EFFECTS OF NUTRITIONAL SUPPLEMENTATION ON RECIDIVISM IN MALE PROBATIONERS CONVICTED OF DOMESTIC VIOLENCE

AKA:
THE DOMESTIC VIOLENCE REDUCTION PROJECT
OF THE VIOLENCE RESEARCH FOUNDATION

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1. SPECIFIC AIMS

Several recent studies suggest that nutritional supplementation may reduce the likelihood of violent behavior in humans (e.g., Gesch, et al., 2002; Hamazaki et al., 1996; Schoenthaler et al, 1997; Walsh, Glab & Haakenson, 2004). However, methodological problems limit the extent to which these studies can be relied upon as definitive guidelines for intervention. In the proposed study, a standard nutritional supplement will be given daily to male offenders convicted of domestic violence (DV) and participating in state-mandated batterers intervention programs (BIPs). The purpose of the study will be to determine if DV recidivism rates can be further reduced by augmenting BIPs with nutritional intervention. Specifically, we will:

1. For purposes of screening, gather sociodemographic, psychoeducational, medical, and nutritional information from a cohort of up to 1000 male probationers convicted of a crime of DV, as they enter into their state-mandated BIPs;
2. Obtain informed consent from at least 600 individuals who have been screened for disqualifying (i.e., severe comorbid) conditions;
3. Randomly assign subjects to either an a) active nutritional supplement group (n = 300) or b) placebo group (n = 300) for a period of one year, commencing with the initiation of their first session of the 52-week state-mandated BIP, and continuing through program completion;
4. Gather information pertaining to all incidents of violent behavior, from a) periodic interviews with spouses/domestic partners; b) reviews of police records; and c) reviews of treatment program outcomes;
5. Contrast outcomes for the active nutrient vs. placebo groups to determine the effects of nutritional supplementation on a) frequency and b) severity of future incidents of DV, as well as programmatic outcome measures.

2. BACKGROUND AND SIGNIFICANCE

Scope of Problem

In 1989, U.S. Surgeon General C. Everett Koop estimated that 15 million women in the U.S. would suffer from DV at some time in their lives (Jones, 1993). The most recent Department of Justice National Crime Victimization Survey, released in December, 2008, indicates that during 2007 U.S. residents experienced approximately 5.2 million violent crimes. The overall U.S. victimization rate was 20.7 per 1,000 persons, a figure that has remained relatively stable since 2003. In 2007, about 623,000 violent crimes--554,000 against female victims and 69,000 against male victims--were committed by an intimate partner (DV). On average, more than three U.S. women per day are murdered by their husbands or boyfriends (USDOJ, 2008).

On September 17, 2008, 1,553 of an estimated 2,000 U.S. DV programs participated in the annual National Census of Domestic Violence Services. The information provided by the participating programs pertained to services provided

during the 24-hour survey period, during which 60,799 victims of DV were served. Of these, 30,433 found refuge in emergency shelters or transitional housing, and 30,366 adults and children received non-residential assistance and services. During the 24-hour survey period, 21,683 hotline calls were answered, or, an average of 14 calls per minute (NNEVD, 2008).

Early Studies

The first major survey on DV was carried out for the year 1975-76 by Straus, Gelles, and their colleagues. In 16% of 2,143 families surveyed by telephone, at least one incident of DV had occurred during the prior year; in 28% of these families, at least one incident of DV had occurred since the inception of the marriage. While two-thirds were minor incidents, the remaining third consisted of serious assaults, such as punching, kicking, biting, beating and attacks with a gun or knife. Straus and Gelles (1986) reported that the overall rate of DV was 160 per 1,000, and of severe incidents of violence, 61 per 1,000. These percentages remained roughly the same from 1975 to 1985. In a later nationwide study of 8,145 families, Straus & Gelles (1990) found that 12% of couples reported that the wife had been assaulted by her partner one or more times during the previous year.

Recent Estimates

Recent reports indicate that one in four women in the United States will report having experienced DV at some point in her life. In 2001, 691,710 nonfatal and 1.247 fatal violent victimizations were committed by intimate partners in the U.S. The Centers for Disease Control and Prevention have indicated that, in 2005, women experienced two million injuries from. In 2005, 1,858 U.S. women were murdered by males, 92% by someone they knew. Of women victims who knew their attackers, 62% were wives, common-law wives, ex-wives, girlfriends or ex-girlfriends of the offenders (VPC, 2007). Of the female homicide victims from 1976 to 2005, 41% were killed by an intimate partner or other family member (Catalano, 2007).

Additionally, about 5.5 million children in the U.S. live in families in which DV occurred at least once in the past year, and seven million children live in families in which severe partner violence occurred (CDC, 2008). In a recent review, Stover (2005) concluded that “60% to 75% of families with intimate partner violence have children who are also battered.” On a single day in 2008, 16,458 children were living in a domestic violence shelter or transitional housing facility. Another 6,430 children sought services at a non-residential DV assistance program (USDOJ, 2008).

California. In October, 2003, Laura Lund, of the California Department of Health Services, Epidemiology and Prevention for Injury Control Branch, released a 53-page report entitled “Violence against Women in California, 1992-99.” Among Lund’s findings was the fact that during 1998 and 1999, about 620,000 women per year experienced violence or physical abuse by their intimate partners, or DV. During these same two years, 916,000 children were

present in the households where DV had occurred. Over the eight year time frame, an average of 2,712 women per year had been hospitalized as the result of DV. During this same eight year time frame, an average of 563 women per year were murdered, 34% by intimate partners. Lund's report indicated that women who experienced DV were more likely to be young (under 45), a member of an ethnic minority, poor, unemployed, poorly educated, and without health insurance. Women who experienced DV were also more likely to be pregnant (Lund, 2003).

In 2006, Moreen Libet and Zipora Weinbaum of the California Department of Health Services, reported on data collected during a 2003-2004 survey of 7,735 women. In response to questions about intimate partner physical and psychological violence, 4.3% reported physical violence and an additional 4.5% reported psychological violence only during the previous 12 month period (Libet & Weinbaum, 2006).

On September 17th, 2008, 62% of identified DV intervention programs in California participated in the 2008 National Census of Domestic Violence Services. During this 24-hour survey, 3,872 victims of DV were served, including 2,281 adults and 1,591 children; 1,142 victims were served in shelters, another 870 in transitional housing, and 1,860 in non-residential settings. During this same 24 hour period, 1,081 DV hotline calls were answered (NNEDV, 2008).

San Bernardino County. In the 2003 Lund survey, San Bernardino County ranked third, behind Los Angeles County (1714), and San Diego County 302), in the total number of homicides involving female victims, with 296, an annual average of 37, of which about one-third annually were committed by an intimate partner. With an average annual rate of 4.7 female homicide victims per 100,000, San Bernardino County ranked 1st among all 58 California counties. With an average annual rate of 17.9 per 100,000, San Bernardino County ranked 7th among all California counties in hospitalizations for women victims of violence (Lund, 2003).

Riverside County.

Orange County.

[This is an example of the type of data needed, by county. We need recent data for San Bernardino County, Orange County, Riverside County]

Processing of cases

In a February 2008 report from the US. Department of Justice, results of a May 2002 survey of 15 large urban counties, including California's Alameda, Orange, Riverside, San Diego and Santa Clara counties, was published (Smith, Durose, & Langan, 2008). During this one-month time frame, 2,629 violent felony cases were filed, almost 70% of which were either sexual assaults or aggravated assaults. One-third of these felony cases (836) were classified as DV, 62% of which were further classified as assaults. The majority of the DV arrestees were unarmed during commission of their offense, 70% using hands, fists, feet or teeth in the commission of their offense. Of the 836 arrested, 83.8 % were convicted,

97% following a guilty plea. Of those convicted, 58% were sentenced to prison and 36% sentenced to jail. The mean duration of sentence was 71 months, if the DV involved sexual assault, and 27 months if the DV involved aggravated assault. Interestingly, at the time of their most recent arrest, almost 23% of the DV defendants had been on probation or pretrial release.

Reporting Biases

From 1995 to 2005, 15,719 articles on DV were published (Stover, 2005). Most need to be cautiously interpreted because of a number of methodological problems, some of which may be insurmountable (Bachman, 1998; Ellsberg et al., 2001; Jackson et al., 2003; Moffit et al, 1997; Smith, 1994;). It is clear that underreporting is the most serious threat to an understanding of true prevalence. Women victimized over a long periods of time tend to underestimate the frequency and severity of the violence they have experienced when their reports are compared with hospital records or witness statements; male batterers tend to underreport their violent actions and minimize their responsibility (Babcock, Green & Robie, 2004; Moffitt et al, 1997). Further, only about one out of every five DV incidents is reported to authorities (Rosenfeld, 1992). Unlike victims and offenders who are strangers, victims and offenders in DV situations have a continuing relationship in which there are increased opportunities for violent encounters. And, because they are bound together in a continuing relationship, it is quite likely that the victim will be violated repeatedly by the offender. Since one partner in the relationship is invariably weaker and more vulnerable, the abuser often threatens the victim with additional violence if the crime is reported, leading to failure to report, hence continuing exposure. Smith (1994) summed up the evidence on underreporting in the following statement:

> "To My knowledge, there is no systematic empirical evidence that women survey respondents overreport their victimization, and I cannot think of a convincing theoretical reason for why they would do so."

Repetitive nature of domestic violence

Recidivism rates among DV offenders are estimated to be anywhere from 40 to 80% when victims are followed longitudinally and interviewed directly (Garner, Fagan & Maxwell, 1995; NIJ, 2003; Shepard, 1992). For example, in a carefully designed follow up of the National Institute of Justice's Spousal Assault Replication Program, Maxwell et al. (2001) found that about 36% of arrested DV offenders reoffended within the 6 month follow up window, while 48% of those who were not arrested reoffended. Moreover, 3,147 interviewed victims reported more than 9,000 incidents of aggression since the initial DV incident. The alternative to arrest, batterers' intervention programs (BIPs), has shown similar recidivism rates. For example, Gondolf (1997), followed 662 batterers, all participants in four well-operated BIPs, located in four urban centers across the U.S., for 15 months, and found that 32% of female partners reported at least one reassault during this time frame, 61% of which resulted in bruises or injuries, while 12% required medical

attention. Saunders (1993), in a review of all available information on male DV offenders, found the recurrence of violence was 52% within six months for those who did not complete a BIP, and 32% for those who did complete a BIP. In recent a meta-analysis of treatment outcomes for DV offenders, based on an analysis of 36 studies, Babcock et al. (2004) found that, based on partner report, DV offenders had a 40% chance of being successfully nonviolent without treatment, and a 35% chance with treatment, the logical conclusion being that about 60% of DV offenders will recidivate.

In California, a follow up of BIPs by Taylor (2000) indicated that at least 67% of victims experienced at least one of the following types of DV during the immediate six month time frame: 1) controlling behavior (45 %); 2) psychological abuse (60 %); 3) threats of physical abuse (23%); and, 4) physical abuse (30%). In a carefully designed follow-up of 376 criminal defendants in Brooklyn, with some participants selected by lot to a control group (community service) and the remainder others participating in either an 8-week or 26-week batter treatment program, Davis, Maxwell and Taylor (2003), the results of victim interviews indicated recidivism rates within 6 and 12 months of program assignment as shown in Table 1.

Table 1. Recidivism Rates in Davis, Maxwell and Taylor (2003) study.

Treatment	6 months	12 months
26 week program	23%	14%
8 week program	19%	18%
Community service	21%	22%

Intervention

Most prevention approaches stress education, including use of social learning models to train individuals in resolving conflicts in non-violent ways. The Duluth Domestic Abuse Intervention Project model ("Duluth Model") is perhaps the best-known BIP model, and has been widely adopted throughout the U.S. (Pence, 1985; Pence & Paymar, 1993; Healey, Smith & O'Sullivan, 1998). Key components of the model include: (1) creating a philosophical approach that centralizes victim safety; (2) developing polices and protocols that enhance victim safety; (3) enhancing networking among service providers; (4) building monitoring and tracking systems that strengthen system accountability; (5) advocating for battered women within the criminal justice system and the broader community to insure a supportive infrastructure; (6) providing sanctions and rehabilitation opportunities for abusers; (7) undoing the harm violence to women does to children; and (8) evaluating the coordinated community response for victim safety and offender accountability.

However, in controlled studies, no BIP, including the Duluth Model, or the less extensively used cognitive-behavior therapy (CBT), seems to be more than minimally effective in reducing the recurrence of DV (Davis et al., 2003; Gondolf & Jones, 2001; Gordon & Moriarty, 2003; Jackson et al, 2003; Maxwell et al, 2001;

Rosenfeld, 1992; Dunford, 2000; Dunford et al, 1990). For example, in a carefully designed follow up study, Davis et al., 2003, concluded that their results indicate that BIP "merely suppresses violent behavior for the duration of treatment." Much of the extant literature has been recently subjected to a rigorous meta-analysis by Babcock, Green and Robie (2005), who reviewed 70 empirical studies and selected 48 that met minimum criteria for inclusion in that they could be a) classified as experimental, quasi-experimental, or pre-post, b) had some form of comparison group, and c) relied on either victim report or police report as the index of recidivism. These authors concluded that in general, the effects size due to the BIP was in the "small" range, and there were no significant differences with respect to the type of program (i.e., "Duluth" vs. CBT), reporting method, or study design. Relying on the most rigorous of the studies—those meeting the criteria for "true" experimental design, the effect sizes were even smaller, approximately .1 of a standard deviation. Babcock et al. summarize the overall trend as indicating that a woman is 5% less likely to be assaulted by a man who was arrested, sanctioned, and attended a BIP than by a man who was simply arrested and sanctioned.

Even the above picture, indicating perhaps a small reduction of recidivism associated with BIPs may be overstating the case, as partner follow-up rates in these studies range from 22% to 90% of the sample, and those who are lost to follow-up are thought to be more abusive (Babcock et al., 2005).

California's BIP programs. In California, as in many other states, there are specific provisions in the law pertaining to the disposition of DV offenders. Since 1994, if a defendant is convicted and placed on probation for conduct perpetrated against any of the persons defined in Family Code section 6211 (e.g., spouses, cohabitants, dates/former dates, domestic partners/former domestic partners, defendant's children) and the conduct could be enjoined under Family Code section 6320, the court must impose all of the terms and conditions of probation set forth in Penal Code section 1203.097. Included in the provisions is a 52-week BIP that meets the following requirements:

a. The program must be approved by the probations department;

b. The defendant must enroll within 30 days of sentencing or release date;

c. The program must provide periodic progress reports at least every 3 months;

d. The defendant must complete the program within 18 months of enrollment;

e. The defendant can have only three unexcused absences; and

f. The court cannot waive program fees, but the court must consider the defendant's ability to pay and ensure that a program with a sliding fee scale is available.

Most recently, a review of the effectiveness of California's BIPs, supported by the National Institute of Justice, was conducted by MacLeod et al. (2009). These investigators, drawing a sample of over 1,000 men enrolled in BIPs across five state jurisdictions (Los Angeles, Riverside, San Joaquin, Santa Clara, and Solano counties), looked at rates of program completion and re-offense. According to the investigators, the educational topics included in the BIPs were those identified by the California legislature as important for helping to end abuse. There was no

statistical association at all between program and offender's likelihood of re-offense. For offenders who successfully completed the 52-week BIP, attitudes and beliefs showed small, positive changes along a number of dimensions, including taking greater personal responsibility, understanding the effect of abuse on others, and anger management.

Causes of Domestic Violence

In an often-cited position paper of the American Public Health Association (APHA), the causes of DV are characterized as "Social, economic, psychological and environmental…" The factors most often mentioned are (a) intergenerational cycle of violence, (b) gender role-typing, (c) discrimination, (d) stress and social isolation, (e) cultural acceptance of violence, and (f) drug and alcohol abuse (APHA, 1993). The National Research Council Panel on Understanding and Control of Violent Behavior (Reiss & Roth, 1993) proposed a matrix for organizing risk factors for violent behavior, as shown in Table 1.

As noted elsewhere (e.g., Short, 1998), the causes of violence are even more complex than depicted in Table 1, as there are myriad interactions among social and individual influences and, indeed, the boundaries between the so-called psychosocial and biological realms have been blurred considerably over the past two decades. Consider, for example, the model proposed by Raine (2002), depicting the multiple interactions that need to be considered (Figure 1).

Table 2. Matrix for Organizing Risk Factors for Violent Behavior (from Reiss & Roth, 1993).

Units of observation and Explanation	**Proximity to Violent Events and Their Consequences**		
	Predisposing	Situational	Activating
Social			
Macrosocial	Concentration of poverty	Physical structure	Catalytic social event
	Opportunity structures	Routine activities	
	Decline of social capital	Access: Weapons, emergency medical services	
	Oppositional cultures		
	Sex-role socialization		
Microsocial	Community organizations	Proximity of responsible monitors	Participant's communication exchange

	Illegal markets	Participants' social relationships	
	Gangs	Bystanders' activities	
	Family disorganization	Temporary communication impairments	
	Preexisting structures	Weapons: carrying, displaying	
Individual			
Psychosocial	Temperament	Accumulated emotions	Impulse
	Learned social responses	Alcohol/drug consumption/	Opportunity recognition
	Perceptions for reward/penalties for violence	Sexual arousal	
	Violent deviant sexual preferences	Premeditation	
	Cognitive ability		
	Social, communication skills		
	Self-identification in social hierarchy		
Biological	Neurobiologic traits	Transient neurobiological "states"	Sensory signal-processing errors
	Genetically mediated traits	Acute effects of psychoactive substances	Interictal events
	Chronic use of psychoactive substances or exposure to neurotoxins		

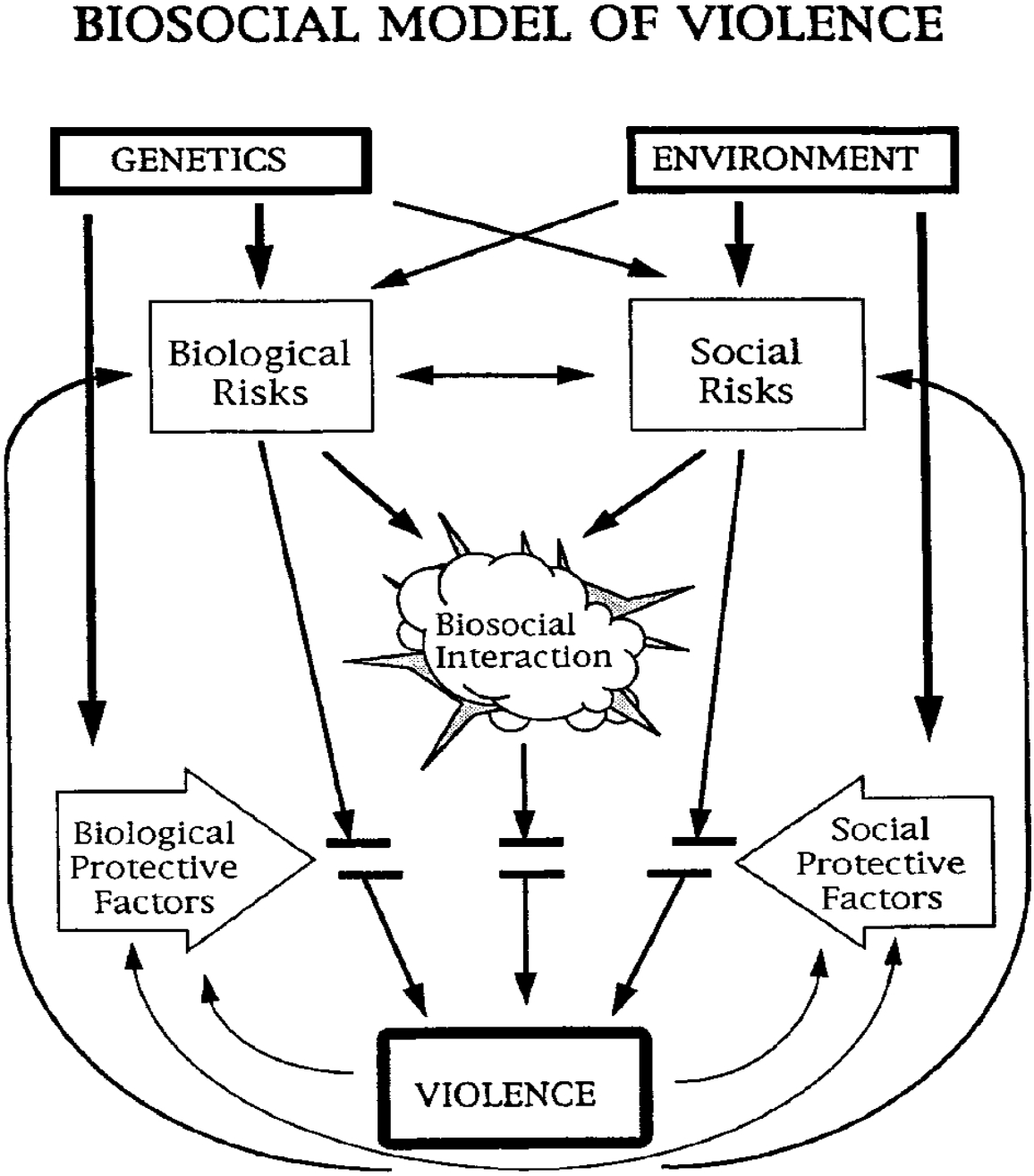


Figure 1. Raine's model of biosocial interaction (from Raine, 2002).

A more complex theory, with many elements of the theory linked to specific research findings is that of Ellis (2009), who terms it the "evolutionary neuroandrogenic theory" (ENA), depicted in the flow diagram on the following page.

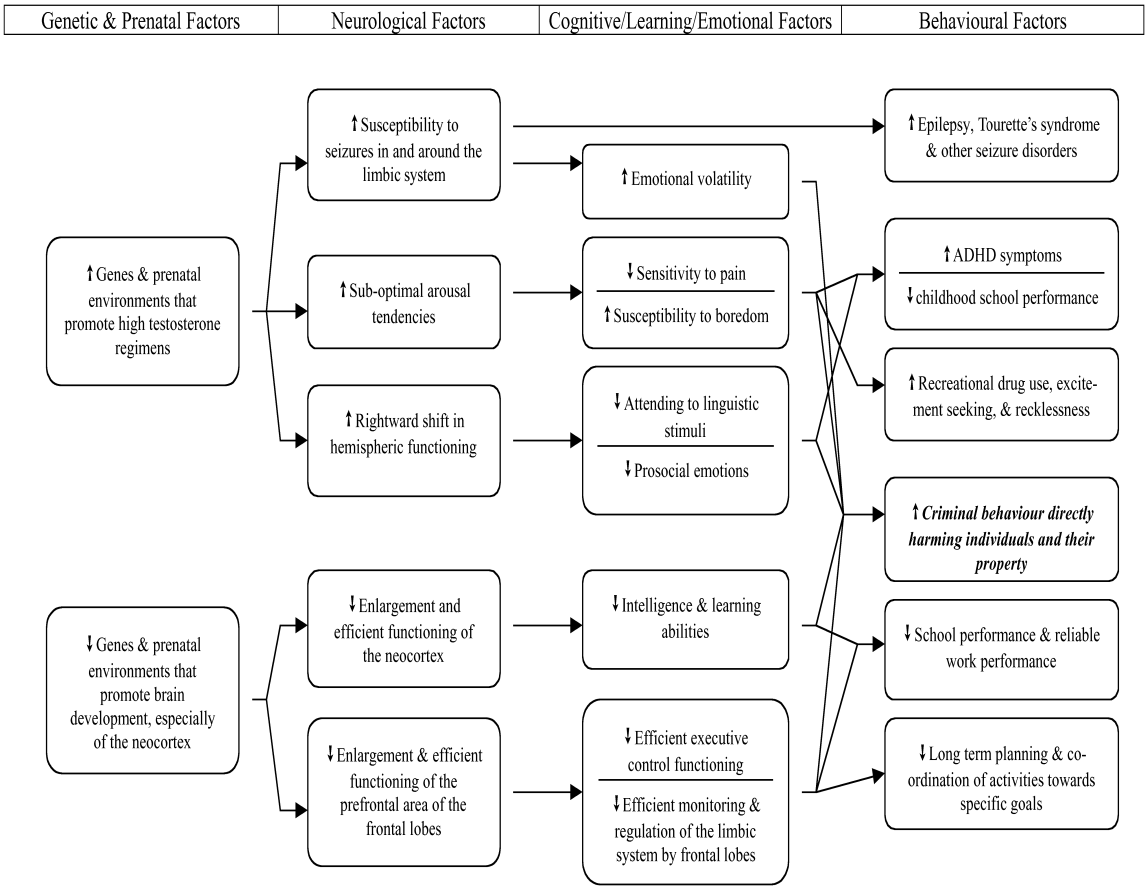


Figure 2. Flow schematic of Ellis' (2005) evolutionary neuroandrogenic theory of violence.

Focus on Offender Characteristics

In the 1993 publication of the National Research Council Panel on Understanding and Control of Violent Behavior, it was recommended that more research be undertaken on the assaulter's characteristics, including neurobiological factors involved in violent behavior (Reiss & Roth, 1993). The panel suggested five reasons for studying neurobiological factors: (1) Identification of specific neurobiological markers; (2) prevention of risks such as exposure to neurotoxins; (3) development of pharmacological control; (4) determination of the effects of drugs and alcohol; and (5) improvement in measuring neurobiologic responses which add information to research studies.

However, with a few noteworthy exceptions, violence research has continued to be dominated by investigations of non-biologic factors. Very recently, Ratchford and Beaver noted: "Part of the reason that the criminological community opposed biological explanations is because they are viewed as mutually exclusive and logically incompatible with various perspectives favored by sociologists who have dominated the discipline" (Ratchford & Beaver, 2009). By way of example,

consider one of the most influential theories in modern criminology, that of Gottfredson and Hirshi (1990), who have attributed antisocial behaviors to and intervening construct, “low self-control.” In this conceptualization, the development of self control is the product of parental socialization techniques, e.g., monitoring and recognizing misbehavior, consistent punishment of antisocial behaviors, and, to a lesser extent, non-familial social institutions, such as the school. And, there has been overwhelming empirical support for this theory (see Pratt & Cullen, 2000, for a meta-analysis of supporting research studies). However, recent studies that have now carefully contrasted the relative contributions of these psychosocial factors with the contributions of biological determinants.

For example, Beaver and Wright (2005) found that anoxia suffered at the time of birth was related to lower levels of self-control, irrespective of parental involvement (i.e., psychosocial) factors. Beaver, Wright and DeLisi (2007) found that neuropsychological deficits in executive functions, said to be mediated by the prefrontal cortex, had statistically significant effects on levels of self-control, even after controlling for a number of psychosocial factors, such as parental socialization. Raine et al. (2005) also showed similar neuropsychological deficits, independent of psychosocial adversity, to be predictive of a life-course persistent antisocial path. Indeed, a wide range of antisocial behaviors have now been associated with factors such as genetic predispositions as well as adverse prenatal/perinatal events (see Moffit, 2005, and Raine, 2002 for recent reviews).

Below, a comprehensive review of the neurobiology of violence is provided to illustrate the wealth of existing information to support our contention that there are neurobiological antecedents to many cases of DV, and that these conditions might be reversible by nutritional supplementation.

The Neurobiology of Violence

Selective dysfunction of certain brain structures has long been implicated in studies of patients who are violence prone (e.g., Anderson et al., 1999;, Bach-y-Rita et al, 1971; Elliott,1992; Heimberger et al., 1966; Mark & Ervin, 1970; Narabayashi, 1963; Tardiff, 1998). Studies of animals with experimentally-induced lesions have converged on a system of brain structures involved in the production and/or suppression of aggressive behavior (e.g., Albert et al, 1981; Bard, 1928; Bard & Mountcastle, 1948; Brady & Nauta, 1953; Cain, 1974; Latham & Thorne, 1974; O'Boyle, 1974; Reeves & Plum, 1969; Reis, Doba & Nathan, 1972; Schreiner & Kling, 1956; Thompson, 1978; Thorne, 1993; Thorne, Aaron & Latham, 1973, 1974; Thorne, Wallace & Danzig, 1978; Wallace & Thorne, 1978; Wheatley, 1944; Zeman & King, 1958). The neural circuitry that appears to be most involved most often is the amygdala, anterior cingulate cortex, and areas of the prefrontal cortex (Davidson, Putnam, & Larson, 2000; Lesch, 2005). Electrical stimulation of these structures has been shown to elicit and/or inhibit aggressive behavior (Delgado, 1965, 1969; Heath, 1963; Heath, Monroe & Mickle, 1955; King, 1961; Valenstein, 1973).

5-HT and aggression. Individuals with histories of episodic violence appear to

have dysfunctional projections of the neurotransmitter, 5-hydroxytryptamine (serotonin, or 5-HT) to the neural networks involved in the modulation of aggression (see Berman et al., [1997, 2009], Moore, Scarpa & Raine [2002], Siever [2008], and van Goozen et al. [2007], for recent reviews). Inappropriate aggression has been associated with:

(1) Low serum levels of 5-hydroxyindoleacetic acid (5-HIAA), a 5-HT precursor (Brown 1982; Brown & Goodwin, 1984, 1986; Linnoila et al, 1983; Roy et al, 1986, 1988; Valzelli, 1974);

(2) low cerebrospinal fluid (CSF) levels of 5-HIAA (Bioulac et al., 1980; Birger et al., 2003; Coccaro et al., 1997; Kruesi et al, 1990, 1992; Moore, Scarpa, & Raine, 2002);

(3) low 5-HIAA/5-HT ratio in whole brain homogenates, reflecting a low rate of 5-HT turnover (Valzelli, 1969, 1971);

(4) intensity of prolactin response to 5-HT agonists (Berman et al., 1997; Fishbein et al., 1992; Manuck et al, 1998; Stoff et al, 1992); and

(5) depletion of the 5-HT precursor, tryptophan (Trp) (Bjork et al.,1999, 2000; Marsh et al, 2002).

Pharmacologic treatments that enhance brain 5-HT levels have proven beneficial in patients with clinical disorders symptomatized by inappropriate aggression (Pinner & Rich, 1988; Ratey et al, 1989, 1991; van Praag & Lemus, 1986). And, in studies of laboratory studies of induced aggression, administration of Trp appears to reduce aggressive responding (Berman et al., 2009; Bjork et al., 1999, 2000; Cherek & Lane, 1999; Cherek et al., 2001; Marsh et al., 2002).

To date, carefully-controlled (i.e., double-blind, placebo-controlled) experiments have shown equivocal results of Trp and aggression. The most likely sources of the equivocal laboratory results are a) individual differences in propensity towards aggression and b) the lack of credible provocation in the human laboratory setting (Berman et al., 2009), the latter explanation deemed plausible because of evidence that episodic or impulsive aggression (as opposed to premeditated or planned aggression) is usually in response to perceived threat (Davidson et al., 2000; Siever, 2008). The main effect of depleting 5-HT appears to be an exaggerated threat perception together with a reduced inability to control the resultant enhanced emotional state (Craig & Halton, 2009; Soubrie, 1986).

Genetically-transmitted disorders of 5-HT mechanisms. A detailed evaluation and meta-analysis of 24 genetically informative studies of aggression concluded that heritability accounted overall for about 50% of the variance (Miles & Carey, 1997). A review of studies of twins convicted for violent offenses resulted in a conclusion that there were significant differences in concordance rate between monozygotic and dizygotic twins (Cloninger & Gottesman, 1987). Adoption studies have also linked genetic factors with adult criminality (Bohman et al, 1982; Cloninger et al., 1982; Hutchings & Mednick, 1975; Mednick et al., 1983; Sigvardsson et al., 1982).

Individuals with the XYY chromosome show reduced 5-HIAA accumulation and increased aggression (Bioulac et al., 1980; Schiavi et al., 1988), and it had been suggested that the Y chromosome may contain factors related to 5-HT turnover in men. However, Brunner and colleagues described a Dutch family in which affected

males had borderline mental retardation and a tendency toward inappropriate aggression (Brunner et al, 1993a, 1993b). Since only males were affected, it appeared to be an X-linked recessive disorder. Biochemical and genetic studies showed a lack of monoamine oxidase-A (MAO-A) activity and a mutation in exon 8 of the MAO-A structural gene localized on Xp11-21. This was the first demonstration of a specific single base pair mutation resulting in aggressive behavior in humans. More recently, a variant in the serotonin transporter gene has been shown to be associated with violent suicidal behavior (Courtet et al., 2001).

To date, the most investigated gene with respect to human aggression has been MAO-A, mutations of which have been shown to correlate with aggression (see Craig, 2007; Craig & Halton, 2009, and Moffitt, 2005, for recent reviews). However, as noted by Craig and Halton (2009), there are numerous candidate genes for aggression including those specifically rated to the 5-HT system such as the 5-HT transporter (SLC6A4; see Reif et al, 2007) and tryptophan hydroxylases 1 and 2 (TPH1 and TPH2) (see Manuck, et al., 1999).

Other candidate genes in aggression extend well beyond those that are specifically tied to the 5-HT system, including those that encode for the androgen receptor (CAG; Rajender et al, 2008); dopamine beta hydroxylase (DBH; Galvin et al, 1991), catechol-O-methyl transferase (COMT; Gogos et al, 1998), the norepinephrine receptor gene (ADRB1; Silver et al, 1999), and nitric oxide synthase (NOSI; Reif et al, 2009). ,

Gene x environment interactions. It is now evident that both heritability and common environment are responsible for individual differences in aggression (Craig & Halton, 2009; Moffitt, 2005; Reif et al., 2007), and gene by environment (G X E) interactions must now be considered in any genetic/neurobiologic theory of aggression. For example, Caspi et al., (2002) used a measure environmental risk (child maltreatment) as well as an identified gene (a MAO-A promoter polymorphism), to study 442 Caucasian male participants in the longitudinal Dunedin Multidisciplinary Health and Development Study. Among boys with combined histories of the low MAO-A activity allele and severe maltreatment, 85% developed some form of antisocial outcome. Participants having the combination of the low-activity allele and severe maltreatment constituted only 12% of the male birth cohort but accounted for 44% of the violent convictions.

In the Virginia Twin study for Adolescent Behavioral Development (Foley et al, 2004), studied 514 Caucasian male twins and measured environmental risk with an adversity index. MAO-A genotype and adversity interacted significantly, such that 15% of the boys having adversity and high MAO-A activity developed conduct disorder, in comparison to 35% of boys having adversity plus the low-activity MAO-A allele. Thus, it is clear that a functional variant in the MAO-A locus interacts with stressful upbringing. Maltreated males were significantly more likely to develop antisocial problems if they had a low activity genotype in a particular MAO-A variant; conversely, a high activity promoter variant of MAO-A confers protection against stressful and abusive childhood (see Craig, 2007; Craig & Halton, 2009; Kim-Cohen et al., 2006, Taylor and Kim-Cohen, 2007).

The MAO-A G X E interaction is but one of a number of examples of systematic investigation of the interactive role of hereditary and environmental influences.

Other genes, such as serotonin transporter polymorphisms (5-HTTLPR; e.g., Caspi et al, 2003) or the glucocorticoid receptor gene (e.g., McGowan et al, 2009) may be investigated in a similar manner, as suggested in a comprehensive G x E strategy by Moffitt (2005).

5-HT-based pharmacotherapy. The earliest study of the putative effects of 5-HT on maladaptive behavior was conducted by Greenberg and Coleman (1976), who treated retarded subjects with histories of aggression who were also found to have low blood 5-HIAA levels in comparison to matched controls. After pharmacological treatment that increased 5-HIAA, their maladaptive behaviors diminished dramatically. However, these early findings were not always replicated (see, for example, Yarbrough et al., 1987). But soon thereafter, the 5-HT-aggression theory was supported when it was shown that aggression could be suppressed by the then-newer generation of 5-HT-enhancing drugs such as buspirone (Levine, 1988; Ratey et al., 1989, 1991; Realmuto et al, 1989; Riblet et al., 1982), trazadone (O'Neil et al., 1986), fluoxetine (Sovner et al., 1993), m-chlorophenylpiperazine (M-CPP) (Hollander et al., 1994), d,l fenfluramine (Cherek & Lane, 1999), or paroxetine (Cherek et al., 2002)..

Non-pharmacologic influences on 5-HT. Serotonin can be affected by non-pharmacologic means. For example, stress or pain will increase corticosteroid levels, which will in turn activate enzymes that route the 5-HT precursor amino acid, tryptophan (Trp), away from 5-HT conversion (Bender, 1989). Diet can also affect 5-HT production, both directly and indirectly. The amount of Trp that enters the brain, to be available for subsequent conversion to 5-HT, may be altered by dietary 5-HT content . High protein foods, rich in competitor amino acids, may reduce 5-HT production, while a relatively high carbohydrate diet may raise brain 5-HT levels (Blum et al., 1992; Boullin, 1963; Wurtman, 1987; Wurtman & Fenstrom, 1974; Wurtman & Wurtman, 1988). Xanthines, such as caffeine and theobromide (found in coffee, cocoa, and colas), activate enzymes that lower 5-HT production (Orlikov & Ryzov, 1991). The production of 5-HT can be adversely affected by abnormal levels of trace metals. For example, manganese (Mn) can be responsible for biochemical reactions that compromise 5-HT activity (Chandra, & Shukla; Donaldson, 1987; Neff, Barrett & Costa, 1969; Subhash & Padmashree, 1990). In our collaboration with the Golub laboratory at the University of California, Davis, we have also shown that manganese over-absorption not only affects brain 5-HT levels, but also results in aggressive and impulsive behavior of juvenile rhesus monkeys (Golub et al., 2005).

Nutrition-based therapy

Based on studies such as those reviewed in the two preceding sections, the manipulation of neurotransmitter/neuromodulator levels via diet and/or dietary supplementation, with the ultimate aim of correcting aberrant behaviors, has been advocated for some time. For example, Rimland and Larson (1981) recommended “megavitamin therapy,” citing studies that indicated that such treatment had “proven useful in treating various behavioral disorders…and opposition to it by the medical establishment may consequently be expected to diminish in the near future.”

Despite Rimland's optimism, many controlled studies have not demonstrated substantial benefits of megavitamins in reduction of aberrant behavior.

A major hindrance to progress in the area of nutrition-based intervention stems from the fact that a vast number nutrient/vitamin/mineral deficiencies, imbalances, or over-absorptions have been associated with a lowered threshold for aggression, for example: selenium (Benton & Cook, 1991), tryptophan (Bjork et al, 1999; 2000), fatty acids (Corrigan et al, 1994; Stevens et al, 1995, 1996), copper/zinc ratios (Walsh et al, 1997;), cholesterol (Golomb et al, 2000), docosahexaenoic acid (Hamazaki et al, 1996), zinc (Moynahan, 1976), lead (Needleman et al., 1996; Masters et al, 1998), manganese (Gottschalk et al,), sugar (Kruesi et al, 1987; Lien et al., 2006; Schoenthaler, 1982), Vitamin B-6 (Dakshinamurti et al., 2000, folates (Alpert & Fava, 1997), and generalized vitamin-mineral deficiencies (Schoenthaler et al, 1997; Gesch et al., 2002). However, in humans with disordered behavior (e.g., perpetrators of DV), there is abundant evidence to support the contention that while they may have identifiable and statistically significant dietary deficiencies and/or indices of toxic exposures, they are more often than not the product of more generally disadvantageous environments. In such environments, malnutrition and/or toxic exposures are more common, and are likely to occur in conjunction with a host of socioeconomic and psychosocial stressors, which interact with one another (e.g., inadequate housing X lead exposure; poverty X malnutrition X stimulant abuse; alcohol abuse X liver disease X over-absorption of manganese; see Masters and Coplan, 1999, for a an comprehensive example of one set of interactions).

In addition to the analytic challenges mentioned above, additional vulnerabilities and/or protective factors are conferred by genetic variations that are only now becoming apparent (Craig & Halton, 2009; Moffit, 2005). Interventions will almost always focus on a limited set of biomarkers/therapeutic indicators, depending on the orientation of the investigator and, given the fact that multiple outcome measures are typically observed, dietary interventions may appear to have significantly influenced one or another aspect of aberrant behavior. However, determining the effects of confounding influences, especially genetic and experiential variables, is a daunting task, and attempts at replication of successful nutritional interventions often fail.

Sugar. By way of example, it is known that fluctuations in brain glucose can cause temporary disturbances in thought, mood, and concentration, as well as irritability (Virkunnen & Huttunen, 1982; Virkunnen, 1986). A plausible causal chain linking hypoglycemia, irritability and lowered threshold for aggression was based on evidence that a central 5-HT deficit resulted in a dysfunction of the regulatory mechanisms of the suprachiasmatic nucleus, thereby disturbing glucose metabolism and producing a tendency towards both hypoglycemia and violent outbursts (Linnoila, Virkkunen, George & Higley (1993). As mentioned above, low levels of the serotonin metabolite 5-HIAA in cerebrospinal fluid (CSF) was been observed in numerous studies of violent offenders, who also seem to have an accompanying tendency to develop hypoglycemia following an oral glucose load (Virkkunen, 1982, 1984, 1986). Indeed, while hypoglycemia is a rare condition, affecting less than one percent of the general population, its prevalence in

populations of violent offenders was shown to be significantly higher. And, experimentally, it has been shown that manipulation of blood glucose levels can alter the aggressive propensities of normal volunteers (Benton et al., 1982; Donohoe & Benton, 1999).

The aforementioned findings have been accompanied by great enthusiasm for restricting the sugar content of diet in individuals who are behaviorally disordered (e.g., Schoenthaler, 1982, 1983a, 1983b, 1983c). The thinking behind such dietary restrictions, as per Lien (2006), is as follows: 1) carbohydrates influence serotonin synthesis and stimulate hypoglycemia; 2) aggressive symptoms result from the associated release of epinephrine; and/or 3) dilution of the micro-nutrient intake with behavioral consequences (see http://www.vitasearch.com/CP/experts/LLienAT11-01-06.htm). However, meta-analyses of double-blind trials of sugar intake, vs. placebo control, have now conclusively shown that sugar intake does not adversely influence aggressive behavior (Wolraich et al, 1995; Benton, 2008). Benton (2008) concluded:

> "To the extent that the influence of sugar on children's behavior plays a role in the recommendation of dietary intakes, the present review suggests that such concerns about sugar are not supported by the evidence. In the future, epidemiological approaches that consider the relationship between dietary practices and behavior need to monitor all aspects of nutrition and not a single food item in isolation. In addition, a wide range of social variables need to be measured to help to distinguish diet form social variables that modulate both diet and behavior." (p. 398)

Correcting chemical imbalances. Biochemical therapy has been defined as "…correction of innate or acquired chemical imbalances using amino acids, vitamins, minerals and other biochemicals that naturally present in the body." (Walsh et al, 2004). Over a ten year period, 8000 behaviorally-disordered patients were treated at the Pfeiffer Treatment Center, in Naperville, Illinois, using a protocol that first screened for chemical imbalances and then provided nutrient supplements to correct each imbalance, the most frequent of which involved disorders of metal metabolism, methylation, pyrrole chemistry, heavy-metal overload, glucose dyscontrol, and malabsorption. In a recent study by Walsh et al. (2004), 258 consecutively-presenting patients at the Pfeiffer center, all diagnosed with attention-deficit hyperactivity disorder (ADHD) accompanied by behavior disorder were screened for co-morbid disorders (e.g. autism), and the resulting 207 uncomplicated ADHD patients were enrolled in a study in which chemical imbalances were identified and patients subsequently treated with individualized biochemical therapy. A primary care nurse gathered information from 3 to 6 months before treatment and 4 to 8 months after treatment, which included incidents of physical assaults, destructive episodes, and verbal outbursts. Reduced frequency of assaults was reported by 92% of the treatment-compliant, previously-assaultive patients ($P<0.001$), with 58% of this group achieving "elimination of the [assaultive] behavior."

While these results are certainly encouraging, the study has several weaknesses, some being identified by the authors. First, the study was not a double-blind placebo-controlled study. Indeed, neither the parents, who acted as

informants on the behavior rating instruments, nor the nurse, who administered the rating instrument, were unaware of the fact that the child was being actively treated. Second, as the authors correctly indicate, the post-treatment period, ranging from 4 to 8 months, was insufficient to determine the lasting effects of treatment. Indeed, some patients were apparently followed twice as long as others, and a more appropriate method of reporting these data might have been through use of random growth curves or survival statistics, rather than in "average decline in incidents/month." The distribution of subject ages ranged from 3 to 55 years (median 11.5), which seems excessive, and it would have seemed appropriate, with a pool of 207 from which to draw, to restrict the range to an "ecologically representative" sample. Certainly, few 3-year olds and even fewer 55-year olds are treated for ADHD-like symptoms.

More critical, however, is the fact that seven chemical imbalances were identified in this sample of 207 subjects: (1), elevated Cu/Zn ratio (75.4%); (2) depressed blood histamine (29.5%); (3) elevated blood histamine (37.7%); (4) elevated urine kryptopyrroles (32.9%); (5) heavy-metal overload (17.9%); (6) glucose dyscontrol (30.4%); and (7) malabsorption (15.5%). Since the total of these percentages is 239.3, it is obvious that subjects were likely to have more than one imbalance. It is also likely that the degree to which each subject expressed one or more of the foregoing abnormalities would have varied, calling for appropriate variations in dosing. In other words, the intervention, even if it were investigated via a double-blind, placebo-controlled study, would not be easily replicable.

Generalized vitamin-mineral supplementation. An alternative approach to customized correction of nutritional imbalances has been advocated by Schoenthaler et al (1997), based on an accumulation of studies that purported to show that dietary changes in prison populations, i.e., increasing nutrients by replacing high fat and sugar foods with fruits, vegetable and whole grains, could correct low blood concentrations of nutrients essential for proper brain function, thus reducing violence owing to malnutrition (e.g., Schoenthaler et al, 1982, 1983a, 1983b, 1983c, 1986). Schoenthaler et al. (1997) correctly noted that their previous studies lacked proper experimental controls, and corrected these inadequacies by using a randomized, placebo-controlled, double-blind design.

The subjects in this 1997 study consisted of 62 residents of a psychiatrically-oriented facility that housed juveniles in a maximum security setting. Baseline rates of violence were determined by averaging data from 13 weeks before intervention. The 62 residents were matched on baseline violence rates and then randomly allocated to the active of placebo group (32 active; 30 placebo). Over a13 week period subjects received either active (12 vitamins and 11 minerals, set at or about 100% of USRDA requirements, with some variations) or placebo medications, in pill form during morning and evening medical rounds. Neither the research nor institutional staff was aware of subject group assignment. The result was a net difference in violent behavior between active and placebo groups was 28%. Based on pre-post analysis of blood concentrations of vitamins/minerals, it appeared that subjects who corrected abnormally low blood vitamin and mineral concentrations during the course of the study benefitted more from the intervention.

A study based on the much the same treatment philosophy, improving behavior

via dietary supplements with nutrients was conducted in the UK by Gesch et al (2002). The subjects were 231 young adult prisoners who were provided with either 1) a standard commercial vitamin/mineral supplement as well as linoleic acid, gamma linoleic acid, eicosapentaenoic acid, and docosahexaenoic acid (n = 116) or 2) vegetable-oil based placebo (n =115). In an "intent-to-treat design, 82 active and 90 placebo subjects were analyzed, all of whom were treated for a minimum of 2 weeks and up to 9 months (average treatment time = 142 days). . The active group achieved a significant ($p<0.005$) reduction in the most serious incidents (including violence).

While these findings are indeed encouraging, the two studies described above have limitations. First, the subjects were all incarcerated, and the structure of prison life may well have had the effect of curbing aggressive behavior over time. In the Gesch et al., (2002) study, for example, the assumption was made that the average probability of a person committing an offense remained constant over time. Further, baseline rates tend to be rather low to begin with, for example, Schoenthaler et al. (1997) base rates and rates of change for violent rule infractions, as shown in Table 3. As is evident from the table, the group receiving active treatment had a 96% reduction in violent offenses; the group receiving placebo had a 67% reduction.

Table 3. Change in Rates of Violent Behavior as the Result of Nutritional Supplementation from Schoenthaler et al. (1997)

Group	Baseline	Change
Active supplement	0.389	0.311
Placebo	0.372	0.209

Additionally, because of the inadequate environmental conditions that are known precursors to incarceration, it is more than likely that being subjected over time to the general prison diet would have proven to be more nutritious than the diets of these prisoners prior to incarceration. This would also hold true for the reduced likelihood that these prisoners would have been ingesting alcohol and drugs. Nevertheless, the results of these two studies do suggest that generalized vitamin-mineral supplementation might be a worthwhile endeavor, if for no other reason than to further eliminate those chemical imbalances that may lower thresholds for aggression.

D. METHODS AND EXPERIMENTAL DESIGN

Method

Subjects. The research population pool will consist of up to 1,000 males residing in Orange, Riverside and San Bernardino counties, each of whom will have been convicted for conduct perpetrated against any of the persons defined in Family Code section 6211 (e.g., spouses, cohabitants, dates/former dates, domestic partners/former domestic partners, defendant's children) and falling under Family

Code section 6320 and, as a result of said conviction, placed on probation. These individuals will have been subjected to the terms and conditions of probation set forth in Penal Code section 1203.097, which includes a 52-week BIP meeting the following requirements:

a. The program must be approved by the probations department;

b. The defendant must enroll within 30 days of sentencing or release date;

c. The program must provide periodic progress reports at least every 3 months;

d. The defendant must complete the program within 18 months of enrollment;

e. The defendant can have only three unexcused absences; and

f. The court cannot waive program fees, but the court must consider the defendant's ability to pay and ensure that a program with a sliding fee scale is available.

Each qualifying subject will be further screened for study inclusionary/exclusionary criteria.

Inclusionary:

1. Male;
2. At least 18 years of age;
3. Convicted for the first time of DV (as per Family Code section 62110;
4. Assigned to BIP a condition of probation;
5. Probation to extend at least 18 months following enrollment in the BIP; and
6. Willing to provide legal informed consent for full participation in study, which will include:
    - 6.1 Daily ingestion of nutritional supplement or placebo
    - 6.2 Screening psychological tests
    - 6.3 Spousal rating scales
    - 6.4 Access to BIP and probation files for up to three years.

Exclusionary:

1. Individuals on probation for felony offenses other than, or in addition to DV;
2. Individuals with clearly psychotic profiles on screening psychiatric rating scales;
3. Individuals undergoing psychopharmacologic treatments which could alter bodily chemistry (e.g., phenothiazines for schizophrenia, lithium carbonate for bipolar illness); and
4. Individuals undergoing simultaneously treatment for substance abuse.

Enrollment will continue until 600 individuals (approximately 200 per county) have been screened into the study. The target sample of 600 subjects has been selected to optimize statistical power, based on the fact that a small-to-medium effect size is anticipated, and multiple outcome measures are to be used. Based on

a small effect size and multiple measures, the power to reject the null hypothesis at the .05 level of significance will be approximately .90 with an N of 600.

Gender and ethnicity. As males are more likely to be assigned to BIPs following conviction for DV, the present study will be restricted to adult males only. It is anticipated that the ethnic/racial composition will be an approximate reflection of the current mix of the three participating counties, in which Latinos are represented in significantly higher proportion than in the US population at large.

Procedures

Informed consent and enrollment. At the time of a potential subject's first appointment with his BIP counselor, the BIP counselor will determine if the subject appears to meet entry criteria for the nutritional study. For those who do appear to meet study inclusion criteria, the BIP counselor will briefly inquire as to the subject's interest in "a research study that is trying to find out if nutrition will help to prevent repeated acts of domestic violence." If the prospective subject indicates an interest, the BIP administrator will provide the name of the prospective subject to the Principal Investigator (PI), and the PI or the PI's designee (a research associate) will arrange to meet the prospective subject at the BIP site, for screening and obtaining informed consent.

At the initial appointment, the PI or PI-designee will explain the nature of the study in detail and provide a written informed consent document (see Appendix C), which the PI will read with the subject, and further assist to help the subject understand the exact nature of the study. The subject will then be offered the opportunity to formally enroll in the study and, upon agreeing to participate, will be asked to sign the formal informed consent document.

As part of the informed consent process, the subject will be informed of the risks of participation, which are considered to be minimal, such as loss of confidentiality, discomfort caused by interview questionnaires, and unforeseen risks that might be occur with vitamin/mineral supplementation. The subject will also be informed that there have been some reported benefits from participation in similar vitamin/mineral supplementation programs, but that he may well receive no benefit from participation. Subjects will be informed that participation is voluntary, and that those who refuse to participate will be entitled to all of the standard offerings of the BIP without prejudice, while those who agree to participate will not have their BIP otherwise modified (i.e., the full 52-session program will still be required.) The subject will also be informed that he may withdraw from the study at any time without affecting his status in the BIP. The subject will be given a copy of the informed consent and the research subjects' bill of rights, which will include the PI's phone number, should any questions arise during the course of the study (e.g., physician inquiries during standard medical treatment).

Screening. After informed consent is obtained, the subject will be interviewed to gain certain background information such as community of origin, socioeconomic status, education/vocation, criminal record, medical history, history of drug/alcohol-related offenses, and history of mental health problems. To the extent possible, this

information will be independently corroborated by referring to the probation files on the subject. Additionally, the subject will be screened with the following structured psychiatric rating scales:

1. Structured Clinical Interview for DSM Disorders (SCID), research version
2. Brief Psychiatric Rating Scale (BPRS)

Health Practices. Diet, exercise and level of physical activity, incidental consumption of alcohol, drugs, or cigarette smoking, and use of colas, caffeine and other substances of interest will be specifically assessed by a self-report, using a Health Practices Questionnaire (see Appendix D).

Nutritional Intervention. At the time of each BIP visit, the subject will be provided with a one-week supply of vitamin/mineral supplements, formulated in a similar fashion to the "Forceval" and "Efamol Marine" capsules used by Gesch et al. (2002; see Table 4). These will be compounded by Designs for Health, Inc. , East Windsor , Connecticut. Essentially, the vitamin/mineral capsule will contain approximately 100% USRDA requirements for vitamins/minerals, and the fatty acid supplement will include the four omega-6 and omega-3 essential fatty acids described by Gesch, et al (2002). All components will be high quality, prescription grade ingredients. Placebo control subjects will receive vegetable oil-based placebo capsules, identical in appearance and taste. Subjects will be instructed to take the vitamin-mineral (or placebo) capsule in the morning, at or around breakfast time, and the essential fatty acid capsule in the evening, at or around supper time. Subjects will continue taking the supplements over the 52-week course of the BIP, or over the 18 months that are allowed, by law, for completion of the 52 BIP sessions, whichever occurs first.

Table 4. Vitamins and Minerals used in one 'Forceval' capsule, from Gesch et al. (2002)

Nutrient	Potency	UK RNIs[2]	EU RDAs	US DRIs[3]
Vitamin A (µg)[1]	750	700	800	900
Vitamin D (µg)	10	—	5	5
Vitamin BI (mg)	1.2	1	1.4	1.2
Vitamin B2 (mg)	1.6	1.3	1.6	1.3
Vitamin B6 (mg)	2	1.4	2	1.3
Vitamin B12 (µg)	3	1.5	1	2.4
Vitamin C (mg)	60	40	60	90
Vitamin E (mg)	10	—	10	15
Vitamin KI (µg)	—	—	—	*120*
Biotin (µg)	100	—	150	*30*
Nicotinamide (mg)	18	17	18	16
Pantothenic acid (mg)	4	—	6	*5*

Folic acid (µg)	400	200	200	400
Calcium (mg)	100	700	800	1000
Iron (mg)	12	8.7	14	8
Copper (mg)	2	1.2	—	0.9
Magnesium (mg)	30	300	300	400
Zinc (mg)	15	9.5	15	11
Iodine (µg)	140	140	150	150
Manganese (mg)	3	—	—	*2.3*
Potassium (mg)	4	3500	—	—
Phosphorus (mg)	77	550	800	700
Selenium (µg)	50	75	—	55
Chromium (µg)	200	—	—	*35*
Molybdenum (µg)	250	—	—	45

RNI, reference nutrient intake; RDA, recommended daily allowance; DRI, daily recommended intake.
1.Retinol equivalent from intake of ß-carotene.
2.UK RNI for 19 to 50-year-old males.
3.US RDA 19 to 30-year-old males. The values in italics have no US RDA and are defined as adequate intakes (AI). The figures in normal type are US RDAs.

Table 5. Vitamins, Minerals and Fatty Acids used in one daily packet provided by "Designs for Health, Inc."

Outcome measures.

Subjects will be followed for 36 months, up to 18 of which they may be receiving supplements/placebos. The following outcome measures will be used to determine effectiveness of the experimental intervention.

1. Record of BIP program compliance, including time to drop out and time to complete program
2. Repeat DV offenses
3. Behavior and attitudes reflected in spousal interviews, using the Conflict Tactics Scale (CTS2; Straus et al., 1996)

Proposed Statistical Analysis

Data base management. Data base management will involve structuring all data into a uniform database format for ease of analysis and quality assurance. Quality control will consist of several steps. First, frequency distributions will be compiled for all variables and distributions then inspected to identify out-of-range values. This process will be repeated until no more errors can be identified. This information will be maintained in a DBASE III+ file, to conform with the input requirements of the various statistical packages to be employed (e.g., TRYSIS; BMDP). A codebook will be developed to assure that data fields for variables are properly identified.

Confidentiality of database. All data pertaining to study subjects will be entered into a computerized database, in which the subject will be identified by a unique identifier code (UIC) which will not contain the subject's name or any clue to the subject's identity (e.g., address, telephone number) that would allow the subject's data to be linked to him personally. The research assistant responsible for periodically upgrading the file from arrest record data will sign an oath of confidentiality with the understanding that civil and criminal penalties could result from divulging any information about research subjects, whether personally identified or not. The data will be compiled and analyzed in such a way that subjects will remain anonymous in any published report.

Statistical. Analysis. In our first set of analyses, we will use standard logistic regression statistics to determine if there are differences between (1) volunteers vs. non-volunteers, (2) active nutritional supplement vs. placebo, and (3) study completers vs. drop-outs, on demographic variables of interest (i.e., socioeconomic level, education, vocation status, ethnicity, offense type, etc.).

Attrition bias. In any longitudinal study, threat to the validity of the findings could arise as a result of participant attrition. Recent evidence indicates that this an especially difficult problem with individuals who enter BIPs, where nation-wide rates of program completion range from 16 to 80% (Babcock, Green & Robie, 2004), with recent California statistics indicating a 50 to 65% completion rate (MacLeod et al, 2008). Should the loss of participants occur in a systematic way, the safeguards of randomization built into the study design could be compromised and threaten the validity of the findings. We assume at the outset that in BIP programs, attrition will, in fact, be biased, i.e., those who engage in additional acts of DV are more likely to drop from the BIP and/or leave the geographic area than those who remain. The subject database will be used to determine if pre-existing characteristics of subjects are related to attrition, which will provide additional information on the representativeness of the remaining sample.

Survival analysis. Recent years have witnessed major advances in the statistical methods available for the quantitative analysis of longitudinal data, such as those collected in this study. In particular, *survival analysis* has been used to ask (1) whether individuals experience particular events or transitions, (2) when these events are likely to occur, and (3) what other variables predict variation in event occurrence and timing (singer & Willett, 1991, 1993; Willett & Singer, 1993, 1995). In the case of the present study, there is abundant evidence to suggest that a individuals in substantial numbers will drop from the BIP, and also that individuals will recidivate, either during the course of the BIP or at some later time in their lives. Familiar statistical techniques, such as analysis of variance or multiple regression analysis, are ill-suited for addressing such questions because they cannot handle situations in which the value of the outcome, in this case, whether and when an event (recidivism) occurs, is unknown for some people under study. Yet, when event occurrence is studied, such an information shortfall is almost inevitable. No matter how long data are collected, some members of the sample will not experience the target event during data collection, e.g., some will not commit another offense of DV. Such observations are said to be “censored”—the knowledge is imprecise. The dilemma is how to analyze data simultaneously from both censored and noncensored cases, because the censored members form a key group—they are often the ones least likely to experience the event. In the analysis planned for the present study, all who recidivate during observation are assigned explicit event times. Those who do not recidivate during observation are noted as censored and the length of time that they went without recidivating is recorded. Subsequently, their “censored” lifetimes enter into the data analysis in a meaningful way.

In discrete-time survival analysis, the fundamental quantity representing the risk of event occurrence (i.e., recidivism) in each time period is called the *hazard probability*. Its computation in the proposed sample will be straightforward. In each

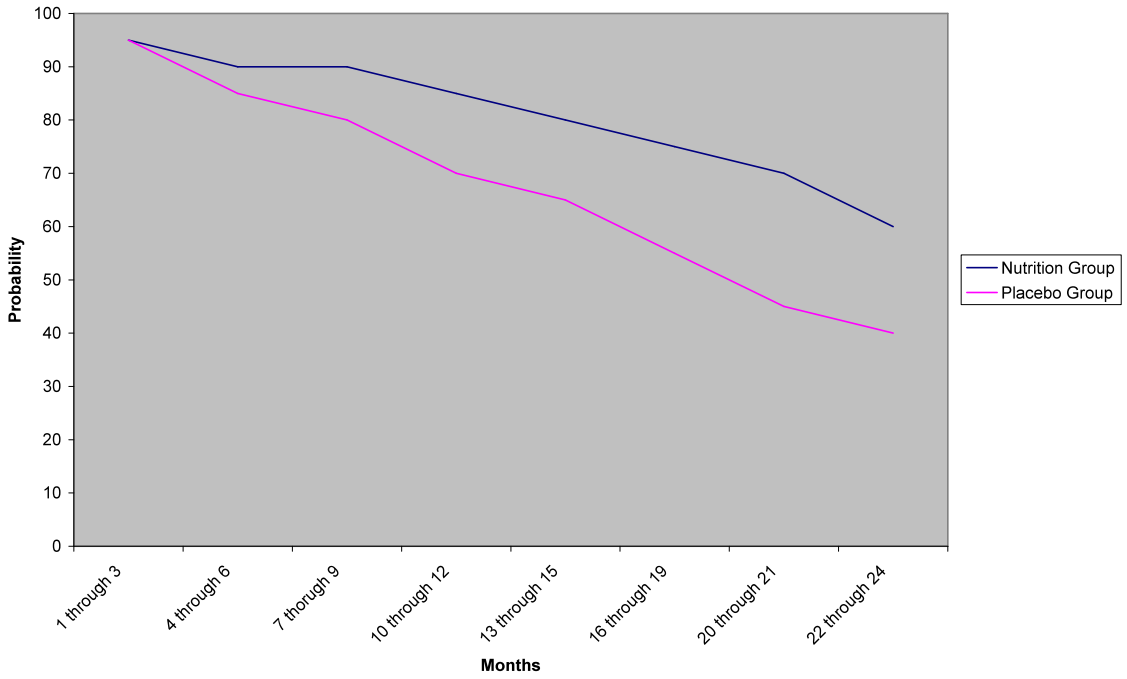
time period, one must identify the risk set—the pool of people who are at risk of recidivating during this period (i.e., those who have reached this time period without recidivating) and compute the proportion of this group this group that will have recidivated during the period (e.g., month 1 through 3). A plot of the set of hazard probabilities against time yields the *hazard function*, a chronologically-ordered summary of the risk of event occurrence. In addition, period-by-period risks can be cumulated to display the proportion of a sample that "survive" through each time period without recidivating. This proportion is called the *survival probability* and the *survivor function* (Willett & singer, 1993).

The discrete-time hazard profile is a set of conditional probabilities, each bounded by 0 and 1. Statisticians who model a bounded outcome like this as a function of predictors generally do not use a linear function to express the relationship. Instead, they use a nonlinear link function that has the net effect of transforming the outcome so that it is unbounded, in order to prevent fitted values from falling outside the permissible range (in this case, between 0 and 1). When the outcome is a probability, as it is here, the logit link function is popular. If p represents a probability, then logit (p) is the natural logarithm of $p/(1-p)$ and, in the case of these data, can be interpreted as the log-odds of onset of recidivism. Letting $h_j(t_i)$ represent the population hazard profile—that is, a list of population conditional probabilities for person j at discrete times, t_i, a suitable statistical model relating the logit transform of hazard to values of the predictor, *nutritional intervention* (**NI**), would be:

$$\text{logit } h_j(t_i) = \beta_0 (t) + \beta_1(\mathbf{NI})_j,$$

where the paramenter $\beta_0 (t)$ is known as the basline logit-hazard profile. It represents the value of the outcome when the value of the predictor, **NI,** is 0 (i.e., it specifies the profile for the placebo group). Once the discrete-time hazard model has been fit, its parameters can be reported along with standard errors and goodness-of-fit statistics in much the same way that results of regular regression analyses are reported. The fitted lines can be used to illustrate the influence of important predictors and fitted to hazard functions can be displayed for prototypical people—those who share substantively important values of selected predictors (e.g., all men who commit DV and undergo treatment in BIPs), as shown in the following figure.

Figure 3. Probability of Recidivism given Nutritional Intervention or Placebo



Unique Advantages of Study

While other studies (e.g., Gesch et al., 2002; Schoenthaler et al, 1997) have been promising, they were conducted on populations who were incarcerated, which tends to artificially inhibit the natural course of violent behavior. Base rates of violent behavior in both studies were typically much lower than base rates of violent incidents among DV offenders who reside in the community (NNEDV, 2008). Further, these studies were conducted over rather constricted time frames, further restricting the probability that a (low base-rate) violent event would occur. Linking the study to an existing intervention (i.e., a BIP) ensures that subjects will receive active treatment irrespective of whether or not they are randomized to the active nutritional supplement or placebo group. The fact that completion of the 52-week program is mandatory will ensure that a sizeable sample (ca. 60% of the original 600 enrollees, based on the McLeod et al. [2009] study) will be followed for at least 52 weeks.

G. HUMAN SUBJECTS

1. Potential study subjects will be selected from the pool of adult males presenting at the Probation Departments of Orange, Riverside and San Bernardino counties for supervision following their conviction of a crime of domestic violence.

2. Tests performed will include a scheduled interview to collect sociodemographic, educational, medical and nutritional background information, and screening psychological tests.

3. Method of soliciting participation. Subjects ill be asked to volunteer for the study. They will not be paid for participation.

4. Risks. There are no known risks of vitamin/mineral/fatty acid supplementations at the levels proposed. Subjects may feel some discomfort during the interview. There will be a risk of breech of confidentiality by study personnel, which will be minimized by careful monitoring of access to subject data.

5. Methods of minimizing risks. All project staff will be carefully trained in methods of interviewing and data collection. The Principal Investigator will periodically spot-check the research staff to ensure that research subjects are not being placed in situations involving inordinate stress or discomfort. All personal information will be coded, with subject names kept in a separate file, away from any personal data pertaining to them.

6. Subjects will be informed that participation in this project is voluntary, and that refusal to participate will involve no penalty, loss of services, or addition to the length of their probation. Subjects will also be informed that they may withdraw entirely from the study at any point in time without penalty or reprisals. Since data collected prior to withdrawal from the study or drop-out from the treatment program will be germane to questions of sample representativeness, data collected form subjects up until the time of withdrawal and/or program failure will be analyzed for purposes of understanding the representativeness of the remaining sample.

F: VERTEBRATE ANIMALS

N/A

G: CONSULTANTS and COLLABORATORS

N/A

H: CONSORTIUM/CONTRACTUAL ARRANGEMENTS

The proposed study is a cooperative effort between the Violence Research Foundation, a non-profit charitable corporation based in San Clemente, California, the University of California, Irvine, and California State University, San Bernardino.

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UNIVERSITY OF CALIFORNIA, IRVINE

CONSENT TO ACT AS A HUMAN SUBJECT

PREDICTING REPETITIVE DOMESTIC VIOLENCE THROUGH ANALYSIS OF TRACE MINERAL CONTENT OF HEAD HAIR

Francis M. Crinella, Ph.D., Principal Investigator
Phone Number: (949) 824-1801

Participant Name:_____

PART I

A. PURPOSE OF THE STUDY

You are being asked to participate in a research study because you are a person who will be enrolling in a state-mandated batterers' intervention program (BIP) as a condition of your probation. This research study is designed to learn whether supplementing the diet of individuals in a BIP with vitamins, minerals and fatty acids will reduce the likelihood of further incidents of domestic violence (DV). The reason you are being asked to participate in this study is that some people have found that providing nutritional supplements to individuals with histories of violence will reduce the likelihood of future incidents. Up to 600 individuals, in three California counties, will be participating in this study.

B. Duration of participation

This study will last approximately 36 months from the time you enroll in your BIP, which consists of 52 sessions that must be completed within an 18 month period. During the time you are in the program, you will be receiving either a nutritional supplement or a placebo (a pill that looks and tastes like the nutritional supplement, but has none of the vitamins/minerals or fatty acids found in the nutritional supplement). You will have a 50% (one out of two) chance of being assigned to the active nutritional supplement group. At the completion of your BIP, you will no longer be taking the capsule, but will be followed through probation and police records, as well as interviews with your spouse/significant other an additional 18 to 24 months (the length of time will be dependent on the time it takes you to complete your BIP).

C. Description of the procedures

Screening. Your probation officer will inform you that you are eligible for participation in this study if are an adult male, residing in Orange, Riverside or San Bernardino counties, and have been convicted for conduct perpetrated against any of the persons defined in

Family Code section 6211 (e.g., spouses, cohabitants, dates/former dates, domestic partners/former domestic partners, defendant's children), falling under Family Code section 6320, and, as a result of your conviction, have been placed on probation, and are subject to the terms and conditions of probation set forth in Penal Code section 1203.097, which includes a 52-week BIP.

You will be excluded if you are:

1. Also on probation for one or more felony offenses other than, or in addition to DV;
2. Have a major mental illness, such as schizophrenia of bipolar disorder;
3. Are undergoing psychopharmacologic treatments which could alter your bodily chemistry (e.g., phenothiazines for schizophrenia, lithium carbonate for bipolar illness); or
4. Undergoing simultaneously treatment for substance abuse.

If you agree to participate in the study, and sign this consent form, we will give you a short interview, lasting about an hour, to find out about your background, including, your family and home situation, education, occupation, medical history and nutrition practices. We will also administer some short psychological screening tests to make sure that you are not suffering from a serious mental illness. We will also interview your wife/significant other using a short questionnaire which will take about ½ hour.

Nutrition supplement. Once we determine that you are qualified, and consent to be in the study, you will be assigned to one of two groups. The first group will be an active nutritional treatment group; the second will be a placebo group. Your assignment will be by chance, and you will have a 50% chance of being assigned to the active nutrition group. You will be given a package of capsules at each of your visits to your BIP. If you are in the active nutritional treatment group, you will receive two capsules per day that contain vitamins, minerals, and essential fatty acids (nutritional supplement group). If you are in the placebo group, you will also receive weekly capsules that look and taste like the capsules being taken by the active nutritional supplement group, but will actually be a simple vegetable oil compound with not much nutritional value. You will not know to which group you belong, nor will any of the study personnel, including your counselors at the BIP and your probation officer. You will be asked to take one capsule in the morning, preferably with your breakfast, and the other capsule in the evening, preferably with your supper. You will continue to take these capsules for the duration of your treatment in the BIP, which may last anywhere from one year to 18 months. When you complete your BIP, you will no longer be given the supplement.

Review of records. For a period of 36 months years from the time of your enrollment in the study, your record will be reviewed on a monthly basis to determine if you have been in trouble with the authorities. We will be especially concerned about any new arrests for acts of domestic violence. We will record this information in a file that identifies you by a code number, not your name. Only your probation officer will know your name, and not any of the personnel conducting this research study. All information will be transferred, without your name linked to it, to a computer data file so we can analyze the results of this study.

Your name, and any other information that could possibly link you to the personal information we are collecting, will not be entered into the computer file, so no one will be able to learn any personal information about you.

Use of data. Periodically, study personnel will review the data file and analyze the results to determine subject progress, with particular emphasis on additional incidents of DV. The results of this investigation may be published, in which case only group data will be reported, with individual identities safeguarded.

D. Description of reasonably foreseeable risks or discomforts

The interview will take about an hour, and some of the questions we will be asking you may be of a personal nature, which could cause you to become embarrassed or upset. You do not have to answer any question that makes you feel uncomfortable. Taking the screening psychological tests may also cause anxiety or embarrassment. The interviews and tests will be administered by someone who is trained to make the experience as comfortable as possible for you. There is a risk of loss of confidentiality which could cause emotional discomfort or embarrassment for you. Study personnel are trained to avoid any action that could compromise the confidential data collected from you.

E. Potential benefits from the research

There may be no direct benefit to you from your participation in this study. Some research has shown that subjects who receive the active nutritional supplement will experience fewer behavioral problems, but some studies do not show a positive effect. This study may help us learn how nutrition affects brain chemicals that are essential for control of aggressive behavior. This could lead to treatments to restore the balance of brain chemicals through a modified diet or vitamin supplements that may be of help to others.

F. Alternative procedures or courses of treatment

There are many ideas about what causes violent behavior, but no single cause has been demonstrated. Since violent behavior is known to be related to chemical imbalances in the brain, and modifications of diet can affect these chemical imbalances, the approach being used in this study is considered a possible additional treatment that may reduce the need for placing people in jail, providing them with psychotherapy or counseling sessions, or giving them tranquilizing drugs.

G. Confidentiality of records

All records related to your background and behavior will be collected and analyzed by employees of the University of California, Irvine. As such, each staff person is required to sign an oath of confidentiality and is subject to legal penalties for any improper release of confidential information.

The records will be stored in a locked cabinet at the office of Francis M. Crinella, Ph.D., the Principal Investigator, located at the UCI Child Development Center, in Irvine. The information on the records will also be stored on a computer disk, for purpose of statistical

analysis, but there will be no way of personally identifying information belonging to particular individuals from this file.

In consenting for this research study you will be allowing us to use portions of the information we collect for medical and scientific education. No subject will be identified by name when these records are viewed by professional colleagues or student trainees.

F. COSTS AND COMPENSATION

You will not be required to pay for participation in this study, nor will you be paid for participation.

G. INJURY

We do not anticipate any harm or injury to you resulting from your participation. In the event that you are accidentally injured by participation in the study, the medical facilities of the University of California Irvine Medical Center will be available to you. The University offers no other form of compensation.

H. QUESTIONS REGARDING RESEARCH

The principal investigator for the study is Francis M. Crinella, Ph.D., Professor of Pediatrics and Psychiatry at the University of California, Irvine. He is the person to contact if you have any questions. Dr. Crinella may be reached at the UCI Child Development Center, 19722 MacArthur Blvdl., Irvine, CA 92612; his telephone number is 949-824-1801. You may call him collect. You may also call your probation officer, who will tell us immediately of your questions or concerns.

I. VOLUNTARY PARTICIPATION

Refusal to participate will involve no penalty or loss of services from your probation department of BIP. You may withdraw from the study at any time, without penalty or loss of services, and your withdrawal will have no effect on the length of your probation.

J. OTHER INFORMATION

You will be advised of any new information discovered that might affect your willingness for continuing participation in this study. You will also be informed of the final results of this study.

CONSENT FORM: PART II

I have read the experimental subjects bill of rights and have been given a copy of it and this consent form to keep. I consent to participate in the study as described above.

_____**Signature of Subject**

_____**Signature of Witness**

_____**Signature of Investigator**

CONSENT FORM - PART III

Experimental Subject's Bill of Rights

Any person who is asked to consent to participate as a human subject in a medical investigation or who is asked to consent on behalf of another, has the following rights:

1. To be told what the study is trying to find out.
2. To be told what will happen in the study and whether any of the procedures, drugs or devices is different from what would be used in standard medical practice.
3. To be told about the risk, side effects or discomforts which may be expected.
4. To be told if the subject can expect any benefit from participating and if so, what the benefit might be.
5. To be told of other choices available and how they may be better or worse than being in the study.
6. To be allowed to ask any questions concerning the study, both before agreeing to be involved and anytime during the course of the study.
7. To be told of any medical treatment available if complications arise.
8. To refuse to participate at all, either before or after the study has started. This decision will not affect any right to receive standard medical treatment.
9. To receive a signed and dated copy of Parts I and II of the consent form and Bill of Rights.
10. To be allowed time to decide to consent or not to consent to participate without any pressure being brought by the investigators or others.

Subject's initials: _____ Date _____

Project Timetable:

MONTH S	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30	31-36	37-48
Startup	X											
Begin enrollment		X	X	X								
Enrollment completed					X							
Active supplementation		X	X	X	X	X	X	X	X	X		
Follow-up			X	X	X	X	X	X	X	X	X	
Statistical analysis											X	X

PERSONNEL *(Applicant organization only)*		
NAME	ROLE ON PROJECT	
Francis Crinella	Principal Investigator	12
Tim Wigal	Co-investigator	12
San Bernardino Faculty	Co-investigator	12
TBN Research Assistant	Project coordinator	12
TBN Research Assistant	Data & Observation	12
TBN Research Assistant	Data & Observation	12
TBN Research assistant	Data & Observation	12
TBN Research assistant	Data & Observation	12
TBN Project Statistician	Database management	12
	SUBTOTALS	

CONSULTANT COSTS

none

EQUIPMENT *(Itemize)*

Computer for Data entry
printer

SUPPLIES *(Itemize by category)*

Telephone
Mailing
Copying
Assessment Materials
Dietary Supplements (2 capsules daily; 52-72 weeks; 300 subjects)
Placebo (2 capsules daily; 52-72 weeks; 300 subjects

TRAVEL

Day trips to BIP sites in 3 counties

	INPATIENT
	OUTPATIENT

ALTERATIONS AND RENOVATIONS *(Itemize by category)*

OTHER EXPENSES *(Itemize by category)*

Contract with Violence Research Foundation for nutritional consultation, etc.

SUBTOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD

CONSORTIUM/CONTRACTUAL COSTS	DIRECT COSTS
	INDIRECT COSTS
TOTAL DIRECT COSTS FOR INITIAL BUDGET PERIOD	

BUDGET CATEGORY TOTALS	INITIAL BUDGET PERIOD *(from Form page 4)*	ADDITIONAL YEARS OF SUPPORT REQUESTED 2nd	3rd	4th
ERSONNEL: *alary and inge* *Applicant organization only*				
CONSULTANT COSTS				
EQUIPMENT				
SUPPLIES				
TRAVEL				
INPATIENT				
COSTS OUTPATIENT				
ALTERATIONS AND				
OTHER EXPENSES				
SUBTOTAL DIRECT				
CONSORTIUM/ CONTRACTU DIRECT				
INDIRECT				

TOTAL DIRECT COSTS	500,000.	500,000.	500,000.	500,000

TOTAL DIRECT COSTS FOR ENTIRE PROPOSED PROJECT PERIOD *(Item 8a, Face Page)* $2,000,000

JUSTIFICATION. Follow the budget justification instructions exactly. Use continuation pages as needed.

Budget Justification

This is the skeleton of a budget. We will have to determine whether or not the UC Irvine personnel work on the project through a contract with Cal State San Bernardino, or whether is a collaborative arrangement. Either option will require negotiations between the business offices of the two universities.

Francis Crinella, Clinical Professor of Pediatrics, Psychiatry & Human Behavior, and Physical Medicine & Rehabilitation, would be the Principal Investigator at approximately 50% of his current salary, extending over 4 years.

Tim Wigal, Associate Professor of Pediatrics and Cognitive Sciences, would be a c-investigator at 25% over 4 years.

It is assumed that one or more faculty members at San Bernardino would also serve as co-investigators, depending on determination of the project workload.

Research Assistants could be either UCI or CSUSB employees, depending on factors such as cost and level of interest. (At UCI, we do have a mechanism in place for hiring research assistants for our clinical drug trials, but there may be other considerations)

The Project Statistician would be a UCI person, and probably at a junior faculty level.

Equipment costs are usual and customary.

The costs of the dietary supplements are completely unknown.

There is a provision for a contract with the Violence Research Foundation, which could be for any amount, depending on the workload and other factors. For example, it might be cost-effective to hire the research assistants through the Violence Research Foundation. Or, the Violence Research Foundation could have a contract for supplying the nutritional supplements, etc.

The estimated first year cost of $500,000 does not include university overhead from either UCI or CSUSB, which will be in the neighborhood of 50%.

Currently, it is estimated that the direct costs over the four years of the study would be $500,000 per year, or $2,000,000. With the various university overheads, this is going to amount to about $3,000,000 over the four years of the study.