RIA) from Farnos Diagnostica, Oulunsalo, Finland. The plasma testosterone level in study III was determined by RIA reagent sets from Orion Diagnostics, Espoo, Finland, while all free testosterone determinations and AD were determined by RIA reagent sets from Diagnostic Products Corporation, Los Angeles, USA. In study III, the DHEA level was determined as described in Sarkola et al., (2000), and DHT as described in Apter et al. (1976). In study IV testosterone and cortisol determinations were made with RIA reagent sets from Orion Diagnostics, Espoo, Finland. In study IV, the DHT RIA reagent set was obtained from Diagnostics Systems Laboratories (DSL-9600), Webster, TX. In study V, the estradiol RIA reagent set was obtained from DiaSorin, Italy (Estradiol-2). Glucose was determined enzymatically (for more details see study I). The within-assay and between assay variabilities for all hormones determination were less than 10-15%. All blood ethanol levels were measured by headspace gas chromatography (Eriksson et al., 1977). Laboratory technicians who were unaware of the identity of each sample assayed all samples.

4.5 Statistical methods

Results are reported as means and SD if not otherwise specified. In studies III-V, logarithmic transformations were used for hormonal data to improve normality. The Mann-Whitney U-test, MANOVA, Pearson's product-moment correlation, Spearman's rank-order correlation, partial correlation, and regression analysis were used depending on the

type of data and the required comparisons. Data were analyzed using SPSS and LISREL statistical programs. Significance is denoted by * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

5. RESULTS

5.1 Aggressive behavior

5.1.1 Group differences on CTS1 and CTS2

In studies I and II, the spouse abusers scored significantly higher on verbal aggression and violence than the sober controls (Md=1.89, SD=1.90 versus Md=0.50, SD=1.03); $t(36)=2.82$; $p < 0.01$). The AGG+ men scored significantly higher on psychological aggression, physical assault, and injury than the AGG- controls in study V as presented in Table 3.

Table 3. Scale means (\pm s.e.m.) and significance based upon the mean difference on the CTS2 for AGG- and AGG+ men (sexual coercion not included, see article V for details).

	AGG- (N=44)	AGG+ (N=40)	p
Negotiation (total)	57.8 \pm 5.8	56.3 \pm 6.3	.866
Emotional	33.3 \pm 3.4	33.2 \pm 3.6	.984
Cognitive	23.1 \pm 3.0	24.7 \pm 3.2	.721
Psychological (total)	15.8 \pm 2.7	33.6 \pm 5.4	.002**
Minor	14.1 \pm 2.5	29.0 \pm 4.1	.002**
Severe	1.6 \pm 0.7	4.6 \pm 1.3	.037*
Physical (total)	1.4 \pm 0.5	11.6 \pm 3.1	.001***
Minor	1.1 \pm 0.3	8.8 \pm 2.3	.001***
Severe	0.3 \pm 0.2	3.1 \pm 0.9	.002**
Injury (total)	0.9 \pm 0.0	1.6 \pm 0.6	.002**
Minor	0.9 \pm 0.0	1.3 \pm 0.4	.072
Severe	0.0 \pm 0.0	0.3 \pm 0.2	.005**

5.1.2 Group differences on the AQ

In the female sample in study III, the AQ subscales served as measurements for a latent aggression construct. The anger scores and the verbal and physical aggression scores were the most important indicators of aggression, while hostility bore the least resemblance to the construct as defined by the other scales. The AGG+ men, in study IV, scored significantly higher on verbal aggression, anger, and hostility scales than AGG- men (Fig. 1). The gender differences on the AQ and the mean score on the AQ subscales for AGG- and AGG+ men in study IV and the females in study III are presented in Fig. 2.

Fig.1. The AGG- and the AGG+ groups mean scores (SD) on the subscales of the AQ.

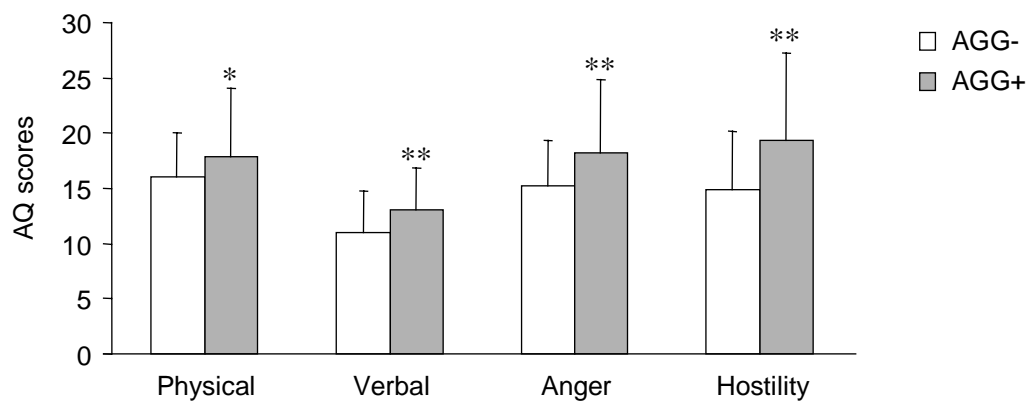
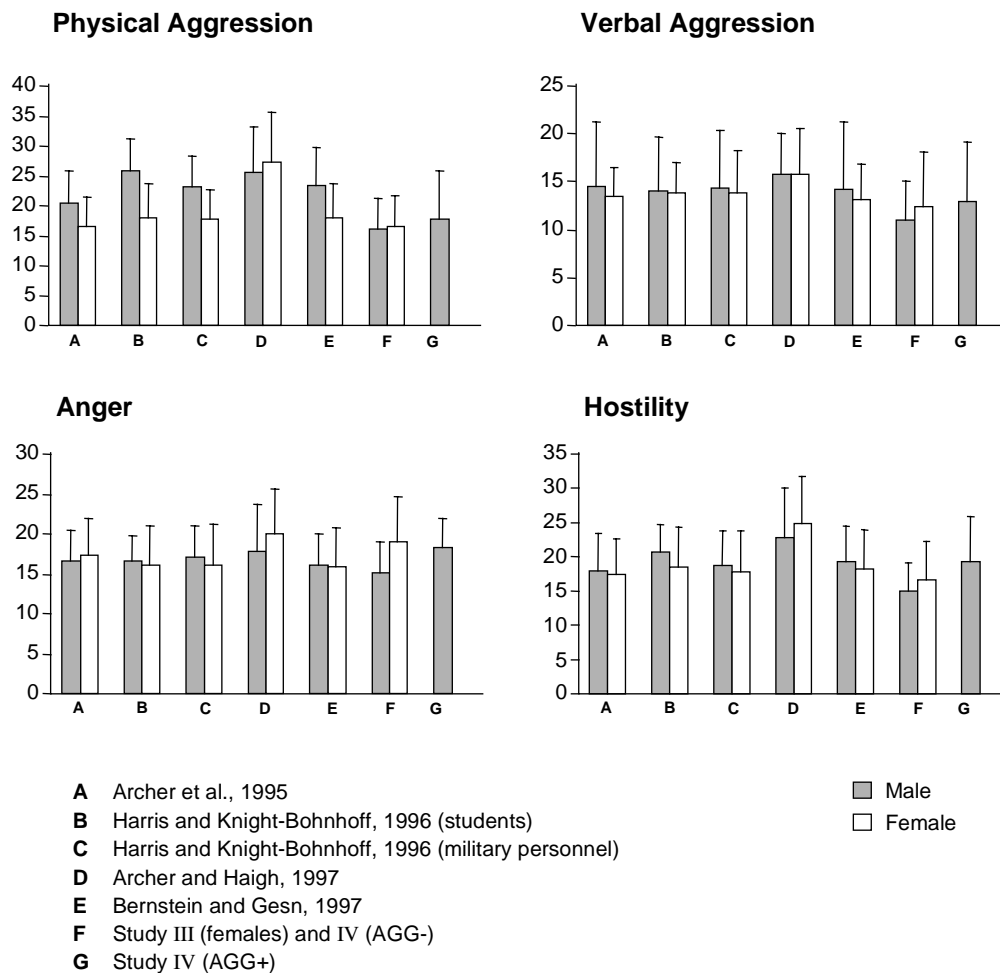


Fig. 2. Gender differences (means and SD) on the AQ scales. The AGG- and AGG+ men in study IV and the females in study III are included.



5.1.3 Inter-parental violence in the family of origin

In study II, more physical aggression in their family of origin was recalled by the spouse abusers than by the controls ($\chi^2(1)=4.76$; $p<0.01$). Similarly, in study IV, the men with a history of alcohol-related aggression had witnessed significantly more inter-parental violence (46.3 %) than the controls (16.3 %) (unpublished result).

5.2 Alcohol use and abuse

5.2.1 Group differences in alcohol intake

The spouse abusers (I, II) differed significantly on their self-reported amount of alcohol intake. The spouse abusers reported a significantly higher median alcohol intake (30 standard portions; 1 portion = 12g ethanol) per week compared with both intoxicated controls (15) and sober controls (2). Almost half of the spouse abusers (47%) reported drinking every day. In studies IV and V, the AGG+ and AGG- reported 16.8 respectively 12.0 drinks per week. The women in study III were light to moderate alcohol drinkers reporting an average alcohol intake of 7.8 standard drinks per week.

5.2.2 Alcohol intake in the family of origin

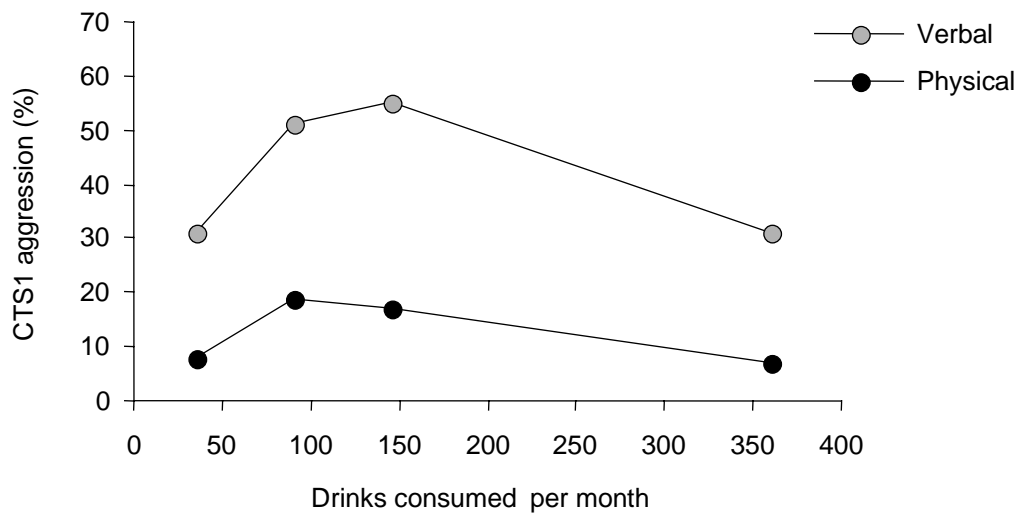
In study II, the spouse abusers recalled significantly more paternal drinking than the controls ($t(36) = 2.17$; $p < 0.05$); 30 % of the fathers of the AGG+ men in study IV were considered problem drinkers compared with 11 % for the control sample (unpublished results).

5.2.3 Alcohol intake and spouse abuse

Those spouse abusers in study I who consumed three to five drinks daily were most likely to engage in aggression compared to those spouse abusers consuming either more or less than this amount (Fig. 3.). In study II, the latent structure model indicated offenders present drinking habits and paternal drinking to be important determinants of accumulated

violence history. Present aggression was well predicted by paternal aggressiveness but was not as closely related to a violent history as was current heavy drinking.

Fig. 3. Proportional use of verbal and physical aggression by offender and spouses as function of the spouse abusers drinking habits



5.3 Steroid hormones and aggressive behavior

In study I, the testosterone level in the intoxicated offenders was significantly lower than their own levels while sober, but their cortisol level was higher when intoxicated. The offenders did not significantly differ from a group of intoxicated but nonviolent controls with respect to testosterone, cortisol, or glucose levels. On the other hand, the offenders' sober state cortisol and glucose concentrations were significantly higher than those of the nonviolent, sober controls.

In the female sample in study III, the LISREL analyses indicated free testosterone (24%), DHT (16%), and AD (14%) to be statistically significant predictors of aggression,

each accounting for over 10% of the variance. When hormones were analyzed individually, the highest correlation was found between free testosterone and verbal aggression ($r=.49$, $p=.004$) while DHT correlated more specifically with the anger subscale ($r=.38$, $p=.029$). A common feature for all androgens, except for DHT, was the small negative correlation with age and a high intercorrelation.

In study IV, there were no significant differences in the steroid hormone levels between AGG+ and AGG- men. Cortisol in the AGG- group showed a tendency to correlate with physical aggression, and DHT tended to correlate with verbal aggression. On the other hand, there were no significant correlations in the AGG+ group between steroid hormones and AQ subscales. When further examining the relationships between AQ and hormones, partial analyses revealed a significant negative correlation between cortisol and physical aggression and positive correlations between androgens, verbal aggression, and anger. Again there was a general tendency for all androgens in both groups to show the high negative correlations with age and the high intercorrelations.

Estradiol correlated positively with the emotional negotiation scale; this scale reflects self-reported feelings of care and respect for the partner during aggressive conflict situations. The correlation was significant in the overall population ($\rho= 0.332$, $p<0.01$). Estradiol also correlated with cognitive negotiation and psychological aggression. Testosterone again correlated with the physical assault and injury scales. Those AGG+ men who reported inflicting injury showed significant distribution differences from all the other subjects. Significantly lower estradiol levels were displayed in these particular AGG+ men even though their testosterone levels did not differ.

6. DISCUSSION

The abuse of women by their male partners has been studied from a wide range of perspectives, yet the theories and models explaining IPV have not fully captured the diversity and complexity in this unfortunately common and difficult human behavioral pattern (Gortner et al., 1997; Soler et al., 2000). The aim of the present thesis was to investigate human aggressive behavior from a multidisciplinary perspective combining psychosocial and biological factors as possible determinants.

6.1 Age

The scores on AQ have been reported to decrease with increasing age in both sexes (Harris and Knight-Bohnhoff, 1996). The results from the men in study IV and V support the inversely related link between age and violence (Dabbs et al., 1987; Harris 1996; Pan et al., 1994). Only a tendency for a negative correlation between age and physical aggression was found in the female sample in study III, but the failure to see a stronger effect might have been caused by the relatively small variation in age among the women. The mechanism responsible for aggressive behavior decreasing with age could involve the decreasing levels of testosterone and DHT modulations with age in men, but it also could reflect social learning. The latter is suggested by the fact that older males were as likely to report use of verbal abuse as younger males. Thus, age might contribute to learning to solve conflict verbally before it escalates into physical abuse (Soler et al., 2000). Along these lines, Choice et al., (1995) found older men to use more effective conflict resolution strategies, reducing the chances of physical aggression.

6.2 Gender

On the AQ, Archer et al., (1995) found men to score higher than women on physical and verbal aggression even though the differences on the verbal aggression scales were small. Archer et al., (1995) reported modest gender differences between the anger and the hostility scales; these gender differences could also be seen in the present results in studies III and IV. Males showed a close association between anger and hostility, but females showed more independence between these two subscales. Women have been reported to use more indirect forms of aggression that are not present in the AQ but which are linked to both anger and hostility, thus diluting the link between verbal and physical aggression. On the other hand, anger is very much a high arousal state that weakens over time leaving resentment and suspiciousness that might transform to hostility. Anger may link the instrumental aggression to more cognitive aspects of aggressive behavior. The women in study III, consisting of healthy students, scored particularly high on the anger scale in comparison to other studies with comparable samples. This may reflect cultural differences although the possibility cannot be rejected that the difference is an artifact of the translation into Finnish of the AQ test.

6.3 Childhood victimization

The degree of childhood victimization present in the current male samples indicated that inter-parental violence was more common in the spouse abusers' family of origin than in those of the nonviolent controls. This supports the intergenerational transmission of social learning. Witnessing violence has been suggested to be as harmful as experiencing actual abuse as a child (Gelles, 1980), and has been found to be a

consistent risk marker for later violent behavior (Hotaling and Sugarman, 1986). Hotaling et al., (1990) suggested that learned violent behavior can be generalizable across targets and settings. They found that men who had been assaulting their wives were also eight times more likely to have severely assaulted a person outside the family than men in nonassaultive families. Huesmann et al., (1984) suggested, based on data spanning over three generations, that when a characteristic style of aggressive responding develops it seems to persist. The ultimate causes for this may be a mix of both genetically transmitted influences and inappropriate learning conditions. The genetic factors could include testosterone; the father to son hereditary of total testosterone concentration in adulthood is about 30% (Dabbs, 1990; 1992). Kalmuss (1984) have found that exposure to physical aggression against the mother increased the probability of both husband-wife and wife-husband aggression in the next generation. In addition, both sons and daughters who had witnessed inter-parental violence were more likely to be both victims and perpetrators of violence. In a study by Bergman and Brismar (1993) male spouse abusers were compared with battered males with respect to their experiences of violence in the family of origin. Contrary to expectations, these two groups had very similar backgrounds in terms of experiences of violence in the family of origin. The differences between aggressors and victims were small, and many of the males changed roles from being a victim at one time to becoming an assailant at another.

6.4 Alcohol and violence

The offenders in study I were highly intoxicated at the time of their arrest, supporting other studies on the alcohol-aggression relationship (Bushman, 1997; Bushman and

Cooper, 1990; Chermack and Giancola, 1997; Chermack and Taylor, 1995; Giancola and Zeichner, 1997; Gustafsson, 1985; Lipsey et al., 1997; Steele and Southwick, 1985; Taylor et al., 1977). In addition, weekly alcohol intake of the spouse abusers was significantly higher than that of both control groups. In study IV, the AGG+ men also reported significantly higher problem drinking and overall alcohol consumption (larger quantities per occasion) than did the AGG- controls, which is in agreement with Barnett and Fagan study (1993) of violent married men drinking significantly more than non-violent married men.

The highest verbal and physical aggression rates were found in those spouse abusers who consumed three to five drinks daily. In study I verbal aggression and violence were related to median alcohol intake with a curvilinear association that has also been documented earlier (Coleman and Straus, 1983; Kreutzer et al., 1984). The likely explanation for this non-linear relationship is that alcohol increases aggression only up to an intoxication level under which one is still capable of being verbally aggressive and physically abusive. The sedating and depressing effects of still larger dose then act to reduce aggression. Constantly higher quantities and frequencies of alcohol consumption were more prevalent among violent spouse abusers than in men convicted of violence against other men but not abusing their spouses (Fagan et al., 1988). Alcohol abuse has been found to moderate the influence of stress on aggression (Kessner et al., 1997; Margolin and Foo, 1998). On the one hand, stressful events in life may increase alcohol consumption which in turn increases aggression, and on the other, when the attempt to cope with stress by alcohol intake fails, IPV may result instead (Cano and Vivian, 2001).

In study I, the almost identical intoxication levels between the spouse abusers and the intoxicated but non-violent controls resulted in completely different behavior. The

spouse abusers with a mean alcohol intoxication level of 33.3 mMol/L had all been arrested for aggressive behavior, half of them more than 10 times during the preceding 18 months. The nonviolent, intoxicated (35.9 mMol/L) controls were socializing at bars or pubs with no indications of aggressive behavior, or at least not enough to trigger police intervention as in the case of the spouse abusers. Due to the study design, the spouse abusers were all intoxicated when arriving to the station, so the alcohol-aggression relation was 100%. The situational factors might explain part of this group's behavior since we know that the intoxicated controls had not engaged in spouse abuse during the preceding 18 months. On the other hand, if the married or cohabiting intoxicated controls spend a lot of time at bars drinking with their friends they may have spent less time at home with their spouses reducing the likelihood for conflicts.

Graham et al., (2002) studied the social context of naturally occurring physical aggression and found that incidents occurring in bars are more likely to involve males, drinking, more than two participants, and low emotional impact. Incidents at home tend to occur between intimate couples, involve only two participants, and have high emotional impact.

Acute alcohol intoxication could trigger behavior that might already exist in the subjects by releasing inhibitions and by altering judgment. The alcohol-aggression relation may be mediated by contextual factors (Pernanen, 1991) as well as cultural factors surrounding drinking (Fagan, 1990). Although environmental conditions and social factors have an impact on behavior, the motivation behind a specific act could involve individual characteristics (Banks and Dabbs, 1996). Then again, Grayham et al., (1980) witnessed only 70 incidents of physical aggression during over 600 hours of pub and bar observations, 14 of them occurring within 5 hours in the same pub situated in a socially depressed neighborhood. The majority of drinking occasions do

not lead to aggression and, conversely, acts of aggression and violence occur on their own without the involvement of alcohol (Brain, 1986; Chermack and Giancola, 1997, Lipsey et al., 1997). Thus alcohol is neither a sufficient nor necessary factor for triggering aggression, but only a contributing factor.

Spouse abusers recalled from their childhood significantly more excessive drinking by their fathers than did the nonviolent controls. This supports not only the genetic theories of alcoholism (Cadoret et al., 1987; Schuckit, 1972), but could also be an effect of role modeling and context-specific social learning (Harris, 1995). The fathers of the spouse abusers could have served as models with respect to both violence and alcohol consumption. The spouse abusers resembled their fathers in terms of aggressive behavior. They may have learned also that aggression, especially physical aggression, was permitted in an intoxicated state.

6.5 Aggressive behavior and steroid hormones

6.5.1 Testosterone and DHT

Earlier studies have indicated a positive association between aggression and testosterone especially in atypical groups of the kind represented by the present spouse abusers in study I. However, the spouse abusers sober-state testosterone levels were similar to the non-intoxicated controls despite the slightly older age of the spouse abusers. Thus, there is the possibility that the spouse abusers have had higher testosterone levels to begin with, thereby contributing to their development of aggressive predisposition. The level of testosterone is also documented to start slowly declining already after the age of 20 with approximately 0.4 to 0.8 % annual decline

(Seidman and Walsh, 1999). The testosterone levels for the men and women in the present samples were within the normal ranges.

An association was found between testosterone and physical and verbal aggression in women, confirming the aggression-androgen (Harris et al., 1996) link also in healthy women with a moderate alcohol consumption. Moreover, the possible influence of other hormones was verified by the link between anger and 5 α -dihydrotestosterone. Anger, biologically derived from the limbic system (Herbert, 1989) is described as a universally-experienced natural emotion of a biological nature already seen in infants. Men and women experience anger equally often. Anger often leads up to aggression, making the link to both physical and verbal aggression shorter. The AQ has been considered suitable for studying the associations between biological variables and aggressiveness (Gladue, 1991a; Harris, 1997).

The aggression-androgen relation was also confirmed in study IV, in which testosterone correlated with sober-state anger on the AQ (Archer, 1991; Kouri et al., 1998; Moeller and Dougherty, 2001). On the CTS2 (study V), testosterone was found to correlate with physical assault and injury in the AGG+ group. In addition, the metabolite of testosterone, DHT, was significantly correlated with both verbal aggression and anger in the AGG- group.

6.5.2 Cortisol

The increased cortisol level during intoxication shown by the spouse abusers may partly reflect the unpleasantness of police intervention. In addition, the spouse abusers' sober state cortisol levels were significantly higher than the sober controls', indicating stress activated through the possible hangover and withdrawal effects from

abstaining from alcohol during the interview and blood sampling. As already noted, the spouse abusers' cortisol levels may also have been affected by external stress such as economic instability, unemployment, and recurrent conflicts and arrests. Archer et al., (1995) found unemployed men to score higher on physical aggression compared to students.

In the AGG+ group in study IV, cortisol correlated negatively with physical aggression and anger, in accordance with results from earlier studies (Bergman and Brismar 1994b; Dolan et al., 2001; McBurnett et al., 2000). Cortisol might have a two-way relation, by on the one hand inhibiting testosterone production (Cumming et al., 1983) and on the other, by causing a positive association through parallel differences in the circadian rhythm. Dabbs et al., (1991) proposed that cortisol inhibits violence in high-testosterone imprisoned males. In addition, cortisol has been also related to anxiety, arousal, and depression (Dabbs and Hopper, 1990; Kagan et al., 1988). In sum, the present cortisol results in study I and IV with both positive and negative associations reflect the same mechanisms.

6.5.3 Estradiol

Estradiol, seldom investigated in the context of male aggressiveness, correlated with the emotional negotiation only in the AGG- group. Furthermore, estradiol correlated in the present study with psychological aggression in both male groups. Earlier studies indicated that estrogens decreased physical and sexual aggression in demented men (Kay et al., 1996; Shelton and Brooks, 1999) while the effect on verbal aggression remained unchanged in men suffering from dementia-related aggression (Kay et al., 1996). Estrogens may reduce androgenic effects by suppressing the

anterior pituitary gonadotrophic function in men (Barfield, 1984). Gire and Carment (1993) reported that females used negotiation while men preferred to use threats. Even though women use more conflict resolution behavior, it does not imply that they are less aggressive. The aggression in females might take different forms and be used in different situations than male aggression (Björkqvist and Niemelä, 1992). It is noteworthy to bear in mind that verbal aggression usually precedes physical aggression. It could be speculated, e.g., that a higher level of testosterone might lead to a more intense and frequent reaction of anger that could be expressed in a more violent manner. This has also been acknowledged by Dabbs et al., (1987) suggesting an underlying factor or effect that characterizes the psychological role of testosterone in steering the behavior in humans.

A high score on the negotiation scale could, in fact, also be a sign of a dysfunctional relationship even though the scale in itself reflects the amount of positive effects and actions taken to settle a disagreement. The negotiation scale could reflect a balance in which one partner, but only one, shows affection and a readiness to compromise. The difference on the psychological scale, corresponding to the original verbal scale, could be a sign of better emotional and cognitive abilities of the AGG-group. The AGG+ group again does not seem to get the message through to the partner as often. This result of the additional estradiol link between, on the one hand, emphatic behavior and, on the other, psychological aggression may suggest some re-evaluation of the aggression-androgen relation. The female sex hormone, estradiol, is a metabolite of testosterone jointly with DHT indicating the importance of other hormones in human aggressive behavior.

6.6 Glucose

The significant difference between the sober spouse abusers and the sober controls in study I might be related to the fact that the subjects received no restrictions concerning food intake, and, therefore, it is possible that the abusers, for some reason, ate more prior to the testing. In addition, the spouse abusers significantly higher glucose level might reflect the difficulty to synchronize the time of the day when the blood samples were taken.

6.7 Alcohol and steroid hormones

The spouse abusers (study I) had significantly lower testosterone levels when they were intoxicated, at the time of arrest, than they did when their own sober-state testosterone levels were collected a week later. Heavy alcohol intake, both acute and chronic has been reported to suppress the testosterone level in men (Chopra et al., 1973; Ylikahri et al., 1974). This effect can be seen here in study I in the testosterone levels of the spouse abusers being lower when intoxicated than sober. This suppression effect is most likely also present in the intoxicated controls with an almost identical alcohol level. The alcohol intake of the AGG+ groups was significantly higher than that of the controls, which might have affected their testosterone level although the mean level was not significantly lower. There is always the possibility that the starting levels could have been higher in these aggressive groups but that heavy and in some cases chronic alcohol use has reduced their testosterone levels. Markianos et al. (1987) found normal testosterone levels in non-abstinent male alcoholics while Bergman and Brismar (1994b) found increased testosterone levels

and salivary testosterone in violent male alcoholics. In study I, another intriguing explanation could be an acute testosterone increase at that particular stage of drinking. This effect has been documented in women (Eriksson et al., 1994; Sarkola et al., 2000).

Alcohol has been said to be used for its tension reduction effects during stress and tension reduction has been documented to be an important expectancy factor (Lang et al., 1975). Consequently, alcohol may reduce cortisol by reducing stress and tension that otherwise would increase cortisol.

The AGG- and AGG+ groups (study V) differed significantly in their behavioral reactions correlated to the hormones although the two groups did not differ significantly on either testosterone or estradiol levels. It is possible that differences in alcohol intake may have modulated these relations. Estradiol levels were increased after acute alcohol intake in 72 healthy men (Couwenberg, 1988), and earlier studies have observed elevated estradiol levels in current male and female alcohol users (Handa et al., 1997; Muti et al., 1998; Reichman et al., 1993).

6.8 General concepts

The present studies examined aggression in male spouse abusers and in men who responded to advertisements looking for aggressive subjects. Before considering possible hormonal factors and experiences that might be related to aggression, we need first to ask if there is a general concept of aggression that might apply to both of our groups. Regarding the dimensionality of aggression, Choynowski (1995) grouped over 900 aggression items into 13 scales; the observed high intercorrelation suggested the presence of a still higher order general aggression factor (Eysenck, 1995). The

validity of the AQ when compared to other tests of aggression supports this conclusion. In the present studies, both the spouse abusers and the self-identified AGG+ men scored high on the AQ. Although high aggression in women probably needs to be considered separately, there does seem to be a commonality among different groups of high aggression men.

Starting with this conclusion, the results in the present studies reveal factors common to the aggressive males in the samples. The spouse abusers (study I) used verbal aggression twice as often and the AGG+ men (study IV and V) differed on both the CTS2 (psychological aggression, physical assault and injury scales) and on three out of four subscales on AQ. A high level of hostility was reported by the AGG+ group, which is in agreement with the earlier findings that both hostility and anger are personality characteristics often linked to male batterers (Dutton et al., 1996; Maiuro et al., 1986; Schumacher et al., 2001). It is likely that high verbal aggression increases the probability of using physical aggression in conflict situations. Violence represents the escalated form of aggression used when other methods such as verbal attack, destroying things or withdrawal, fails to lead to the effective resolution of a conflict.

Witnessing abuse in family of origin has been linked to the increased probability of later involvement in IPV. Both the aggressive male groups reported childhood victimization in their family of origin significantly more often than did the controls. In addition, the spouse abusers (study I, II) reported paternal drinking in family of origin, which may be an important determinant of spouse abusers' accumulated history of violence later in life. The genetic models of alcoholism may partly explain the significant link between paternal alcohol abuse and spouse abusers' present drinking. The effects of modeling and context specific learning could also explain why physical violence was admissible in interpersonal violence situations in an intoxicated state.

Overall, alcohol abuse is very common in the aggressive male groups, confirming earlier results on the alcohol-aggression relation. The spouse abusers increased cortisol level and AGG+ groups' negative association to cortisol may indicate a two-way relation to testosterone. Heavy alcohol abuse and stress (e.g. S.E.S. instability) may indicate poor coping mechanisms. The positive association between especially free testosterone and behavioral parameters is in line with studies on a more atypical violent sample. On the other hand, the testosterone level for the aggressive male samples did not differ significantly from that of the controls, indicating a more complex relation between testosterone and aggression in males. The metabolite of testosterone, DHT, was associated with aggressiveness in male and female samples and estradiol, the other metabolite of testosterone, might be a key to further understanding of aggression in humans. The positive finding between estradiol and negotiation and/or empathy might have an important counterbalancing effect for reducing aggression. Testosterone might be connected to the force with which physical aggression is expressed.

In sum, hormonal and genetic factors play a definite although complex role in aggression. Early experiences play a role. Alcohol use clearly has an influence. Furthermore, the interactions between these factors are also important. Consequently, although the present understanding of the etiology of aggression is still vague, it is clear that a multidimensional approach, combining both psychosocial and biological factors, will be necessary for developing a more general concept of human aggression in the future.

6.9 Limitations

There are limitations to the generalization of the present results. A modest sample size increases the likelihood for missing or overlooking some real differences between the groups, increasing the risk for type II error. In future studies, a larger sample population is required in order to replicate, especially the novel findings, reported “for the first time” in men and women. Apart from statistical significance, the outcome between steroid hormones and measures of aggression may be evaluated in terms of practical significance by calculating the effect size. The reason for the small sample size, especially in studies I and II, was that the collection of the subjects was time consuming and demanded substantial efforts under unconventional conditions.

It would also be of interest to evaluate the subjects’ mental health and possible mental disorders by standardized questionnaires. To distinguish different types of disorders could add valuable information about the established link between ASPD, aggressive and violent behavior as well as alcohol abuse. The spouse abusers in study I and II may be heterogeneous as a group in terms of prior history of aggression, criminal background and aggressive behavior outside their home environment. A possible genetic predisposition may also be isolated in the efforts of trying to distinguish between learned and inherited factors.

The potential validity problems with retrospective data, especially in study II, suggest caution is needed with regard to conclusions. Studies that rely on retrospective data especially on abuse and violence in the past can be criticized for subjectivity. When a subject is recollecting past events the subject might describe those events from present life situation and conditions. On the other hand, the recall by alcohol abusers of distant life events and their self-reported alcohol intake, and reports of physical

abuse in comparison to official reports, have been found to be reliable (Sobell et al., 1988; Widom and Shepard, 1996).

Although everything was done to match the blood sample to their intoxicated blood sample levels, the strong diurnal variation of testosterone, with morning concentrations being approximately 20-30% higher than evening values, calls for a certain amount of caution with respect to the second sober state sample. Due to this strong diurnal variation, it is generally advised that samples should always be taken in the morning but this was not possible since it was the levels at the time of aggression that were of interest. In addition, there is a seasonal variation with peak concentrations between May and July (Zitzmann and Nieschlag, 2001), which could have also affected the outcome. The day-to-day reliability of testosterone is high varying from 0.64 (Dabbs, 1990) to 0.85 (Vermeulen and Verdonck, 1992). Among middle-aged men, the reliability is higher because of decreased diurnal and seasonal variability (e.g. Bremer et al., 1983). Another interesting question is if testosterone passes the blood brain barrier. Higher plasma cerebral spinal fluid (CSF) testosterone concentrations have been found in perpetrators of domestic violence and in alcoholic, violent offenders compared to non-violent controls (George et al., 2001; Virkkunen et al., 1994).

It is usually difficult to draw conclusions from self-selection and cross-sectional experiments such as studies IV and V represent here. Associations should be interpreted with caution. In cross-sectional studies bias may arise because of selection into or out of the study population, and it may also be difficult to establish what is cause and what is effect. Both generalization and individualization of study results may lead to misinterpretations such as over-simplification or over-interpretation (Zitzmann and Nieschlag, 2001).

7. CONCLUSIONS

The key findings of this study were:

1. The intoxication level was high for the spouse abusers at the time of the arrest. The spouse abusers resorted to verbal aggression twice as often as the sober controls. The significantly elevated cortisol concentrations in the sober offenders compared to sober controls could be viewed as an effect of stress, or an indirect effect of stress mediated by learned escape drinking. Excessive drinking and spouse abuse could be maladaptive coping strategies that principally serve to maintain the status quo, physiologically as well as psychologically.
2. The spouse abusers' accumulated history of violence was predicted by direct and indirect effects related to drinking. Context-specific social learning may explain why the adult spouse abuser repeated the parental drunken violence behavior pattern witnessed as a child in family of origin.
3. The significant positive correlation between free testosterone and physical and verbal aggression could also be extended to healthy women. The significant positive association between DHT and feelings of anger was shown in women for the first time. Both testosterone and DHT may affect by different pathways the basal regulation of aggression-proneness in women.
4. The positive association between alcohol-drinking and self-reported sober state aggression implies that the etiology of alcohol abuse and aggressive behavior may involve common biological and/or social factors. Cortisol may have both positive and negative effects on aggression by separate mechanisms. These mechanisms together with age, androgens and cortisol all represent factors, which in combination regulate human aggression.
5. The negative association between estradiol and testosterone-related physical aggression, and the positive association between estradiol and self-reported feelings of care and respect in interpersonal conflict resolution situations, indicate a possible counter-balancing effect

in male aggressive behavior. Altogether, estrogen may represent a multifaceted variable in the complex interaction of partner conflicts.

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