Sex differences in direct aggression:

What are the psychological mediators?

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Abstract

Provocation enhances aggression but diminishes the magnitude of the sex difference. This suggests that the greater involvement of men in aggression might derive from men's higher levels of anger or from their lower levels of fear and fear-related inhibition. A review of the relevant literature strongly suggests that there are no sex differences in anger but pronounced differences in fear, especially of physical danger. Three forms of behavioral inhibition (reactive, effortful and self control) which build developmentally on an infrastructure of fear, show negative associations with aggression and sex differences generally favouring females. Cognitive inhibition shows weaker associations with aggression (when IQ is controlled) and inconsistent sex differences. Empathy and guilt, both of which are correlated with inhibition, aggression and sex, are also considered as possible mediators. The relative utility of evolutionary and social role theories in accounting for this pattern of findings is considered.

Men engage in more direct aggression than women, although the effect size varies as a function of the seriousness of the act and the data source. The results of several meta-analytic reviews are summarised in Table 1. The main conclusion to be drawn is that the magnitude of the sex difference increases with the increasingly dangerous nature of the behavior[1]. Physical aggression shows stronger sex differences than verbal aggression and this is consistent across data sources and across nations (Archer, 2004). Sex differences are larger in real-world than in experimental settings and men are clearly over-represented in the more dangerous forms of aggression (Archer, 2004). Data from the United States (Bureau of Justice Statistics, 2000) show that the rate of violent offending by men is 1 offender for every 9 males aged 10 or over, while the comparable rate for women is 1 in 56, giving a per capita rate six times higher among men than among women. As the act of violence becomes more serious, the proportion of women's involvement decreases. Fourteen per cent of simple assaults (attacks without a weapon resulting either in no injury or a minor injury) are perpetrated by women compared to ten per cent of homicides and aggravated assaults (which involve a weapon or serous injury) (Bureau of Justice Statistics, 2002).

Offering a complete psychological explanation of these figures requires a consideration of both gender and aggression. Yet in the past, the contribution of these two fields of study has not been equal. The sex difference in aggression has most often been approached as an issue within

[1] Indirect forms of aggression are not considered in the present article. They show a highly variable sex difference between d = -.02 and d=-.74, depending on the method of data collection (Archer, 2004). Speculatively, it might be suggested that higher levels of fear and inhibition among females contribute to their greater involvement in this form of aggression.

the field of sex differences in social behavior more generally. Gender schema (Martin, Ruble & Szkrybalo, 2002), social role (Eagly, 1987) and social cognitive (Bussey & Bandura, 1999) theories ascribe a central role to stereotypic representations of gender which, through different proximal mechanisms, drive conformity. This approach has been used to explain differences in a variety of domains such as leadership (Eagly & Johnson, 1990), helping behavior (Eagly & Crowley, 1986) and interpersonal style (Cross & Madson, 1997), as well as aggression (Eagly & Steffen, 1986). The present article seeks to redress the balance by examining recent developments in aggression research in order to identify candidate psychological mediators which may underlie the sex difference.

Studies of the effect of provocation and emotional arousal provide a useful roadmap with which to begin this journey. Provocation increases aggression (Berkowitz, 1989; Bettencourt and Miller, 1996). Provocation also diminishes the magnitude of the sex difference, from d = .33 to d = .17 (Bettencourt and Miller, 1996). Knight, Guthrie, Page and Fabes (2002) examined emotional arousal as an explanation of this effect. They proposed that at very low levels of arousal, sex differences are small because both sexes are able to regulate their emotion and behavior. At high levels of emotional arousal, processes necessary for emotional and behavioral regulation are likely to be equally disrupted in both sexes. However at intermediate levels, men either experience greater emotional arousal or weaker ability to control their emotional behavior. Confirming this hypothesis they found a curvilinear pattern in which effect sizes favouring males were greatest at small and medium levels of arousal but small when arousal was

either at baseline or very high. Hence real world sex differences may be attributable either to women's lower levels of anger (impulsion) or their greater ability to inhibit or control the expression of anger through aggressive acts (restraint).

This distinction between impelling and restraining forces forms the organisational structure of this paper. Aggression can be thought of as a contingent strategy that results where the value of the rewards multiplied by the probability of obtaining them exceeds the value of the costs multiplied by the likelihood of incurring them (Campbell, 2005). The costs include the possibility of injury or death. The rewards include the acquisition or maintenance of valued resources. In recent years, the role of emotion in guiding such decision making has been increasingly explored (Bechara, Damasio & Damasio, 2000; Cosmides & Tooby, 2000; Frijda, 1986; Le Doux, 1996; Lerner & Keltner, 2000, 2001; Loewenstein, Weber, Hsee & Welch, 2001; Rogers, Ramnani, Mackay, Wilson, Jezzard, Carter et al., 2004). While anger energises behavior and impels attack, fear (and psychological processes that are built on an infrastructure of fear) inhibits behavior and counsels withdrawal (Blanchard & Blanchard, 2003; Harmon-Jones, 2003; Panksepp, 1998). Hence it is reasonable to propose that the likelihood of aggression depends upon the relative strength of these two emotions. In the context of sex differences in aggression, do men and women differ in the strength of their anger (impulsion) or in fear and fear-related inhibition (restraint)?

Although the present article focuses upon these emotional and motivational bases, this in no way diminishes the importance of cognitive

processes or the possibility of sex differences in them. It is increasingly clear that emotion and cognition are intimately connected (Cosmides & Tooby, 2000) especially in the control of aggressive behavior. Anger can affect depth of processing, facilitate recall, and prime aggressive scripts and knowledge structures (Anderson & Bushman, 2002). Fear -provoking stimuli (detected supraliminally or preconciously) recruit selective attention (Mogg & Bradley, 1998) eliciting coordinated cognitive and behavioral activity designed to deal with the threat (Őhman, 1993). While, for reasons of space, I confine myself chiefly to consideration of emotion, sex differences in the link between emotion and cognition warrants serious consideration.

In order to evaluate the present proposal, I first identify psychological factors that enhance and diminish the probability of aggression. Ideally, we would want to demonstrate that, when each of these candidate variables is controlled, the magnitude of the sex difference in aggression is eliminated or significantly reduced. Where such analyses have been undertaken, they are discussed. However, because of the novelty of the present proposal, such data are often unavailable. In these cases, I review evidence for each variable's association with aggression and for evidence of sex differences. My aim here is preliminary rather than definitive: To narrow the range of possible mediating variables so that future studies can directly address their utility in explaining sex differences in aggression.

Factors enhancing aggressive behavior.

Anger

Anger is an unpleasant or negative emotion that typically occurs in response to threat, disruption of ongoing behavior or deliberate and unjustified

harm (Kring, 2000; Panksepp, 1998). Although anger may not be a necessary prerequisite for some forms of instrumental aggression, in reactive aggression it is a common emotional response to provocation. Few sex differences have been found in the frequency or intensity of anger, and those that do tend to favour women (Averill, 1982; Brody, 1997; Grossman & Wood, 1993; Kring, 2000; Sharkin, 1993). In a poll of over 2,000 Americans, women reported more episodes of anger during the last seven days than men even after controlling for sex differences in emotional expressiveness (Mirowsky & Ross, 1995). Experimental studies which elicit anger through the presentation of film clips or slides do not generally find sex differences in anger intensity (Kring & Gordon, 1998; Wagner, Buck & Winterbotham, 1993). Experiments using vignettes to elicit descriptions of hypothetical emotional reactions similarly find few overall sex differences in anger intensity (Manstead & Fisher, 1995; Milovchevich, Howells, Drew & Day, 2001) and, where they appear on subsidiary analyses, they favour women (Brody, Lovas & Hay, 1995; Harris, 1994).

Archer and Mehdikhani (2003) in a meta-analysis of psychometrically assessed anger derived from 22 samples found no sex difference, d = .006. In a larger study of 46 self-reported anger studies published between 1967 and 2000, Archer (2004) also found no sex difference, d = -.003. Studies appearing since that time have generally supported this conclusion (Birditt & Fingerman, 2003; Costa, Terracciano & McCrae, 2001; Deffenbacher, Deffenbacher, Lynch & Richards, 2003; Paixao, Oliveira, Page, Uwah & Carlton, 2001; Ramirez, Santisteban, Fujihara & Van Goozen, 2002; Yarcheski, Mahon & Yarcheski, 2002; Zwaal, Prkachin, Husted & Stones,

2003). Brebner (2003) used a large Australian (N=2199) and international sample (N=6868). In both samples, women reported a slightly greater frequency of anger, *d*= -.06 and *d*= -.05, and in the international sample women rated their anger as somewhat more intense than that of males, *d*= -.14. Similarly, in a United States sample (Simon & Nath, 2004), women and men did not differ in anger frequency, although in a subsample of those experiencing anger once a day during the previous week, women's anger was more intense and long lasting.

In Berkowitz's (1989) model of aggression, negative affect mediates the relationship between provocation and aggression. Negative affect may well include anger but is sufficiently broad to include other negative emotions or moods experienced in response to provocation. Bettencourt and Miller (1996) examined the possible role of negative affect (operationalised as judges' ratings of the extent to which the participant would feel "unpleasant or negative emotions") as a moderator of sex differences in aggression. Higher levels of judged negative affect were associated with smaller sex differences in aggression, beta = -.13, suggesting that the elicitation of negative mood states diminishes the sex difference in aggression. However male and female judges did not differ in these ratings and hence "gender differences in subjective negative affect did not affect gender differences in aggression" (Bettencourt & Miller, 1996, p.440). Men's more frequent use of aggression does not seem to arise from the fact that they experience higher levels of anger or negative affect.

Anger expression

Though men and women do not differ in frequency or intensity of anger, they may differ in their readiness to express it. Studies of anger expression typically employ self-reports, spontaneous facial and vocal expressions and psychophysiological measures of face muscle activity (Kring, 2000). In self–report studies of anger expression, sex differences have not been found (Allen & Haccoun, 1976; Balswick & Avertt, 1977; Burrowes & Halberstadt, 1987; Dosser, Balswick & Halverson, 1983; Ganong & Coleman, 1985; King & Emmons, 1990). Studies that have used Spielberger's Anger Expression Inventory (Spielberger, Johnson, Russell, Crane, Jacobs & Worden, 1985) also find no sex differences in reports of anger expression and anger suppression (see Kring, 2000). In vignette studies sex differences are rare but, where they are significant, more women than men report that they would express their anger (Brody, 1993; Dosser et al., 1983; Timmers, Fischer & Manstead, 1998 but see Ramirez et al., 2002). Studies that employ spontaneous facial expressions find either no sex differences or that women are more expressive of anger than men (see Kring, 2000; Zwaal et al., 2003). In summary, women and men differ little in the degree to which they openly express their anger to others. Hence sex differences in aggression are unlikely to be attributable to sex differences in willingness or ability to communicate anger.

However a number of studies have found that men and women express their anger in different ways. Men are more likely to directly confront the target of their anger and to verbally and physically assault people (Timmers et al., 1998; Deffenbacher, Oetting, Lynch & Morris, 1996). Women are more likely discuss their anger with uninvolved people (Simon & Nath, 2004) and to

cry (Averill, 1982; Campbell, 1993; Eagly & Steffen, 1986; Hoover-Dempsey, Plas & Wallston, 1986; Timmers et al. 1998; Zemen & Garber, 1996).

In summary, there is little evidence for more intense or more frequent anger among men whether the data are collected from self reports, psychometric inventories, experiments or responses to hypothetical scenarios. The absence of sex differences in anger means that it is a weak candidate for moderating sex differences in aggression (Bettencourt & Miller, 1996). While there are few differences in willingness to express anger, women are less likely to directly challenge or attack their provoker, suggestive of the possibility of greater emotional and behavioral control by women.

Factors diminishing aggressive behavior.

Fear.

Fear is "an evolutionarily conserved affective-motivational system that can be activated under conditions of novelty, sudden or intense stimulation, reactions to danger prepared by evolution, social interactions with unfamiliar conspecifics and conditioned responses to punishment" (Rothbart & Bates, 1998, p. 109). The fear system is "designed to detect danger and produce responses that maximise the probability of surviving" (LeDoux, 1996, p.128).

The amygdala in the temporal lobes plays a central role in coordinating immediate response to fear-provoking stimuli (Davis, 1992). Le Doux's (1996) pioneering research on conditioned fear responses has identified two incoming neural pathways that are activated when the organism faces threat. The "fast" route delivers crude sensory information from the thalamus to the amygdala within 50 ms of a threat, allowing for an immediate response. Through the second "slower" system, the amygdala receives a more detailed

evaluation of the threat from the relevant sensory cortex. This allows for more finely discriminated and contextualised interpretations of the input. Amygdala-cortical connections are bidirectional so that emotional states (such as fear) may direct information processing to threatening stimuli and, reciprocally, cortical representations of threat can activate an emotional response (Damasio, 1994; Derryberry & Reed, 1994). Once activated, the amygdala's connections to a variety of other brain structures cause increases in heart rate, blood pressure, respiration, vigilance, ACTH secretion, and cortical arousal. Behaviorally, it triggers freezing and "these inhibitory connections allow the anticipatory activity in the fear system to suppress approach responses that might lead the organism into a harmful situation" (Derryberry & Rothbart, 1997). Fear and anger systems follow very similar neural pathways. The fear system runs from the central and lateral amygdala through the ventral anterior and medial hypothalamus to the periagueductal gray (PAG) matter; anger runs from the medial amygdala through the medial hypothalamus to the PAG (Panksepp, 1998).

Individual differences in fearful behavior appear from about nine months of age and remain extremely stable over time (Kagan, 1998; Rothbart & Bates, 1998). Infant fear is negatively related to later impulsivity and aggression (Caspi & Silva, 1995; Rothbart & Bates, 1998). Many studies have found concurrent associations between fearlessness and externalizing problems (Cimbora & McIntosh, 2003; Rothbart, Ahadi & Hershey, 1994). Conversely children with high fear of novelty are more likely to develop internalizing problems (Fox, Henderson, Marshall, Nichols & Ghera, 2005;

Kagan, 1998; Kagan, Snidman, Zentner & Peterson, 1999). Is there evidence that the sexes differ in the frequency or intensity of fear?

Developmentally, girls express fear earlier than boys (Nagy, Loveland, Kopp, Orvos, Pal & Molnar, 2001). In infancy, girls show more hesitation in approaching novel objects and greater distress (Gartstein & Rothbart, 2003; Martin, Wisenbaker, Baker, & Huttunen, 1997; Rothbart, 1988). Cross-culturally, according to parental reports, boys show stronger approach behavior than girls (Carey & McDevitt, 1978; Hsu, Soong, Stigler, Hong, & Liang, 1981; Maziade, Boudreault, Thivierge, Caperaa & Cote, 1984). In a large longitudinal Canadian sample establishing trajectories of personality development, more girls than boys were on the high fearfulness trajectory (Cote, Tremblay, Nagin, Zoccolillo and Vitaro, 2002).

Among adults, reviews have generally concluded that women experience fear more intensely than men (Brody & Hall, 1993; Crawford, Kippax, Onyx, Gault & Benton, 1992; Fischer, 1993; Gullone, 2000) although some have argued that the sex difference is context specific (LaFrance & Banaji, 1992). A 37 nation study found significant sex differences in the intensity, duration and nonverbal expression of fear (Fischer & Manstead, 2000). A more recent international survey (Brebner, 2003) found a significant sex difference in the reported frequency, d = -.17, and intensity. d = -.14, of fear in an international sample. Differences have also been found in anxiety both in the United States and cross-culturally (Simon & Nath, 2004; Costa et al., 2003; Feingold, 1994). Women show greater increases in skin conductance and a more marked startle reflex to physically threatening scenes (Bradley, Cuthbert & Lang, 1999; McManis, Bradley, Berg, Cuthbert &

Lang, 2001). Women express their fear more intensely, both verbally and non-verbally, than do men (see Madden, Feldman Barrett & Pietromonaco, 2000). While women are superior to men in accurately identifying emotions, they show a greater accuracy for decoding fear than other emotions (Hall, Carter & Horgan, 2000).

A phobia is a marked and persistent fear of clearly discernable circumscribed objects or situations which the sufferer recognises to be excessive or unreasonable (American Psychiatric Association, 1994, pp. 143). Test norms and meta-analysis of the Fear Survey Schedule confirm that females score higher than males (Arrindell, Kolk, Pickersgill & Hageman, 1993; Gullone & King, 1993). Following adjustment for the influences of masculinity, femininity, masculine gender role stress and dissimulation, biological sex remains a consistent predictor for each of the 5 types of fear (social; agoraphobic; bodily injury, death and illness; sexual and aggressive scenes; and harmless animals) with females scoring higher than males (Arrindell et al., 1993). In a study of animal fears, female biological sex also emerged as a consistent predictor of fear after controlling for gender role, disgust sensitivity, neuroticism, psychoticism and age (Arrindell, Mulkens. Kok & Vollenbroek, 1999). Anxiety sensitivity is a fear of harmful physical, social and psychological consequences of fear itself. Among women, scores are highest on the physical factor on which they are significantly higher than men (Stewart, Taylor & Baker, 1997), while men show the reverse pattern, scoring lowest on physical fears. The same pattern is found among children and adolescents (Walsh, Stewart, McLaughlin & Comeau, 2004). Females appear

to be specially sensitized to threats to their physical integrity while males show stronger fear of threats to their mental health or social standing.

Men make riskier decisions than women (Hersch, 1997). Because this sex difference is especially marked when the risks are physical or life-threatening (Hersch, 1997) and when risky behavior rather than hypothetical choices are examined, it has been suggested that "fear responses may explain gender differences in risk taking more adequately than the cognitive processes involved in the reflective evaluation of options" (Byrnes, Miller & Schafer, 1999, pp. 378). Loewenstein, Weber, Hsee and Welch (2001) propose that current theories of risk overestimate the role of cognition and underestimate the impact of fear. While reflective cognition is useful for making true-false decisions, emotions are central to approach-avoidance decisions (Frijda, 1986). Fear favours cautious, risk-averse decisions (Lerner & Keltner, 2000, 2001). In contrast to expected utility models, fear is insensitive to probability variation: "Feelings of fear… may be sensitive to the *possibility* rather than the probability of negative consequences" (Loewenstein et al. 2001, p.276). Fear, like a good fire alarm, has a low threshold of response because a false positive is less harmful than a false negative. As the prospect of an aversive event approaches in time, fear increases although the probability and negative utility remain constant. In explaining the sex difference in risk taking, Loewenstein et al. (2001) identify women's higher level of fear as particularly relevant. The relationship between sex, fear and risk assessment has been examined in relation to the 9/11 terrorist attacks on the United States (Lerner, Gonzalez, Small, & Fischhoff, 2003). Replicating previous work, fear increased risk assessment while anger diminished it.

Females reported greater fear and lower anger than males and their risk estimates (with respect to the nation, the average American and themselves) were higher. Differences in fear and anger explained 61 per cent of the effect of sex on risk evaluation.

There are two sources of direct evidence that fear mediates the magnitude of sex differences in aggression. Eagly and Steffen (1986) had 200 judges rate 63 experimental studies on a 15-point scale in terms of "How much danger you would face if you enacted this behavior?". Female judges rated danger as significantly higher than male judges and sex differences in aggression were larger to the extent that women estimated that they would face more danger than males (beta = .41). Danger-to-self entered as the strongest predictor in a multivariate regression testing six variables (beta=.38). The amplifying effect of danger on the magnitude of sex differences was strongest in situations where there was freedom of choice to aggress (beta = -.56). Bettencourt and Miller (1996) also found significant sex differences in danger judgements and again effect sizes for aggression were larger where female judges perceive greater danger than males (beta = .18). The authors concluded that this was "especially interesting given that (a) experimental inductions were objectively identical for male and female participants and (b) with few exceptions experimental paradigms provided little if any expectation that targets would have opportunities to retaliate" (Bettencourt and Miller, 1996, p.440). Faced with the same low level of objective danger, women found the situation more dangerous and this predicted their lower level of aggression relative to men.

In summary, evidence from a variety of disciplines and methods suggest that there are sex differences in fear. These are evident self reports, psychometric inventories, reactions to real or hypothetical events and vulnerability to pathological fear. The sex difference in fear accounts for a considerable portion of the differences observed in aggressive behavior.

Inhibition.

Fear as a situated emotion can directly restrain aggressive behavior, but we also have the capacity to inhibit aggression where there is no immediate physical threat. Despite provocation, we routinely inhibit aggression as a function of target (children, old people, bosses), setting (aggression is more likely at a football game or nightclub than in our friends' homes), and personal moral standards (our conception of ourselves as 'reasonable' people).

This requires an examination of the literature on inhibition. The concept which has been widely used but incompletely specified and there is little consensus on a meaningful typology. In organising this material (Figure 1), I begin with an early-developing form of behavioral inhibition (reactive inhibition) that depends directly upon fear. I then consider two further forms, built upon it, which appear later in development; effortful control which appears during the toddler stage and self control which appears in later childhood or adolescence. Developmentalists and clinicians have proposed that individual differences at in each of these forms of inhibition constrain the development of later forms but that the attainment of effortful and social control subsumes rather than supersedes reactive inhibition. As a point of comparison, I lastly consider cognitive inhibition, associated with executive

function, which does not depend upon differences in fear (see Table 2). I use this developmental trajectory as a heuristic device; the focus is upon sex differences in each of these domains rather than the validity of the developmental sequence.

Reactive (fear-based) inhibition. The proposal that behavioral inhibition rests on an infrastructure of fear is widespread. However this basic idea has been described using various terminologies and empirical assessments. In Rothbart's developmental model of temperament (Rothbart & Bates, 1998), the term 'reactive control' is used to describe the early-developing process whereby fear 'automatically' drives attentional processes such that highly anxious individuals show enhanced attention to threats (Derryberry & Reed, 1994, 1996). The positive feedback between individual differences in fear and these attentional biases results in the development of cognitive representations that are differentially sensitised to threat. Reactive control is described as a passive or involuntary system that is later complemented by effortful control. This model shares much with Block and Block's (1980) concept of an early developing ego control which forms the basis for later ego resiliency (see also Fox et al. 2005)

In the behaviorist paradigm, conscience and the passive avoidance associated with it, has been seen as a conditioned response to fear (Dienstbier, 1984; Eysenck 1977; Mowrer 1960). Individuals who are temperamentally low in fear are likely to be relatively insensitive to aversive conditioning during socialization and less likely to show inhibition of aggressive behavior (Raine, 1997). Gray's (1982) influential approach-avoidance theory of motivation is based on the relative strength of the BIS

(behavioral inhibition system) and the BAS (behavioral activation system) with BIS having the capacity to override BAS activation in the face of threat. Stimuli that have been conditioned to punishment or frustrative nonreward activate the BIS which inhibits behavior, increases arousal and allocates attention to relevant threats in the environment. Individuals with BIS systems that are under-responsive, relative to the BAS, are likely to exhibit disinhibited behavior. They are predicted to have particular difficulties with passive rather than active avoidance situations since the deficit specifically affects behavioral inhibition rather than activation.

From a neuropsychological perspective, Davidson (Davidson & Irwin, 1999; Davidson, Jackson & Kalin, 2000; Davidson, Putnam & Larson, 2000) proposes that fear, which triggers amygdala activation, also increases activity in the orbitofrontal and ventromedial areas of the prefrontal cortex, responsible for modulating a variety of negative emotions, including fear and anger (Liberzon, Zubieta, Fig, Phan, Koeppe & Taylor 2002). The prefrontal cortex has a high density of serotonin receptors, implicated in the inhibition of impulsive aggression (Miczek, Weerts, Haney, & Tidey, 1994; Niehoff, 1999) and it is suggested that impulsive aggression is associated with a "a failure to respond appropriately to the anticipated negative consequences of behaving aggressively" (Davidson, Putnam and Larson, 2000, p. 591). This absence of control may originally derive from under-responsive fear registration by the amygdala (Blair, 2004; Mitchell, Colledge, Leonard & Blair, 2002).

A considerable volume of research has successfully explored these ideas in relation to psychopathy demonstrating lower resting EDA, weaker EDA responses to aversive conditioning paradigms, poor passive avoidance

learning, slow resting heart rate, smaller amygdala volume and diminished amygdala response to negatively valenced words, such as “hate” (Fowles, 1993, 1994; Hare, 1978; Kiehl, Smith, Hare, Mendrek, Forster, Brink et al., 2001; Lorber, 2004; Raine 1993, 1997; Tiihonen, Hodgins, Vaurio, Laakso, Repo, Soininen et al., 2000). Are similar deficits seen with respect to aggression in non-clinical populations?

Eisenberg has examined Rothbart’s reactive control (which she terms low “impulsivity”) in her work on externalizing problems. Reactive control is measured chiefly by adult ratings on the Child Behavior Questionnaire or the Block and Block Q-sort. In these studies, association between low reactive control and externalizing problems have been found both concurrently and predictively in children and adolescents (Eisenberg, Cumberland, Spinrad, Fabes, Shepard, Reiser et al., 2001; Eisenberg, Spinrad, Fabes, Reiser, Cumberland, Shepard et al., 2004; Eisenberg, Sadovsky, Fabes, Losoya, Valiente, Reiser et al., 2005; Oldehinkel, Hartman, de Winter, Veenstra & Ormel, 2004; Valiente, Eisenberg, Smith, Fabes, Losoya, Guthrie et al., 2003). Although reactive and effortful control (see below) are correlated at between r= -.47 and r= -. 53, the former nonetheless makes an independent contribution to models of externalizing problems, especially at younger ages.

Low resting heart rate has been found to be concurrently and predictively associated with antisocial behavior, after controlling for a variety of confounds such as height, weight, drug use, motor activity and psychosocial adversity (Raine, 2002). Raine (1996) reported an effect size of d = .56 over 29 studies, with a similar magnitude in females, d = .63, and males, d = .50. In a sample of 16 studies specifically examining aggression, a

lower but significant estimate of d = -.38 was given by Lorber (2004). During presentation of negatively-valenced stimuli, heart rate was lower among more aggressive individuals, d= -.23. Although aggression showed weak conditional associations or none at all with electrodermal activity in his analysis, some studies which have employed EDA reactivity as an independent variable have found longitudinal associations with later aggression (Fowles, 2000).

Examination of the role of medial and orbitofrontal prefrontal cortex (jointly referred to as ventromedial PFC) in reactive control of aggression has employed the Iowa Gambling Task (Bechara et al., 2000). Participants draw cards one at a time from four decks. Each card either awards or demands money. Two of the four decks are 'good' choices (lower immediate gain but smaller future losses i.e. a long term gain) while two are 'bad' (high immediate gain but larger future losses i.e. a long term loss). Patients with damage to the ventromedial cortex show a marked failure to avoid the 'bad' decks in comparison with normal and brain-damaged controls, despite the fact that these subjects perform normally on the Wisconsin Card Sort which assays dorsolateral function. Control participants show a change in skin conductance prior to selecting a card from one of the less favourable packs while patients with VM lesions show such a change after, but not before, such a selection (Bechara, Tranel, Damasio & Damsio, 1996). This suggests that the VM-PFC may be responsible for anticipatory somatic markers (Damasio, 1994) or for the selection of appropriate responses to conditioned and unconditioned stimuli (Rolls, 1996). Violent, but not non-violent, offenders (Fishbein, 2000), patients with intermittent explosive disorder (Best, Williams & Coccaro, 2002)

and boys and men with psychopathic tendencies (Blair, Colledge & Mitchell, 2001; van Honk, Hermans, Putman, Montagne & Schutter, 2002) similarly fail to avoid the 'bad' packs. Studies have supported the role of the orbitofrontal and the ventromedial cortices in inhibiting aggressive behavior in humans (Giancola & Zeichner, 1994a; Grafman, Schwab, Warden, Pridgen, Brown & Salazar, 1996; Lapierre, Braun & Hodgings, 1995). Stimulation of these areas inhibits anger and aggression, while corresponding lesions increase behavioral aggression and disinhibition. Murderers show lower glucose metabolism in these regions compared to non-violent controls (Raine, Buchsbaum, Stanely, Lottenberg, Abel & Stoddard, 1994; Raine, Buchsbaum & LaCasse, 1997).

To what extent are sex differences found in fear-based inhibition? In developmental studies of reactive control, consistent sex differences favouring girls have been found (Eisenberg et al. 2001; Eisenberg et al. 2004; Eisenberg et al. 2005; Kockanska & Knaack, 2003; Oldehinkel et al. 2004; Valiente et al. 2003). There are marked sex differences in resting heart rate the general population with males showing lower resting rates from the age of about 3 years (Raine, 2002). In women, a single administration of testosterone is followed by cardiac acceleration to angry faces, associated with low levels of elicited fear and a willingness to attack (Van Honk, Tuiten, Hermans, Putman, Kopeschaar, Thijssen et al., 2001).

The Iowa Gambling Task, have produced especially interesting results. Typically the dependent variable is the average percentage of "correct" (i.e. long-term beneficial) card choices over blocks of trails. Using this measure, evidence for sex differences has been mixed (Hooper, Luciana, Conklin &

Yarger, 2004; Kerr & Zelazo, 2004; Overman, 2004). But when the dependent variable is altered to the proportion of times a choice is made from decks bearing a lower percentage of loss cards (i.e. packs bearing few minus signs), women exceed men (Hooper et al., 2004; Overman, 2004). Women appear to systematically avoid the packs that more frequently contain penalties suggesting that women are more acutely avoidant of penalising stimuli. Recall that research on decision-making under uncertainty, discussed earlier, shows that fear is insensitive to probability variation (Loewenstein et al., 2001). Furthermore, when presented with threatening stimuli, adults make decisions based on short-term outcomes rather than possible long-term consequences (Gray, 1999). If negative stimuli arouse a stronger amygdala response in females, estimation of long-term net outcomes may be over-ridden.

Volumetric MRI studies of the amygdala have produced inconsistent results of sex differences with reports of larger volume in boys and men (Caviness, Kennedy, Richelme, Rademacher & Filipek 1996; Giedd, Snell, Lange, Rajapakse, Casey, Kozuch et al., 1996; Goldstein, Seidman, Horton, Makris, Kennedy, Caviness et al., 2001), larger volumes in women (van Elst, Woermann, Lemieux & Trimble, 2000) and no sex difference (Gur, Gunning-Dixon, Bilker & Gur, 2002). Larger frontomedial (Goldstein et al., 2001) and orbitofrontal (Gur et al., 2002) cortices have been found in women, although two studies which failed to adjust for intracranial volume found no sex difference (Raz, Gunning, Head, Dupois, Mc Quain, McQuain et al., 1997; Szeszko, Bilder, Lencz, Pollack, Alvir, Ashitari et al., 1999). Interpreting their finding of greater female orbitofrontal volume in tandem with equal amygdala

volumes, Gur et al. (2002, p.1001-2) suggest that "women have greater tissue volume available for modulating amygdala input. This finding may explain sex differences in emotional behavior, particularly aggression". Serotonin has been implicated in inhibitory control of aggression and women's 5-HT binding potential has been found to exceed men's in a number of brain regions including the frontal cortex, orbital and medial PFC, and the amygdala (Biver, Lotstra, Monclus, Wikler, Damhaut, Mendlewicz et al., 1996; Parsey, Oquendo, Simpson, Ogden, Van Heertum, Arango et al., 2002).

The amygdala and the orbitofrontal cortex are involved in the recognition of facial emotion, especially fear and anger (Adolphs, 2002; Zald, 2003). Females are more accurate than males in decoding facial expressions in infancy[2], d = -.25, childhood and adolescence, d = -.13 and adulthood, d = -.32 (Hall, 1978, 1984; McClure, 2000). Despite this, surprisingly few neuroimaging studies have examined sex differences (Adolphs, 2002). Differences that have been reported are small and not yet firmly replicated (Kesler-West, Andersen, Smith, Avison, Davis, Kryscio et al., 2001; Killgore & Yurgelun-Todd, 2001). Unambiguously threatening faces trigger greater activation in the amygdala and the orbitofrontal cortex in women compared to men or adolescents of either sex (McClure, Monk, Nelson, Zarahn, Leibenluft, Bilder et al., 2004). Fearful faces also trigger increased activation in the prefrontal cortex of adult women but not men despite the fact that during childhood levels of amygdala activation are similar in both sexes (Killgore, Oki & Yurgelun-Todd, 2001). Other studies have reported a similar pattern of

[2] Throughout (and in keeping with predominant usage) a negative effect sizes indicate that females score higher than males. In some cases, I have added a minus sign to bring the reported results in line with this convention.

small childhood differences (Thomas, Drevets, Whalen, Eccard, Dahl, Ryan et al., 2001) followed by a female post-pubertal shift to greater greater frontal lobe activity (Idiaka, Okada, Murata, Omori, Kosaka, Sadato et al., 2001).

Interesting results that directly address inhibition of aggression have come from an inventive PET study in which participants were asked to vividly imagine a series of events associated with aggression (Pietrini, Guazzelli, Basso, Jaffe & Grafman, 2000). In the baseline condition, participants imagined an elevator ride with their mother and two men. They were also asked to imagine that the two men assaulted their mother while they simply watched (cognitive restraint), that they were held by one of the men and prevented from assisting their mother (physical restraint) and that they were able to attack the men with all their strength (unrestrained aggression). During the three conditions involving aggressive content, the subjects showed significant rCBF decreases in the medial orbitofrontal cortex compared to the neutral condition with the largest changes occurred in the unrestrained aggression condition. Under cognitive restrain, there was significantly greater rCBF bilaterally in the medial frontal gyri suggesting that "functional deactivation of these frontal cortical areas was strongest when subjects were instructed to express rather than to try to inhibit their aggressive behavior" (Pietrini et al., 2000, p. 1777; see also Blair, Morris, Frith, Perett & Dolan, 1999; Dougherty, Shin, Alpert, Pitman, Orr, Lasko, Macklin, Fischman & Rauch, 1999). Unrestrained aggression also showed increases in limbic system activation, heart rate and systolic blood pressure that were inversely correlated with medial frontal activity. Congruent with earlier studies, limbic system activity was greater in women (Pietrini, Guazzelli & Grafman, 1998;

Pietrini, Guazzelli, Jaffe, Sandhu & Grafman, 1998) and women also showed greater deactivation in the OFC than men (Ricciardi, 2004) indicating stronger disinhibition when taking (imagined) aggressive action.

Effortful control. Following the early manifestation of reactive control, Derryberry and Rothbart (1997) describe the later development of effortful control ("the ability to inhibit a dominant response to perform a subdominant response", Rothbart & Bates, 1998, p. 137). This second system of control develops during the toddler period providing a form of self-regulation that goes beyond the reactive impact of fear. With age, effortful control explains more of the variance in children's social behavior than reactive control in line with its increasing power to modulate behavior (Eisenberg et al., 2001; Murphy, Eisenberg, Fabes, Shepard & Guthrie 1999). Effortful control operates through conscious selective attention and, while it can theoretically be mobilised to oppose the dominant underlying motivational system, it more usually works to enhance it: A child low in reactive fear is unlikely to effortfully direct attention to threatening cues in the environment. (Derryberry & Rothbart, 1997, p.648). Fearfulness has been empirically linked to better effortful control (Kockanska, Coy & Murray, 2001; Kockanska & Knaack, 2003).

Although the definition of effortful control appears to some (Carlson, 2003) to overlap with executive inhibition, Posner and Rothbart (2000) emphasise that it this form of control is *temperamental* rather than cognitive. While executive inhibition addresses the cognitive ability to focus attention on a single dimension of a task and to ignore competing stimuli (see below), effortful control centres on the child's competence in controlling their behavior;

"the skills inherent in effortful control are used to regulate emotion and behavior associated with emotion" (Liew, Eisenberg & Reiser, 2004, p. 300). It has been operationalized behaviorally as the child's ability to follow experimenter instructions in a variety of tasks requiring them to inhibit their preferred response or by parent or teacher report on the Child Behavior Checklist. Effortful control is positively associated with a variety of moral behaviors, including restraint from touching forbidden objects and resistance to cheating in games (Kochanska, Murray, Jacques, Koenig & Vandegeest, 1996; Kochanska, Murray & Coy, 1997). Negative relationships, both concurrent and prospective, between effortful control and eternalising behaviors including aggression have been frequently reported (Eisenberg, Fabes, Guthrie, Murphy, Maszk, Holmgren et al., 1996; Eisenberg, Guthrie, Fabes, Shepard, Loyola, Murphy et al., 2000; Eisenberg et al., 2005; Gilliom, Shaw, Beck, Schonberg & Lukon, 2002; Kochanska & Knaack, 2003; Kochanska, Murray & Harlan, 2000; Murray & Kochanska 2002; Oldehinkel et al., 2004; Rothbart & Bates 1998; Ruff & Rothbart, 1996; Valiente et al. 2003).

A number studies have confirmed girls superiority in complying with adult proscriptions. Maccoby and Jacklin (1974) concluded that girls show higher levels of obedience. Recent work on effortful control has consistently substantiated this conclusion (Eisenberg et al., 2001; Eisenberg et al., 2004; Gervai, Turner & Hinde, 1993; Kochanska & Aksan, 1995; Kochanska et al., 2001; Kochanska & Knaack, 2003; Kochanska et al., 2000; Kochanska et al., 1997; Kochanska et al., 1996; Liew et al., 2004, Olson, Schilling & Bates, 1999; Valiente et al. 2003). Bjorklund and Kipp's (1996) narrative review of childhood sex differences in resistance to temptation, found a moderate

female advantage with 6 out of 11 studies favouring girls. A quantitative review of 98 studies investigating resistance to temptation found only a weak effect size, *d* = -.06, favouring females (Silverman, 2003a[3]). However this analysis included studies of cheating in examinations or tests, an active and instrumental behavior to a temporally remote goal rather than a failure to suppress an immediately attractive behavior. When studies investigating resistance to touching a forbidden object were considered, a much stronger effect size, *d* = -.41, was found favouring girls.

Self control / Impulsivity. While impulsivity has been defined in a bewildering number of ways (Evendon, 1999), it is broadly accepted to be a tendency to act on the spur of the moment, without consideration of long-term consequences. Hirschi (1969) proposed that the attractions of antisocial behavior are immediate and evident, and that desistance not involvement requires explanation. Among children, social control is normally imposed by families, schools and other institutions. By adolescence, this externally-exerted control becomes internalized as self control. Antisocial and criminal behavior is proposed to result from low self-control in interaction with situational opportunities (Gottfredson & Hirschi, 1990). Following their initial conceptualization, self-control has been operationalized chiefly as a combination of impulsivity, risk seeking, present orientation, temper, and carelessness in psychometric instruments. Their proposal has been tested in twenty-one empirical studies with over 49,727 participants. The effect size[3] found for low self-control, d = .41, ranks as "one of the strongest known correlates of crime" (Pratt & Cullen, 2000, p.952) and is unaffected by the

[3] The effect size in the original article is given as *r* but has been converted to *d* to maintain continuity with other effect sizes reported.

measure used to assess self-control. Although the items employed on self-control questionnaires have generally been found to be unidimensional across and within sex (Grasmick, Tittle, Bursik & Arneklev, 1993; LaGrange & Silverman, 1999; Piquero & Rosay, 1998, but see Longshore, Turner & Stein, 1996), the impulsivity and risk seeking subscales have been found to be almost as predictive as the full scale (Arneklev, Grasmick, Tittle & Bursik, 1993; Deschenes & Esbensen 1999; Nakhaie, Silverman & LaGrange, 2000; Piquero & Rosay, 1998; Wood, Pfefferbaum & Areneklev, 1993).

Impulsivity forms a key part of Moffitt's (1993) account of the etiology of delinquent behavior. She proposes that persistent involvement in antisocial and violent behavior stems from impulsivity which results from the confluence of early neuropsychological problems, difficult child behavior and poor parenting skills. Although impulsivity was seen as the behavioral manifestation of the child's executive and verbal neurological dysfunction, a study which examined the factor structure of a variety of impulsivity tasks found that it was behavioral rather than cognitive impulsivity that correlated most highly with delinquency (White, Moffitt, Caspi, Bartusch, Needles & Stouthamer-Loeber, 1994; see also Moffitt, Caspi, Rutter & Silva, 2001). Vulnerable children who experience inconsistent parenting practices are less likely to achieve effortful compliance with parental demands. Such effortful control may form the basis for, and be internalised as, self control or low impulsivity. In longitudinal studies, impulsivity has been found to be predictive of offending in both the United States and England (Farrington & Loeber, 1999). Impulsivity is prospectively predictive of violent offending (Farrington,

2003; Henry, Caspi, Moffitt & Silva, 1996) and is more closely related to stranger violence than to partner violence (Krueger, Caspi & Moffitt, 2000).

Psychometrically, impulsivity has been measured with a wide variety of instruments. Data collected using 21 such scales from nine inventories have revealed four factors (Whiteside & Lynam, 2001) that have been replicated using confirmatory factor analysis (Lynam & Miller, 2004). The factors are; Lack pf Premeditation (a tendency to act without reflection), Urgency (tendency to act rashly when under experiencing negative affect), Sensation Seeking (seeking exciting and adventurous activities) and Lack of Perseverance (maintaining attention on a task). The first two of these corresponds to impulsivity as here conceptualised. Lack of premeditation and urgency, weakly inter-correlated at r = .28, are more strongly associated with self reported aggressive and delinquent acts than the other two impulsivity scales (Miller, Flory, Lynam & Leukfeld, 2003). Lack of premeditation is associated with both selecting and enacting an aggressive response while urgency is more closely associated with a hostile attribution bias (Lynam & Miller, 2004). Relations are as strong for women as for men.

Sex differences have been found in tests of self-control theory (Burton, Cullen, Evans, Alarid & Dunaway, 1998; La Grange & Silverman, 1999; Nakhaie et al., 2000; Tittle, Ward & Grasmick, 2003) and these seem to be especially pronounced for the subscales of impulsivity and risk seeking (LaGrange & Silverman, 1999). Self control eliminates or significantly reduces the effect of sex on general and violent offending (Burton et al. 1998; Gibbs, Giever & Martin, 1998; La Grange & Silverman, 1999). In a longitudinal New Zealand study (Moffitt et al., 2001), boys age 5-11 were higher then girls on

hyperactivity (including impulsivity) measured by both parents' reports, *d* = .25, and teachers' reports, *d* = .54. Childhood hyperactivity explained 35 per cent of the sex difference in adolescent antisocial behavior. By age 18, ninety-six per cent of the sex differences in adolescent anti-social behavior could be explained by scores on two MPQ higher order personality traits; Negative Emotionality and Constraint (defined as an inability to modulate impulsive expression). Constraint showed a very significant sex difference, *d* =.-59. The correlation between Constraint and self-reported delinquency was identical for both sexes, r=-.44 (Caspi, Moffitt, Silva, Stouthamer-Loeber, Krueger & Schmutte, 1994, see also Miller & Lynam, 2001).

However, sex differences among undergraduates on Whiteside and Lynam's (2001) four factor model of impulsivity are weak, with the exception of Sensation seeking, d = .60, on which males score higher (Lynam, 2005). International data using Zuckerman's sensation seeking scale also show a marked sex difference in the male direction (Roberti, 2004; Zuckerman, 1994). Sensation seeking assesses a positive appetite for risky activities rather than an inability or unwillingness to control impulsive expression. This raises two possibilities about how sensation seeking might mediate the sex-aggression relationship. The first is directly congruent with a fear-based proposal. Sensation-seeking is negatively associated with risk appraisal and fear (Roberti, 2004). Individuals with high sensation seeking scores evaluate a range of activities including criminal behavior as less risky (Horvath & Zuckerman, 1993). High sensation seeking is also associated with a less threatening interpretation of fear-eliciting objects and situations (Franken, Gibson & Rowland, 1992). Hence sex differences in sensation seeking may

directly reflect underlying differences in fear. If so, the current argument that fear and fear-based inhibition explain sex differences in aggression remains plausible.

However sensation seeking has also been conceptualised in terms of behavioral compensation for underarousal (Eysenck, 1997; Raine, 2002; Zuckerman, 1994). For individuals with relatively stronger parasympathetic and / or weaker sympathetic nervous system reactivity, maximum hedonic tone is experienced at higher levels of stimulation relative to the population at large. Low arousal as measured by heart rate is associated with antisocial behavior and females have higher heart rates then males (see Reactive fear-based inhibition). Underarousal may be phenomenologically experienced as boredom due to lack of external stimulation and men show significantly higher rates of boredom proneness (Dahlen, Martin, Ragan & Kuhlman, 2004; Lynam 2005). Men's greater involvement in aggressive behavior may reflect not a lack of impulse control but a higher threshold for the point at which stimulation turns from hedonic to dysphoric. The escalation of a verbal argument would, in this model, become distressing to women at a much earlier point than it would to men, resulting in earlier submission, withdrawal or emotional overload, such as crying. In this model, the role of fear is more indirect, acting to alter preferred or tolerable levels of arousal. Further research could usefully pit these two potential mediators of the sex-aggression relationship against one another.

Preference for a smaller immediate reward rather than a more valuable delayed reward has been taken by some to be a behavioral measure of impulsivity (Evendon, 1999). Impulsivity is thus conceived of as a problem

with the ability to delay gratification. Delay of gratification is uncorrelated with resistance to temptation (Toner, Holstein & Hetherington, 1977) and cognitive inhibition tasks (Olson, Schilling & Bates, 1999; Solanto, Abikoff, Sonuga-Barke, Schachar, Logan, Wigal et al., 2001; Swann, Bjork, Moeller & Dougherty, 2002). Criminals are argued to show a steeper time discounting function preferring immediate to delayed rewards and particularly discounting future aversive events such as punishment (Wilson & Herrnstein, 1985). Male and female parolees with a history of violent crimes choose more immediate rewards (Cherek, Moeller, Dougherty & Rhoades, 1997; Cherek & Lane 1999). Preference for immediate reward is highly correlated with performance on a laboratory measure of aggression, the Point Subtraction Paradigm (Cherek et al., 1997). Immediate smaller rewards are more often selected by Individuals low in premeditation and this same trait is significantly associated with higher aggression (Lynam & Miller, 2004). In children also, delay of gratification has been shown to be associated with aggression and delinquent behavior (Mischel, Shoda & Rodriguez, 1989).

With regard to sex differences, Bjorklund and Kipp (1996) concluded that there was a weak female advantage in delay of gratification studies. Silverman (2003b[3]) subsequently reviewed 33 studies of delay of gratification confirming a small effect size favouring women, d = -.12. Using preferences for immediate or delayed lottery payouts, Kirby and Marakovic (1996, see also Kirby & Marakovic, 1995) found that men discounted delayed rewards more steeply than women suggesting greater impulsivity in men.

Executive function inhibition. Executive functions are largely, but not exclusively, associated with the dorsolateral region of the frontal lobes. They

include attention, concentration, reasoning, concept formation, formulating goals, anticipation, planning, programming and initiating sequences of behavior, self-monitoring, self awareness, inhibition of unsuccessful, inappropriate or impulsive behaviors, interruption of behavior and shifts to more adaptive alternative behaviors (Henry & Moffitt, 1997, p. 281). These functions appear to encompass virtually every process required for goal-directed, intelligent and integrated behavior. Given their ubiquity, they have been implicated in a very wide variety of syndromes including depression, obsessive compulsive disorder, neurofibromatosis, effects of preterm birth, Alzheimer's disease, alcoholism, epilepsy, schizophrenia, spina bifida and alcoholism.

They have been intensively examined in relation to disinhibitory and externalizing disorders such as attention deficit hyperactivity disorder, conduct disorder, antisocial personality disorder and psychopathy. A meta-analysis of studies using six commonly-used EF tests (Morgan & Lilienfeld, 2000) found modest effect sizes for clinical syndromes (ASPD, d= .08; CD d = .36 and psychopathy, d= .25) but more marked effects for criminality, d= .94, and delinquency, d = .78. Are similar relationships found for aggression in non-clinical populations?

A number of studies have reported associations between poorer EF performance and aggression (Hughes, White, Sharpen and Dunn, 2000; Lau, Pihl & Peterson, 1995; Seguin, Arsenault, Boulerice, Harden and Tremblay, 2002; Seguin, Pihl, Harden, Tremblay & Boulerice, 1995; Stanford, Greve & Gerstle, 1997). However the tasks used to assess EF correlate very highly, r > .90, with the g factor of general intelligence (Kane, Hambrick & Conway, 2005;

Kyllonen, 1996). Debate continues as to whether EF and IQ are essentially the same construct and, if not, the role of EF in facilitating performance on various IQ tests (Ackerman, Beier & Boyle 2005; Blair, in press). Whatever the outcome, it is clearly important to control for IQ because it has shown consistent associations with antisocial behavior (Lynam, Moffitt & Stouthamer-Lauber, 1993) and with aggression (Giancola & Zeichner, 1994b).

Studies which have systematically controlled for IQ have used two measures of EF: the Self Ordered Pointing task (SOP), which assesses the ability to organise, plan and monitor a sequence of responses and the Conditional Association Task (CAT), which assesses the ability to learn a series of conditional associations between unrelated stimuli. Like most EF tasks, they tap cognitive rather than behavioral impulsivity: While the outcome measure necessarily involves a motor response the focus of interest is the ability to control cognitive processes, chiefly sustained attention and memory. Combining these two measures, Hoaken, Shaughnessy and Pihl (2003) designated participants as low or high quartile EF scorers. Because there was a significant between-group difference in IQ, this was used as a covariate in the analysis. Low EF individuals gave higher shock intensities in the Taylor Aggression Paradigm although the experimental design does not allow examination of the relative contribution of the two tasks. Giancola and Zeichner (1994b) found no relationship between aggression and SOP. But when IQ and SOP performance were controlled, there was a significant relationship between CAT errors and aggression. Using similar measures, Seguin, Boulerice, Harden, Tremblay & Pihl (1999) found that the CAT task produced an anomalous pattern in which unstable-aggressive boys performed

more poorly than both stable aggressive and non-aggressive boys. These latter two groups did not differ when IQ and general memory were controlled. However the SOP revealed both aggressive groups to do worse than non-aggressive boys after controlling for IQ and general memory. Some of these participants were tested again at age 20 (Seguin, Nagin, Assaad & Tremblay, 2004). The young men were classified into low and high aggression trajectory groups and EF was assessed by SOP, CAT and Number Randomisation. There were significant between group differences on all three EF tests, even after controlling for IQ and general memory. However these controls "considerably attenuated" the relationship (Sequin et al., 2004, p.609).

Capacity to focus attention has emerged from factor analytic studies of psychometric impulsivity (White et al., 1994; Whiteside & Lynam, 2001). The association between this factor and aggression has been non-significant (Lynam & Miller, 2004) or considerably weaker than behavioral impulsivity measures (White et al., 1994). In this latter study, cognitive impulsivity, unlike behavioral impulsivity, was unrelated to antisocial behavior when IQ was controlled (Loeber, Farrington, Stouthamer-Loeber, Moffitt, Caspi & Lynam, 2001).

The marked sex differences in disinhibitory pathologies and in criminality have suggested to some commentators the possibility of a sex difference in underlying executive function (Paschall & Fishbein, 2002). Few studies have examined sex differences in EF performance in the normal population and most have been performed on children. Sex differences have not been found using the parent-report Children's Executive Functions Scale (Navarette, Goulden & Silver, 1998). The Continuous Performance Test

(which requires participants to press a button when a designated letter appears on the screen) has produced inconsistent results (Greenberg & Waldman 1993; Kirchner & Kopf, 1974; Levy & Hobbes, 1979). While boys show faster reaction times, they do not generally achieve greater accuracy (Pascualvaca, Anthony, Arnold, Rebok, Ahearn, Kelam et al., 1997; Rebok, Smith, Pascualavaca, Mirsky, Anthony & Kellam, 1997) and Finnish girls aged 3-12 performed better than boys on an auditory Continuous Performance Task with a markedly higher cognitive load (Klenberg, Korkman & Lahti-Nuuttila, 2001). The Digit Cancellation task appears to favour girls at 7-8 years who show faster completion times and fewer errors (Pasculavaca et al. 1997). Girls also outperform boys on a visual attention task (analogous to Digit Cancellation) in a Finnish sample of 3-12 year olds (Klenberg et al., 2001). However between the ages of 10 and 13, while girls continue to complete the task more quickly, there are no differences in accuracy (Rebok et al. 1997). No sex differences are found in children on the Wisconsin Card Sort Test (Pasculavaca et al. 1997; Rebok et al. 1997) or on the Tower of London test (Klenberg et al. 2001). Among adults, using the Tower of Hanoi, men show lower number of moves (Leon-Carrion, Morales, Forastero, Dominguez-Morales, Murillo, Jimenes-Baco et al., 1991), shorter move latency and fewer illegal moves (Ronnlund, Lovden & Nilsson, 2001). WISC subtest measures are taken by some to be tests of EF. While girls and boys perform similarly on arithmetic and digit span subtest of the WISC, girls achieve higher scores on the coding subtest (Pasualavaca et al. 1997; Barr 2003). In general, sex differences appear to be absent, weak or inconsistent on EF tests. To the extent that such tasks correlate highly with or are used as

measures of IQ, the inconsistency and weakness of sex differences is perhaps not surprising.

Summary.

In developmental studies, *reactive control* is associated with aggression and externalizing disorders and girls show consistent evidence of superior control. In terms of physiological reactivity, aggression is associated with a lower resting heart rate (but not weaker electrodermal activity) and heart rate is lower in men than in women in community samples. Orbitofrontal and ventromedial regions of the prefrontal cortex are associated with reactive inhibition of aggression. Although studies of sex differences have not been conclusive, there is some preliminary evidence that women may have greater orbitofrontal volume and a higher density of serotonin receptors associated with the modulation of emotion. Frontal activity, assayed by the IGT, is associated with aggression. Although sex differences have not been found on the traditional dependent measure, some studies have found that women are differentially sensitive to and avoidant of penalties.

Developmental studies that have simultaneously addressed both *effortful control* and externalizing / aggressive behavior have found an association and female superiority. However to the extent that resistance to temptation is an assay of effortful control, a much weaker female advantage has been found. Criminological studies have found associations between low *self control* or high *impulsivity* and antisocial and aggressive behavior. Sex differences in these measures mediate the magnitude of sex differences in antisocial behavior. However using a psychometric instrument derived from established psychological measures of impulsivity, sex differences have not

been found in undergraduate populations with the exception of the sensation seeking scale on which men score higher. There have been only a few studies of delay of gratification in relation to aggression: They are suggestive of a possible relationship but sex differences seem quite modest.

Few studies of aggression and executive function have controlled for IQ. Those that do, report some associations with aggression though these are not always consistent. Studies which have included measures of impulsivity as well as cognitive inhibition find a stronger relationship with aggression for the former. Sex differences in executive function tasks among normal populations are neither consistent nor strong.

Correlates of fear and effortful control.

Below I briefly consider two ancillary domains, empathy and guilt, which are associated with fear, inhibition and aggression and which show some evidence of sex differences. Future work may reveal the temporal and causal associations between these variables.

Empathy can be defined as an affective response that stems from the apprehension or comprehension of another's emotional state or condition and is similar to what the other person is feeling or would be expected to feel (Eisenberg, 2000). It has been proposed that empathic concern for another person enhances the inhibition of aggressive behavior (Blackburn, 1993; Davis, 1996; Feshbach, 1978). The neural structures subserving empathy include the orbitofrontal cortex and amygdala (Grattan, Bloomer, Archambault & Eslinger, 1994; Spielberger, Johnson, Russell, Crane, Jacobs & Spinella, 2002) and hence overlap with those involved in emotional recognition and regulation. Greater empathy is associated with higher levels of fear and even

more strongly with effortful control (Rothbart, Ahadi & Hershey, 1994). The relationship is of equal strength for both sexes.

Empathy is negatively related to aggression and antisocial externalizing problems, although the effects are more marked for questionnaire methods as compared to other indexes such as facial and gestural expressions, and picture and experimental inductions (Eisenberg, 2000; Miller & Eisenberg, 1988). Empathy is also lower among offenders, *d* = -.28, particularly violent offenders, *d* = -.39 (Jolliffe & Farrington, 2004) and the relationship appears to be of equal magnitude for both sexes.

Among children, girls demonstrate greater empathic concern for another's distress whether measured by maternal report (Kochanska, DeVet, Goldman, Murray & Putnam, 1994) or behaviorally (Zahn-Waxler, Radke-Yarrow, Wagner & Chapman 1992; Zahn-Waxler, Robinson & Emde, 1992). Sex differences in empathy have been found in experiments using self report measures but are less evident when physiological or nonverbal reactions are assessed (Eisenberg & Lennon, 1983). Psychometric measures of empathy consistently report a higher mean for female samples (e.g. Baron-Cohen & Wheelwright, 2004; Eysenck & Eysenck, 1978). Empathy forms a central component of measures of nurturance and expressivity on which women score higher than men (Hoyenga & Hoyenga, 1993). Ickes, Gesn and Graham (2000) found an effect size, *d* = -.26, favouring women over fifteen studies of empathic accuracy. However when they included only those studies that cued the participant to the importance of accuracy, the effect size rose to *d* = -.56.

Guilt can be defined as an agitation-based emotion or painful feeling of regret when the actor actually causes, anticipates causing, or is associated with an aversive event (Ferguson & Stegge, 1998, p.20). It has been distinguished from shame on the basis that the latter is more concerned with other's evaluation of the self as a whole and need not involve behavior that is aversive to others (e.g. a poor public speaking performance). Because these two concepts are not always operationally distinct, I will focus on guilt. Guilt is positively correlated with empathy (Tangney, 1991; Tangney, Burggraf & Wagner, 1995) and, like empathy, guilt is associated with both fear (Kochanska et al., 1994) and effortful control (Rothbart et al., 1994).

Preschoolers who exhibit signs of conscience are less prone to transgressions (Kochanska et al., 1994) and these children, when implicated in contrived mishaps, showed affective and behavioral evidence of guilt (Kockanska, Casey & Fukumoto (1995). Guilt is associated with lower levels of aggression (Tangney, Wagner, Hill-Barlow, Marschall & Gramzow, 1996). Very low levels of guilt are associated with externalizing problems (Eisenberg, 2000), conduct disorder (Cimbora & McIntosh, 2003), antisocial personality disorder (Dinn & Harris, 2000) and psychopathy (Morrison & Gilbert, 2001).

In self report studies, women rate themselves as more likely to experience guilt in response to hypothetical incidents than men (Ferguson & Eyre, 2000). However fewer sex differences are found in studies that assess guilt intensity in response to real or hypothetical events, or the frequency of guilt in everyday life. It is likely that the nature of the precipitating event may be critical for sex differences: Ferguson and Eyre (2000, p.266) conclude that "women see themselves as likelier to experience guilt than men for behaviors

that clearly contradict feminine gender roles (e.g., anger, aggression, being inconsiderate to others)." Preschool girls generally display greater distress than boys after engaging in or witnessing aggression and this is confirmed by parental reports (Ferguson & Eyre, 2000). Among both adults and children, sex differences have been found in social representations of aggression indicating that women, more than men, view aggression as a failure of self control resulting in feelings of guilt (Campbell 1993; Campbell & Muncer 1994). Frodi, Macauley and Thome (1977) concluded that guilt about acts of aggression is higher in women and is an important mediator the sex difference in aggression.

Eagly and Steffen (1986) tested this proposal in their meta-analysis. They asked judges to rate each dependent variable used in the studies in terms of "How much anxiety or guilt would you feel if you enacted this behavior?". The wording here is unfortunate because anxiety and guilt are not synonymous and anxiety may have been interpreted to mean fear. This would create a confound between this analysis and their consideration of danger-to-self as a mediator. Unfortunately, correlations between the judges' ratings of danger and anxiety/guilt are not reported but, when sex differences in both variables were entered in a multivariate regression, the impact of anxiety/guilt diminished from beta=.38 in the univariate regression to beta=.30 suggesting only a moderate confound. Guilt and anxiety associated with aggression made a significant contribution to explaining the magnitude of the sex difference. Female judges rated the participants' aggressive actions as significantly higher in anxiety/guilt than did male judges. Nonetheless guilt

may vary as a function of the sex of the victim; men feel more guilt about cross-sex aggression than do women (Archer, 2000; Harris, 1994).

Conclusions

If we conceive of aggression as a trade-off between impelling and inhibitory emotions, the sex difference does not appear to reside in the former. Fear inhibits aggression, shows sex differences and significantly explains the sex difference in aggression. Researchers have noted that aggression diminishes with age as inhibitory processes develop in childhood and adolescence (Tremblay & Nagin, 2005). To the extent that these processes are built upon fear, they are critical in explaining aggression more generally and sex differences in particular. The evidence presented here makes a prima facie case for sex differences in those forms of inhibition most closely allied to fear levels.

Methodological issues.

Firm conclusions about the present proposal must await resolution of terminological, conceptual and measurement issues in the field of inhibitory processes. Within behavioral inhibition research, confusion exists as to the distinctiveness of impulsivity, self-control, sensation seeking, risk-taking, lack of planning, hyperactivity and other usages. Even within impulsivity, the various measures bear inconsistent relationships with one another (Hoaken et al., 2003). Among studies of cognitive inhibition, some see behavioral inhibition as the key developmental competence that allows for the emergence of executive control (Barkley, 1997), some see behavioral inhibition as a facet of executive function (Pennington & Ozonoff, 1996), some see deficits in behavioral inhibition as the manifestation of failure in cognitive

executive functions (Hoaken et al., 2003) and others view them as distinctive entities (White et al., 1994). In short, it is unclear whether behavioral inhibition is a precursor, manifestation, result or fellow-traveller of cognitive inhibition. It is also frequently unclear whether terms such as impulsivity or inhibition are being used to indicate a deficit in specific task performance (a competence problem) or a characteristic preference (a personality trait) (Solanto et al., 2001). Clarification of the relationship of these various concepts and measures to one another and to aggressive behavior, together with data on sex differences, will be important in firmly establishing the mediators of sex differences in aggression.

Theoretical issues.

In recent years, two approaches to sex differences have taken center stage and been involved in vigorous debate; social psychological and evolutionary approaches (Archer, 1996; Bussey & Bandura, 1999; Eagly, 1997). Despite internal diversity and disagreement, social and developmental theorists share the view that sex differences arise from the internalisation of societal norms or roles about the appropriate behavior of men and women, varying in the extent to which they invoke modelling (Bussey & Bandura, 1999), gender schematic processing (Martin , Ruble & Szkrybalo, 2002) or conformity (Wood & Eagly, 2002) as the mediating process. According to social role theory (Eagly, 1987; Eagly & Wood, 1991), sex differences result from the sexual division of labour, especially into family and occupational roles. The tasks assigned to each sex tend to enhance congruent skills and beliefs, and to give rise to gender role expectancies (of women as communal and men as agentic) to which people conform or are socialised. Wood and

Eagly's (2002) more recent biosocial theory proposes that men's greater involvement in warfare and aggression derives from two anatomical differences between the sexes: Men's greater size, speed and upper body strength, and women's obligatory role in childbearing and nursing infants. Their causal chain can be broadly summarised thus: Men's greater body strength makes them better suited for warfare while women's role in child care prevents them from travelling far from home; consequently 'warrior values' are incorporated into the male stereotype; males but not females are socialised into and conform to this stereotype resulting in sex difference in aggressive behavior. The magnitude of sex differences varies with local ecological and economic pressures. In common with other gender theorists, Wood and Eagly reject any essential psychological differences between the sexes; "Our biosocial model does not assume that sexual selection pressures that contributed to physical dimorphism between the sexes are major influences on sex-typed *psychological* attributes" (Wood and Eagly, 2002, p.702). Rather, psychological differences between men and women are acquired through cultural conformity and socialization. Not surprisingly, these and other gender theorists align themselves against evolutionary perspectives (Bussey & Bandura, 1999; Wood & Eagly, 2002).

An evolutionary approach emphasises that, across many species including our own, asymmetries of parental investment have had a significant impact on those aspects of psychology that have consequences for inclusive fitness. Sex differences are not monolithic (where selection pressures act equally on both sexes, no differences are expected) but do appear in those domains associated with sex-specific reproductive success. Evolutionary

analyses have been offered of sex differences in both aggression and inhibition. Daly and Wilson (1988) argue that males' higher level of aggression derives from their greater fitness variance compared to females. Under effective polygyny (and there is much morphological evidence that this was present during hominid evolution, Daly & Wilson, 1983), men had very high incentives in terms of reproductive success for establishing intra-sexual dominance and, in consequence, securing a large number of mates. This selective advantage meant that more aggressive males out-reproduced their peers and the net result is seen in the gene pool today. Daly and Wilson (1994) are agnostic as to the psychological mechanisms underlying this adaptation, recognising that the mechanism could involve an increased appetite for risk or lower levels of fear or inhibition. Campbell (1999, 2002) suggested the latter in a complementary view which focuses on female disincentives for aggression. In this view, women's desistance from aggression is not a function of fewer incentives (inherited dominance in female-bonded primates is associated with greater reproductive success; Ellis, 1995) but because direct aggression incurs higher potential costs. Offspring's greater dependence on the mother than the father, women's higher parental investment in each offspring and the limited number of that a woman can bear in a lifetime relative to a man mean that women's reproductive success depends upon avoiding injury and death to a greater degree than men's. Because this approach emphasises costs rather than rewards, the proposed psychological mechanism is an inhibitory one. The avoidance of direct physical risks is mediated by higher levels of fear of bodily injury and is manifested in women's avoidance of high risk activities generally,

including direct forms of aggression. Taylor, Klein, Lewis, Gruenewald, Gurung and Updegraf (2000) concur that a woman's mothering role and her need to avoid direct aggression are central to explaining their contemporary desistance from aggression. They propose that testosterone mediates the relationship between threat and attack and, in consequence, females show lower rates of aggression. Bjorklund and Kipp (1996) argue that inhibitory ability was more critical to women's reproductive success than to men's in relation to mate choice and the need to prioritise the interests of offspring and restrain aggression against them.

Gender and evolutionary theories lead to divergent predictions with regard to the proposal that sex differences in aggression arise from differential fear and fear-based inhibition. Three such predictions are described below.

Cross-cultural consistency. Social role theorists propose that "the female gender role emphasises avoiding physical harm to oneself" but that less traditional forms of this role "include an emphasis on assertiveness" (Eagly & Steffen, 1986, p.310). A reasonable prediction would be that fear should be greater among women who accept traditional female gender roles. Yet, as noted earlier, correction for gender role adherence and dissimulation does not eliminate significant sex differences in fear (Arrindell et al., 1993). While evolutionary psychology does not discount environmental factors (the essence of a successful adaptation is the 'goodness-of-fit' between the gene's product and the specific environment), fear is here posited as a sex-linked and species-typical adaptation. Hence it is expected that women would show higher fear across a range of cultures, albeit with variation in effect size as a result of facultative adaptation. Sex differences in fear show "strong cross-

national consistency" (Gullone, 2000, p.444). Similar evolutionary predictions would apply to behavioral inhibition, although the prediction of schematic and role theories in this domain is unclear since inhibitory processes are not readily visible and hence not directly available for integration into gender schemata or stereotypes. One cross-national study using ratings and observations of 4 year old children in Britain and Hungary found sex differences, but not cultural differences, in self control favouring girls (Gervai et al., 1993). Further multi-national studies will be critical in examining the cultural specificity or universality of sex differences in inhibition.

Development. If sex differences are acquired through a cumulative process of socialization or enculturation as social theories suggest, then it would seem reasonable to suggest that sex differences should increase with age. However this has not been found to be the case (Hyde, 1984) and gender theorists now suggest that the age effect may not be linear (Martin, Ruble & Szkrybalo, 2002). Either way, the effect size for aggression, d = .53, does not vary significantly across three age groups investigated (Archer & Cote, 2004). Fear has been found to diminish with increasing age in both observational and self rating studies and this is true cross-nationally (Gullone, 2000), probably reflecting children's increasing ability to regulate their emotions. However the sex difference is marked in childhood, adolescence and adulthood (Brebner, 2003; Gullone, 2000). A longitudinal study found similarity in the developmental trajectory of fear and impulsivity in boys and girls (Cote et al., 2002, see also Roberts & DelVecchio, 2000).

Because gender theorists identify stereotypes as the key to sex differences, it was originally suggested that a child would not be expected to

show sex-typed behavior until such cognitive representations were in place (Martin, 1993; Martin & Halverson, 1981). However sex differences in fear (Gartstein & Rothbart, 2003) and aggression are apparent by the age of 2 (Archer & Cote, 2004) despite the fact that gender labelling, a necessary prerequisite for gender stereotypes, is not firmly achieved until six months later. Longitudinal studies have generally found weak evidence that gender knowledge predates gender-congruent behavior (Aubry, Ruble & Silverman, 1999; Campbell, Shirley & Candy, 2004; Fagot & Leinbach, 1989;Trautner, 1992). Acknowledging this, schema theorists have proposed that the ability to perceptually discriminate males and females, which may appear in the first year of life, is sufficient for the initial development of gender schema (Martin, Ruble & Szkrybalo, 2002; Ruble & Martin, 1998). Investigation of these rudimentary schema will require ingenious research methodology but may demonstrate an earlier understanding of the sex-linkage of fear, inhibition and aggression. Nonetheless, such schema would not be expected to guide sex-congruent behavior until the child was able to categorise themselves as male or female, an ability that is unlikely to be in place before the age of two years (Campbell, Shirley & Caygill, 2002).

Gender schema theorists also accept that early-appearing sex differences may be related, inter alia, to “biological influences” (Martin, Ruble & Szkrybalo, 2002 p.918). Such biological influences may include genetic or hormonal factors associated with fear and anxiety which underpin the responsiveness of the child to agents of socialisation and their consequent impulsivity. Substantial genetic mediation has been found in two different twin samples for the correlation between impulsivity and aggression (Seroczynski,

Bergman & Coccaro, 1999; Vierikko, Pulkkinen, Kaprio & Rose, 2004). An important question for future biological research is the extent to which such a common genetic predisposition is sex-limited (gene expression depends upon hormone levels, such as testosterone) or sex-linked (including non-random X inactivation in females, Craig, Harper & Loat, 2004).

Coherence. A strong criterion for the identification of an adaptation is "special design"; the components involved are integrated, efficient, specific and coordinated to solve some evolutionary relevant problem. If the present proposal represents an adaptation, we would expect to find the pattern of significant correlations between fear, behavioral inhibition and aggression. These correlations should hold equally for both sexes although the values associated with the components would differ with boys in general showing higher aggression and lower fear and inhibition. According to schematic and role theories, each gender role has a number of associated attributes (e.g. for females, not exposing oneself to danger and demonstrating concern for others) but the internalisation of one is not contingent on the internalisation of others. The molecular parts are not functionally integrated at a psychological level. It seems reasonable to propose that there is considerable scope for individual differences, in both sexes, in the extent to which they internalise and behaviorally conform to each of the various gender-relevant attributes. If this is the case, the correlations between aggression, fear and inhibition documented by developmental psychologists require explanation.

Gender and aggression theorists have much to learn from one another. I have suggested that gender theorists could develop a more specific and sophisticated account of sex differences by considering recent research in

aggression, especially the developmental emphasis upon the child's increasing ability to manage aggressive behavior by emotional and cognitive forms of control (Anderson & Bushman, 2002). Equally, aggression theorists have often failed to appreciate that a theory that does not implicitly predict sex differences is problematic. Studies have often used exclusively male samples or treated sex as a covariate or side issue---apparently failing to realise that the ability to explain the sex difference in aggression constitutes a sine qua non for any adequate theory. It is hoped that by explicating a possible model of how emotion and inhibition may mediate sex differences in aggression, a clearer framework for integrative research uniting both camps may emerge.

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Table 1: Summary of meta-analytic reports on the magnitude of weighted *d*

	Self report or psychometric	Other report	Observational	Experiments	Aggregated methods
Overall aggression	.30/.42[a] .33[c] .46[d] .28[f]	.48/.61[c] .48[d] .42/.63[a]	.49[a] .83[c] .35[d] .51[f]	.29[b] .30[d] .24[e]	.47[c] .66[d] .50[f]
Physical	.39/.59[a]		.33/.84[a]	.40[b] .36[e]	.91[c] .59[d] .60[f]
Verbal	.19/.30[a]	.24/.51[a]	.09/.14[a]	.18[b] .30[e]	.46[c] .28[d] .43[f]

a Archer (in press); *b* Eagly, A. & Steffen (1986); *c* Knight, Fabes & Higgins (1996); *d* Knight, Guthrie, Page & Fabes (2002); *e* Bettencourt & Miller (1996); f Hyde (1986)

Table 2: Summary of classes of inhibition in relation to aggression and sex.

Construct	Indicative tasks and measures	Relationship to aggression	Relationship to sex	Relationship to fear
Reactive (fear-based) inhibition	Child Behavior Questionnaire or Q-sort. Heart rate. Iowa Gambling Task. Neuroimaging studies	Strong	Moderate female advantage.	Fear directly implicated
Effortful control	Child Behavior Questionnaire. Compliance with adult proscription.	Strong	Marked female advantage.	Based on reactive fear-based inhibition
	Resistance to temptation	No studies	Moderate female advantage.	
Self control / Low impulsivity	Psychometric measures. Adult ratings.	Moderate to strong	Marked female advantage in community studies but not among undergraduate samples.	Based on effortful control.
	Preference for immediate reward	Modest (Few studies)	Weak female advantage	
Executive function inhibition	Executive function tasks (usually CAT and SOP)	Modest (when IQ controlled).	None or inconsistent	No causal connection.

Figure 1: Sequence of development of capacity to inhibit aggressive behavior.

Developmental stages are shown vertically with each stage building upon the preceding one. Subsequent stages subsume but do not replace preceding ones.