國立臺北大學犯罪學研究所

碩士論文

指導教授　周愫嫻教授

催產激素對兒時創傷及暴力／衝動之中介效果

The Mediational Effect of Plasma Oxytocin Level on Childhood Trauma and Aggression / Impulsivity

本論文獲得法務部司法官學院108年傑出碩博士犯罪防治研究論文獎

研究生　吳佳慶

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謝誌

跨入不同領域的研究所，是個艱辛的挑戰，過程的收穫卻也是難以訴諸筆墨。曾經想過，研究所求知過程，如果教授只是單方面知識傳授，我覺得那就失去了研究學問的理想。所幸犯罪學研究所提供的師資、課程內容、教學資源，豐富多元且學風自由，實實在在讓我能有機會藉著不斷專研、討論、辯論來增加不同領域的知識。

內心最感謝的，是指導教授周愫嫻教授。從研究發想、收案過程、分析、論文撰寫，都細心給予指導；在每一次研究遇到挫折、困難時，周教授都傾全力協助解決問題。當初因著周教授學術研究與涵養來報考研究所；也有幸得到周教授的青睞指導碩士論文。在周教授兩年的指導下，可深刻感受到其嚴謹治學與研究的態度，但相處下來卻是輕鬆自在的，也能感受到其對學生的尊重，亦師亦友的師生情誼，銘記於心。

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感謝吳建昌副教授及盧孟良教授對於論文的指導與建議，在口試時提出了研究上許多的缺點與不足，讓論文架構更完成、成熟。感謝研究所上所有老師兩年來所提供的所有學術養分。帶職進修是件有點辛苦的事，感謝工作上長官陳俊興教授的諒解與包容，也很感謝盧孟良教授提供許多學術資源的協助與研究指導。

能與一群來自不同領域及背景的同學一起學習、成長，是件很難能可貴的事情，豐富了我的閱歷，也認識了一群很優秀的朋友。感謝家人在我就讀研究所的這兩年，承受了我所轉載的情緒與壓力。

僅將此研究獻給每一位在研究路上伸出援手的貴人。

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社會科學學院犯罪學研究所碩士班

107學年度第2學期畢業生論文

研究生：吳佳慶 撰

業經本委員會審議通過

題目：催產激素對兒時創傷及暴力／衝動之中介效果

The mediational effect of plasma oxytocin level on childhood trauma and aggression / impulsivity

論文考試委員：

召集人 [signature]

委員 [signature]

委員 [signature]

委員 [signature]

指導教授 [signature]

系（所）主任 [signature]

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研　究　生：吳佳慶　　指導教授：周愫嫻

論文提要內容：

研究目的

暴力犯罪，特別是殺人案件，經常因為媒體大肆報導而成為社會大眾矚目的焦點，衝擊著社會安全的網絡。摒除嗜血性軟土深掘的報導來呈現暴力犯罪者的負面新聞及其身邊關係人，暴力犯罪者的特徵及暴力犯罪的真正成因是極鮮少被正視。從有限的司法領域及精神醫學的研究中發現，兒時創傷經驗具有明顯的傷害性及延續性影響，會導致大腦功能及體內催產激素的改變，可能導致成年期的暴力。本研究目的為探討催產激素在兒時創傷經驗與成年期暴力間的中介角色。

研究方法

本研究採橫斷面設計，經法務部保護司同意下在臺北地檢署、士林地檢署、桃園地檢署及新竹地檢署觀護人室收案。研究對象為暴力犯罪者、毒品犯罪者、酒駕者男性，控制組為健康男性且未有前科紀錄者。研究對象接受問卷調查，問卷內容包含個人資料、犯罪經歷、精神疾病史、暴力及衝動量表。研究對象之兒時創傷經驗以自填式回溯問卷評估，同時進行澄清式訪談來確認其兒時創傷經驗。研究對象體內之催產激素以血漿中催產激素之濃度為檢驗標準。

研究結果

本研究共納入了 178 位研究對象，其中暴力組 33 位、毒品組 37 位、酒駕組 33 位及健康對照組 75 位。研究發現，暴力犯罪者學歷較低、多為單身且對自身健康狀況較為不滿意。暴力犯罪者在各種兒時創傷經驗中比例皆為最高，且相較於健康對照組有較高的肢體虐待創傷經驗。本研究發現兒時創傷經驗與暴力有顯著正相關，兒時創傷與血漿中催產激素之濃度為顯著的負相關，血漿中催產激素之濃度與暴力亦為顯著的負相關。血漿中催產激素之濃度對兒時創傷與暴力間的中介效果有顯著影響，在全組別分析中為部分中介效果，而在暴力組分析中為完全中介效果。

研究結論

暴力犯罪的形成是錯綜複雜的，與犯罪者個人因素機器成長至社會背景有著難以劃清之相互作用。縱使難以描繪其全貌，本研究試圖釐清暴力犯罪者的兒時創傷與暴力之間的關係。本研究推論因著兒時創傷經驗而降低了血漿中催產激素的濃度，並隨後導致暴力行為風險增加。

關鍵詞：催產激素、兒時創傷、暴力、犯罪

ABSTRACT

THE MEDIATIONAL EFFECT OF PLASMA OXYTOCIN LEVEL

ON CHILDHOOD TRAUMA AND AGGRESSION / IMPULSIVITY

by

GOH, KAH KHENG

July 2019

ADVISOR: Dr. JOU, SUSYAN

DEPARTMENT: GRAUDUATE SCHOOL OF CRIMINOLOGY

MAJOR: CRIMINOLOGY AND CRIMINAL JUSTICE

DEGREE: MASTER OF ARTS

Background

Violence remains a leading cause of mortality worldwide. Violent crimes, especially homicides, always draw the public attention. However, the genuine characteristics of violent offenders and the formation models of violence crimes are seldom being discussed. The association between trauma in childhood and criminality in adulthood has been demonstrated in various countries and settings. It has been posited that the breaking of an attachment bond through childhood trauma ultimately directs a child to a life of crime. In addition to neglect, childhood trauma can result from physical, sexual, or emotional abuse. Furthermore, studies have proposed that attachment may contribute to brain function alterations. The regulation of oxytocin, the "cuddling" hormone, is disrupted by childhood trauma. However, the interactions between oxytocin level, childhood trauma, and aggression remain unclear. In the light of the above evidences, this study is aiming to examine the role of oxytocin as a determinant step, in linking childhood trauma to aggression. This study investigated the relationship between oxytocin level and childhood trauma in violent offenders.

Methods

This study was conducted between November 1, 2018 and April 30, 2019 after obtained the consent from Ministry of Justice. Violent offenders and nonviolent (substance- and alcohol-related offenses) offenders (all men, aged 20 to 65 years) were recruited from probation offices in Taipei, Shihlin,

Taoyuan, and Hsinchu (Taiwan), whereas healthy nonoffending participants were recruited from the community through research advertisements. Participants received a questionnaire requesting basic demographic data and details of current offenses, mental illnesses, aggression and impulsivity. Early childhood trauma experiences were assessed by Childhood Trauma Questionnaire - Short Form and in-depth clarification interviews were conducted for cross-validation. Phlebotomy was performed to obtain blood samples for plasma oxytocin level measurement.

Results

Almost 90% of the offenders were classified as having experienced at least one type of childhood trauma, and violent offenders had higher childhood trauma scores than nonviolent offenders and control participants did. Furthermore, childhood trauma was significantly associated with later aggression. Participants in the violence group had the lowest plasma oxytocin levels, whereas those in the control group had the highest. Plasma oxytocin level was inversely correlated with childhood trauma and aggression in all participants. The relationship between childhood trauma and aggression was mediated by plasma oxytocin level.

Conclusion

This study aimed to explore the mechanism leading from childhood trauma to later aggression in violent offenders. It might be difficult to fully illustrate the whole picture of violent crimes, since crime formation is always a complex interplay between the individual and the society in which he or she grows up. Childhood trauma is undoubtedly correlated with aggression whereas plasma oxytocin level is inversely correlated with childhood trauma. A theoretical framework has been postulated to explain the possible pathway, as experienced childhood trauma decreased the plasma oxytocin levels and subsequently contributed to higher aggression in violent offenders. On the limitation of cross-sectional analysis, it is recommended that longitudinal relationships should be examined to confirm the more definitive causality terms over time.

Keywords: oxytocin, childhood trauma, violence, crime, aggression.

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Chapter 1 Introduction

1.1 Overview

Violence remains a leading cause of mortality worldwide. The burden and harm elicited by violent crimes are tremendous, together having negative effects on society in terms of insecurity and physical disability. Violent crimes, especially homicide, draw the public's attention, especially in terms of pursuing the perpetrators of such crimes. However, the full details of such incidents, especially in relation to the true characteristics of violent offenders and the formation models of violent crimes, are seldom considered. Research on forensic and psychiatric samples have suggested a relationship between childhood trauma and violent crimes (Baglivio et al., 2014; Baglivio, Wolff, Piquero, & Epps, 2015; Craparo, Schimmenti, & Caretti, 2013; Marco, Vladimir, Chiara, Marco, & Alec, 2009; Wolff, Baglivio, & Piquero, 2015). Trauma experienced in childhood has severe consequences for not only those who experienced it but also society as a whole. The ways of interpreting the old internal map of the perceived world can damage their ability to function as a mature and responsible adult. Such children may create a false self to bury feelings and lose touch with who they really are. They may live their lives in fear, thinking that they are not being cared for, loved, or accepted (Winnicot, 1965). Furthermore, those children may develop victimhood thinking: they may feel like they have no control over their lives and use negative self-talk, an unconscious negative running monologue that disempowers them, thus making them feel like victims (Heru, 2001). Such a person who experienced childhood trauma may have learned to hide parts of themselves and present themselves as a passive person. This person may end up "abandoning" themselves. Passive aggressiveness is a pattern of anger expression in such children (Dyson, 1990). It has been postulated that those traumatized during childhood can translate internal harm to external harm. The association between trauma in childhood and criminality in adulthood has been demonstrated in various countries and settings (Brewer-Smyth, Cornelius, & Pickelsimer, 2015; Craparo et al., 2013; Kolla et al., 2013; Marco et al., 2009). However, less is known about theoretical frameworks for explaining the route from childhood trauma to adulthood aggression.

Violent crime is an extreme form of aggression, and homicide is an extreme manifestation of violent crime. The characteristics of violent offenders and the formation models of violent crimes are seldom discussed. However, research in the fields of forensics and psychiatry has suggested that childhood trauma contributes to adulthood violence

(Brewer-Smyth et al., 2015; Kolla et al., 2013). Childhood trauma is an important risk factor for adulthood aggression. Attachment is among the most crucial psychological theories discussed in relation to explanatory models of aggression (Cyr, Pasalich, McMahon, & Spieker, 2014; Houston & Grych, 2016). The breaking of an attachment bond through childhood trauma ultimately directs a child to a life of crime (Myers et al., 2008). Studies have proposed that attachment may contribute to brain function alterations although studies have yet to confirm that such alterations occur.

In addition to its effects on labor and lactation, oxytocin, the "cuddling" hormone, plays a fundamental role in human attachment. Animal studies have demonstrated that oxytocin is related to maternal aggression (Bosch, Meddle, Beiderbeck, Douglas, & Neumann, 2005) as well as to the regulation of responses to stress (Bisagno & Lud Cadet, 2014; Olff et al., 2013). The regulation of oxytocin is disrupted by childhood trauma (Heim, Newport, Mletzko, Miller, & Nemeroff, 2008a). However, the interactions between oxytocin, childhood trauma, and aggression remain unclear. To the best of our knowledge, studies specifically examining the correlations between childhood trauma and oxytocin levels in violent offenders are limited.

1.2 Background to violent crimes in Taiwan

The number of violent crimes in Taiwan has decreased since 2005 according to annual violent crime statistics released by the National Police Agency, Ministry of Interior Affairs (National Police Agency, 2017). Figure 1 shows data on reported violent crimes in Taiwan from 1997 to 2017. When analyzing official crime statistics, it is crucial to clarify the factors that may have affected the exact numbers counted, including law reforms, police policies, or changes in statistical calculations. Notably, the calculation of violent crimes was modified from that concerning homicide, robbery, abrupt taking, and kidnapping in 1990 to that related to current definitions of violent crimes, such as homicide, kidnapping, robbery, abrupt taking, aggravated assault, intimidation-extortion, and forcible sexual intercourse in 2000. In addition to the lifting of martial law in 1986, the introduction of a policy for the verification of crime reports issued by police increased the number of violent crimes significantly (Hsieh, Sheu, & Shi, 2006). According to police crime reports, aggravated assault constitutes the largest proportion of violent crimes reported, followed by homicide, forcible sexual intercourse, robbery, abrupt taking, kidnapping, and intimidation-extortion (National Police Agency, 2017). The aforementioned crime statistics were retrieved from

official crime reports; they do not include the dark figure of crime (i.e., crimes that go unreported and or are not discovered). The overall number of violent crimes reported incudes attempted crimes. Among these violent crimes, homicide and aggravated assault are those that predominantly relate to violence and aggression. Figure 2 presents data on reported homicide and aggravated assault incidents in Taiwan from 1997 to 2017. Notably, decreases in the rates of homicide and aggravated assault were more substantial than decreases in the rates of other violent crimes.

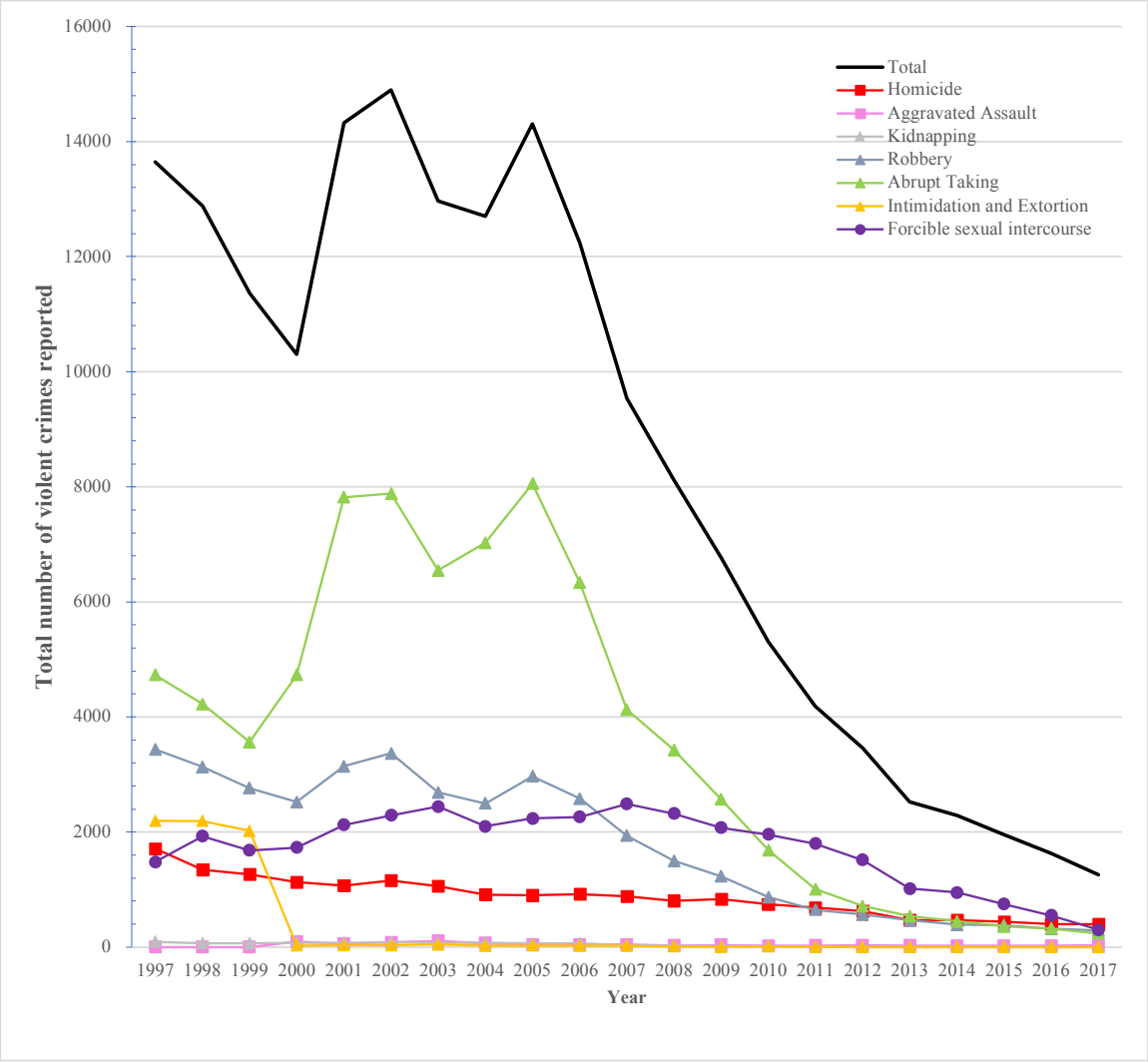

Figure 1. Reported violent crimes in Taiwan from 1997 to 2017. Reproduced from "Violent Crime Statistics" by National Police Agency, Ministry of Interior Affair, 2017, with last accessed 12 September 2018 on https://ba.npa.gov.tw/npa/stmain.jsp?sys=100.

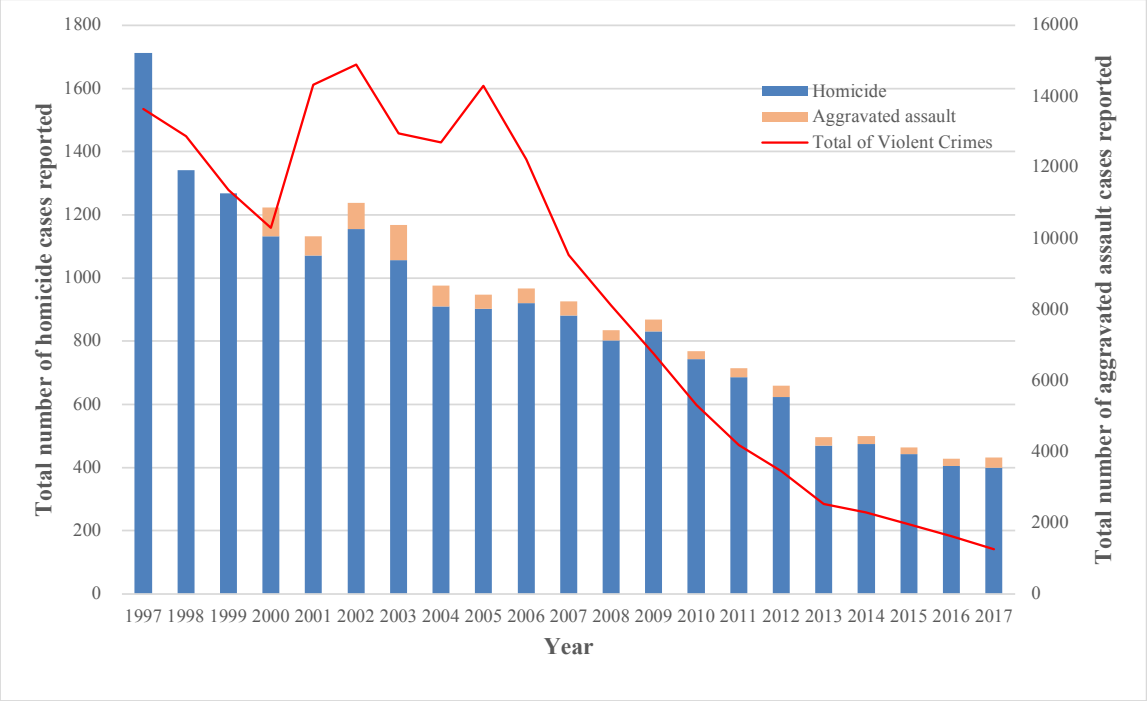

Figure 2. Reported Homicide and Aggravated Assault in Taiwan from 1997 to 2017. Reproduced from "Violent Crime Statistics" by National Police Agency, Ministry of Interior Affair, 2017, with last accessed 12 September 2018 on https://ba.npa.gov.tw/npa/stmain.jsp?sys=100.

1.3 Background to childhood trauma in Taiwan

Childhood trauma is prevalent worldwide, resulting in severe lifelong consequences (Hughes et al., 2017). Failure to provide supervision by caregivers and/or results in actual or potential harm to a child (Chang et al., 2018), whether in the form of physical abuse, emotional abuse, sexual abuse, neglect, or exposure to dangerous environments may be traumatic for a child. In addition to physical injury and death, childhood trauma can lead to brain dysfunction and is associated with developmental delay, cognitive impairment, poor academic performance, psychiatric morbidity, risky behavior, revictimization, and perpetration of abusive behaviors. Recent evidence has shown that childhood trauma alters the trajectories of brain development. Depending on the type and timing of exposure, this can subsequently alter the sensory system, network architecture, and circuits involved in threat detection, emotional regulation, and reward anticipation (Teicher, Samson, Anderson, & Ohashi, 2016). The alteration of brain functions could be related to the reduced volume of the hippocampus, anterior cingulate, and ventromedial and dorsomedial cortices in individuals with childhood trauma. This can alter the development of sensory systems for

processing and conveying stressful experiences, resulting in distinct ecophenotypes of mental disorders as well as aggression.

Severe cases of child abuse and maltreatment are being increasingly detected in Taiwan (Chen, Yang, & Chou, 2016). Efforts have been devoted to reducing child maltreatment. Relevant statutory provisions were implemented in 1973 through the promulgation of the Children Welfare Act, ratified by the United Nations Convention on the Rights of the Child. Subsequently, the doctrine of *parens patriae* was adopted with the concept of the child's best interests, shifting the issue of child protection from a private family matter into the public sphere (Chen et al., 2016). The act was then amended in 2003 and 2011 before being superseded in 2015 by the Protection of Children and Youths Welfare and Rights Act.

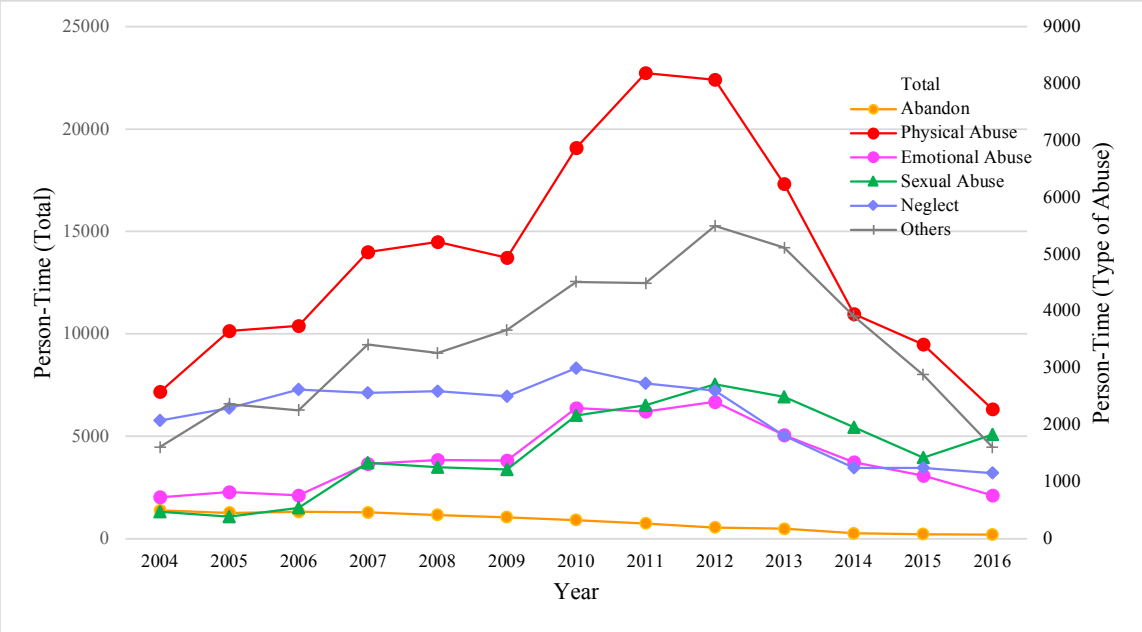

Figure 3. Reported Child and Youth Abuse in Taiwan from 2004 to 2016. Reproduced from "Statistics of Child and Youth Protection" by Ministry of Health and Welfare, 2016, with last accessed 16 September 2018 on https://dep.mohw.gov.tw/DOS/lp-2985-113.html.

The prevalence of child maltreatment is difficult to estimate, with frequent claims that it is always underestimated. A population-based study of 5276 adolescents in 17 cities and townships of Taiwan showed that 91% of them had experienced at least one form of maltreatment, with the most frequent type of child maltreatment being violence exposure, followed by emotional abuse, neglect, physical abuse, and sexual abuse (Feng, Chang, Chang, Fetzer, & Wang, 2015). As shown in Figure 3, in concordance with the

aforementioned results, physical abuse had the highest prevalence among all abuse types according to the Child and Youth Protection Statistics released by the Ministry of Health and Welfare, Taiwan (Ministry of Health and Welfare, 2016). Adolescents reported an average of 7.4 victimization episodes each over their lifetimes (Feng et al., 2015), and adolescents aged 12 to 17 years (Chen et al., 2016) comprised the subgroup that experienced maltreatment the most. Overall, the reported prevalence of child abuse has decreased since 2012, and reported child neglect showed the most considerable decrease among different forms of maltreatment. Notably, reports of sexual abuse increased, surpassing reports of neglect since 2013 (Chen et al., 2016; Ministry of Health and Welfare, 2016). More crucially, despite a decrease in the overall mortality rate for children in Taiwan, the mortality rate for children with substantiated records of maltreatment experiences increased since 2010 (Chen et al., 2016).

1.4 Research problem

Aggression and impulsivity are commonly observed in violent offenders. These distinct tendencies are the main influencing factors of violent crimes. Furthermore, they complicate the lives of these violent offenders and increase the crime prevention cost and burden. Numerous studies have stated that aggression is more commonly observed in those with high impulsivity than in the general population. However, the analysis of aggression and its formation theory is at too early a stage for conclusions to be drawn.

Oxytocin plays a crucial role in human attachment. It is associated with maternal aggression in animal models and contributes to depression and anxiety in humans (Olff et al., 2013). The disrupted regulation of oxytocin was noted in individuals with childhood trauma (Heim et al., 2008a), and oxytocin regulation may contribute to the phenotypes of weakened attachment and social bonding after childhood trauma. Furthermore, the effects of childhood trauma on aggression and subsequent violent crimes were demonstrated (Baglivio et al., 2015; Marco et al., 2009; Widom, 1989). Furthermore, oxytocin levels were correlated with maternal aggression in animal studies (Bosch et al., 2005); however, the implications of oxytocin in human aggression remain unclear.

A history of aggression was inversely correlated with oxytocin levels in the cerebral spinal fluid, indicating that oxytocin plays a mechanistic role in human aggression (Lee, Ferris, Van de Kar, & Coccaro, 2009). In a study of general healthy participants, compared

with a placebo group, behavioral aggression was slightly higher in the experimental group directly after the intranasal administration of oxytocin. However, the opposite was found as the study period progressed (Romney, Hahn-Holbrook, Norman, Moore, & Holt-Lunstad, 2018). In another study of healthy participants, compared with the placebo group, the intranasal administration of oxytocin increased the aggressive responses of participants in the experimental group while playing a monetary game (Ne'eman, Perach-Barzilay, Fischer-Shofty, Atias, & Shamay-Tsoory, 2016). By contrast, intranasal oxytocin administration decreased social threat hypersensitivity and accordingly reduced anger and aggressive behavior in people with borderline personality disorder (Bertsch et al., 2013a). Notably, oxytocin promoted in-group trust and cooperation and defensive but nonaggressive behavior toward competing outgroups in healthy male subjects who self-administered oxytocin (De Dreu et al., 2010). Oxytocin promotes prosocial behavior if the environment is perceived as safe and familiar, whereas it enhances defensive behavior if the environment is perceived as unsafe (Olff et al., 2013). As proposed in a social salience study, exogenous oxytocin reinforces the salience of social stimuli. To some extent, its effects depend on the context of the stimuli (Shamay-Tsoory & Abu-Akel, 2016). Despite this body of evidence, inconsistent results were found in patients in clinical settings and healthy participants when the correlation between oxytocin levels and aggression was examined.

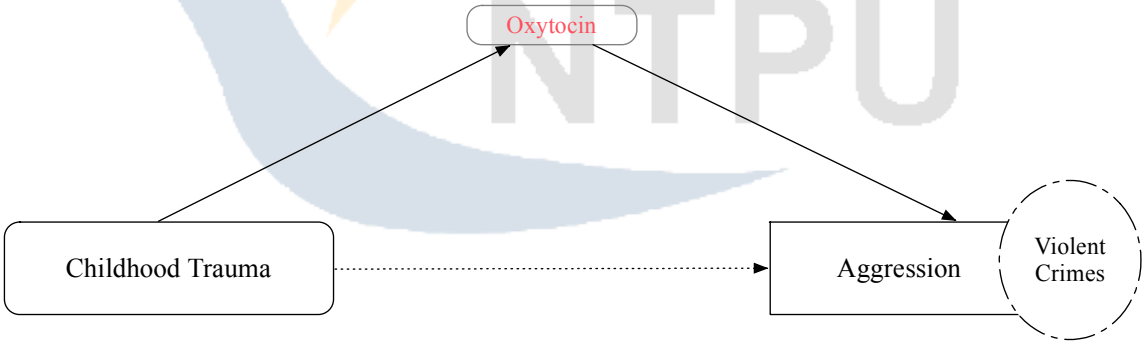

Figure 4. Theoretical model of oxytocin's role in linking childhood trauma.

The implications regarding oxytocin in violent offenders are among the main interests in this study. According to related studies, childhood trauma may disrupt the regulation of oxytocin, and a decrease in oxytocin levels may be correlated with heightened aggression levels. However, how oxytocin mediates the route from childhood trauma to adulthood aggression is still unknown. It is crucial to revalidate the correlation between oxytocin levels and aggression in violent offenders. Furthermore, this study aimed to build a theoretical

framework that may explain the mechanism through which childhood trauma leads to subsequent aggression in violent offenders. To elucidate factors related to the relationships between oxytocin, childhood trauma, and aggression, a theoretical model explaining the role of oxytocin was constructed (Figure 4). In the proposed trajectory from childhood trauma to adulthood aggression, oxytocin is considered to contribute to adulthood aggression. In addition, with the presumption that aggression is a phenotype associated with violent offenders that manifests in them committing violent crimes, this study aimed to examine the role of oxytocin as a determinant, in relation to the concept of enzymes, in the link between childhood trauma and aggression.

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Chapter 2 Theoretical Framework

2.1 Definition of childhood trauma

Childhood adverse events, colloquially referred to as adverse childhood experiences or child maltreatment, have a wide range of circumstances; these adverse events include early parental loss by death or abandonment, the witnessing of interparental violence, dysfunctional parenting, sexual abuse, physical abuse, emotional abuse, childhood neglect, and bullying. Such factors pose a severe threat to a child's well-being (Herrenkohl, 2005; Krug, Dahlberg, Mercy, Zwi, & Lozano, 2002). The consequences of maltreatment were used to identify and dichotomously separate children who were and were not maltreated. The harm standard was used to obtain operational definitions of child maltreatment first in the National Incidence Study to examine the prevalence of childhood maltreatment in the general population. Then, allegations of maltreatment in studies of legal cases were translated into variables that were applied in subsequent studies (Herrenkohl, 2005).

Childhood trauma is a possible outcome of exposure to adverse events during childhood. When a child perceives an event as being extremely frightening and harmful in their emotional or physical experience, childhood trauma is considered to have occurred. Childhood trauma is broadly defined as any act in which a caregiver fails to provide appropriate supervision, resulting in actual or potential harm to the health, development, or dignity of a child (Feng et al., 2015). Experts who participated the WHO Consultation on Child Abuse Prevention drafted the first definition of child trauma that is widely accepted: "Child abuse or maltreatment constitutes all forms of physical and/or emotional ill-treatment, sexual abuse, neglect or negligent treatment or commercial or other exploitation, resulting in actual or potential harm to the child's health, survival, development or dignity in the context of a relationship of responsibility, trust or power" (Krug et al., 2002). Childhood trauma has been separated into four types, namely physical abuse, sexual abuse, emotional abuse, and neglect.

Physical abuse is the intentional use of physical force that results in, or potentially results, physical injury to a child. Physical abuse can result from disciplining or physical punishment, ranging from that which leaves no physical mark to a physical act that causes permanent disability, disfigurement, or death. Such physical acts can take the form of hitting, kicking, punching, beating, stabbing, biting, pushing, shoving, throwing, pulling, dragging,

dropping, shaking, strangling, smothering, burning, scalding, and poisoning. Such acts exclude injuries to the anal area, genital area, or surrounding areas that often occur during probably intent to engage in sexual behavior, which should be considered sexual abuse (Leeb, Paulozzi, Melanson, Simon, & Arias, 2008).

Sexual abuse is defined as any sexual act with, sexual contact with, or exploitation of a child, regardless of whether it is completed or attempted. Penetration of the mouth, penis, vulva, or anus of a child by another individual (with their body or by using an object) is considered sexual abuse. Touching of the genitalia, anus, groin, breast, inner thigh, or buttocks directly or through clothing, without the involvement of penetration, is considered abusive sexual contact (Leeb et al., 2008). Touching required for the daily care of a child should not be considered sexual contact. Exploitation or noncontact sexual abuse can include the intentional exposure of a child to sexual activity, filming of a child in a sexual manner, and the sexual harassment, prostitution, or sexual trafficking of a child (Leeb et al., 2008).

Emotional abuse is more difficult to define than sexual and physical abuse. Intentionally giving a child a sense of worthlessness or being unwanted, endangered, or unloved is considered emotional abuse. Episodically or continuously blaming, isolating, terrorizing, intimidating, restraining, exploiting, spurning, and belittling a child or other harmful behaviors are considered forms of emotional abuse that can potentially damage a child emotionally (Leeb et al., 2008).

Child neglect occurs when a caregiver fails to meet the basic physical, emotional, medical, or educational needs of a child. Physical neglect is defined as the caregiver's failure to provide adequate nutrition, hygiene care, shelter, or clothing to a child. Emotional neglect occurred if a caregiver ignores a child, denies them emotional responsiveness, deprives them of an emotional response, or inadequate access to mental health care. Medical neglect is the failure to provide a child with adequate access to medical care, such as not administering prescribed medication or not seeking medical attention in a timely manner. If a caregiver fails to provide a child with access to adequate education, does not enroll a child in school, or encourages a child to drop out of school, this is considered educational neglect. Failure to supervise a child to ensure their safety, such as exposing them to violence, is also defined as child neglect (Leeb et al., 2008).

Cultural considerations, such as those related to different standards and expectations for parenting behavior, should be taken into account when applying a global approach to child abuse. Acknowledging cultural differences is crucial in defining generally accepted principles of parenting behavior. As such, the definition of child maltreatment in Taiwan, especially that defined in The Protection of Children and Youths Welfare and Rights Act, is identical to that formed by international consensus mentioned previously (Chiu & Chiang, 2010). With the limitations of a self-report questionnaire, which was applied in this study, the construct of childhood trauma was restricted to the forms of physical abuse, sexual abuse, emotional abuse, physical neglect, and emotional neglect (Bernstein et al., 2003). Prospective and retrospective measures have been used to identify childhood trauma; however, agreement between both measures has been low (Baldwin, Reuben, Newbury, & Danese, 2019). It is argued that children with childhood trauma who are identified prospectively may have different risk pathways to mental illness than those reported that reported to have childhood trauma retrospectively. Therefore, understanding the link between childhood trauma and negative consequences in adulthood, including violent crimes, is crucial to addressing such issues.

2.2 Definitions of aggression, violence, and impulsivity

Aggression is complex and heteregenous. It is influenced by complex interactions between biological, psychological, and social variables. The expression of aggression as a behavior is multifaceted. In addition, aggression is clinically linked to psychopathy and psychotic symptoms in forensic studies (Stahl, 2014). Aggression is commonly defined as an intention to harm another person who is motivated to avoid that harm. Usually, the perpetrator has strong faith that the behavior will harm the target (Allen & Anderson, 2017). Several key elements are applied to distinguish aggression from other phenomena. Aggression is a behavior that is observable (i.e., it is not only a thought or feeling). Aggressive cognition and affect are frequently precursors to aggressive behavior (Allen & Anderson, 2017). Aggresion involves an intentional desire to harm another person; thus, accidental harm is not considered to be aggression (Allen & Anderson, 2017). The recipient of harm must be motivated to avoid the harm, excluding masochism, suicide, or assisted suicide from the realm of aggression (Allen & Anderson, 2017).

Table 1

Taxonomy of aggression proposed by Krahé

Aspect	Subtypes	Examples
Response modality	Verbal	Shouting or swearing at someone
	Physical	Hitting or shooting someone
	Postural	Making threatening gestures
	Relational	Giving someone the "silent treatment"
Immediacy	Direct	Punching someone in the face
	Indirect	Spreading rumors about someone behind their back
Response quality	Action	Making another person engage in unwanted sexual acts
	Failure to act	Withholding important information from a colleague at work
Visibility	Overt	Humiliating someone in front of others
	Covert	Sending threatening text messages to a classmate
Instigation	Proactive	Grabbing a toy from another child
	Reactive	Yelling at someone after having been physically attacked
Goal direction	Hostile	Hitting someone out of anger or frustration
	Instrumental	Taking a hostage to secure a ransom
Type of harm	Physical	Broken bones
	Psychological	Fears and nightmares
Duration of effects	Transient	Minor bruises
	Lasting	Long-term inability to form relationships
Social units involved	Individuals	Intimate partner violence
	Groups	Riots and wars

Different categorizations of aggression have been proposed. However, controversy remains regarding the most suitable taxonomy of aggression. Aggression appears in numerous forms and may be classified based on the target (e.g., self-directed or other-directed), mode (e.g., physical or verbal, direct or indirect), cause (e.g., medical or substance-induced), instigation (e.g., proactive or reactive), or duration of aggression (e.g., transient or lasting). The taxonomy of aggresssion proposed by Krahé is illustrated in Table 1 (Krahé, 2013). Proactive versus reactive aggression is the most widely utilized and most heuristically valuable classification of aggression (Siever, 2008). Proactive aggression, also termed premediated, predatory, or instrumental aggression, is a planned behavior with clear goals that is not typically associated with frustration or a response to an immediate threat. By contrast, reactive aggression, also referred to as impulsive, affective, or hostile

aggression, is accompanied by high levels of autonomic arousal and precipitation by provocation. It is associated with negative emotions, especially anger or fear. Reactive aggression represents a response to perceived stress. The lack of premediatation in the behavior might lead to it being considered as defensive aggression when the threat is dangerous and imminent, whereas individuals with the pathological behavior of a reactive response may rationalize their aggression as being within the boundaries of a defensive response (Siever, 2008).

Violence is an extreme form of aggression (Allen & Anderson, 2017). The relationship between aggression and violence has been conceptualized as being on a continuum of severity, with relatively minor acts of aggression being on one end and violence being at the other end of the spectrum (Allen & Anderson, 2017). All violent behaviors are considered instances of aggression, but not all aggressive behaviors are considered instances of violence (Allen & Anderson, 2017).

Violence is often linked to impulsivity. This link has been investigated from various perspectives and theories, yielding several definitions. Impulsivity is often considered a risk factor for violence and is thought to play a critical role in its perpetration (Bjørkly, 2013). Impulsivity is considered to be a swift action without forethought or conscious judgment. It is characterized by risk taking, a lack of planning, and quick decision-making. Three-dimension impulsivity theory and three-contributing-factors impulsivity theory are widely accepted by researchers. Three-dimension impulsivity theory mainly distinguishes impulsivity into that related to motor (action without thinking), cognition (quick decision-making), and nonplanning (decrease in consideration of the future), whereas three-contributing-factors impulsivity theory suggests that three factors contribute to impulsivity, namely acting on the spur of the moment (motor activation), not focusing on the task at hand (inattentiveness), and not planning and thinking carefully (nonplanning; (Patton, Stanford, & Barratt, 1995). Among the three factors, decreased attention and planning are the main factors underlying impulsive behavior (Bakhshani, 2014). Impulsivity is defined as “a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individuals or to others”(Moeller, S. Barratt, M. Dougherty, M. Schmitz, & Swann, 2001). In other words, a comprehensive definition of impulsivity should mention (a) decreased sensitivity to the negative consequences of the behavior, (b) immediate and unplanned reactions to stimuli before processing information thoroughly, and (c) a lack of regard for the long-term

consequences of a behavior (Moeller et al., 2001). Impulsivity is different from but related to aggression (Carlos, David, Alberto, & Antonio, 2009). It is related to a cetain extent to violent delinquency and crimes (Chan & Chui, 2012). A high level of impulsivity does not automatically explain violent incidents (Bjørkly, 2013).

In this study, agression is defined as any intentional threat by a person to inflict harm on objects, themselves, or others in physical or verbal form. Violence is defined as intentional acts in terms of actual or intended attempts to cause bodily injury or harm to another person. In this study, impulsivity is defined as an unplanned reaction to a stimulus regardless of the negative consequences of such actions on the impulsive individuals or others.

2.3 Definitions of violent crimes and offenders

Violent crimes are social phenomena that have existed in human society since time immemorial. Violent crimes are difficult to eliminate, regardless of degrees of social development or the establishment of a political, economic, or economic system. Along with changes over time and those related to social and economic structures, informational structures, and technological innovations, violent crimes have constantly evolved, posing a serious threat to the security of society.

Definitions and measures of violent crimes vary in different countries. According to the Crime Survey for England and Wales, violent crimes include all forms of violent behavior, from minor assaults, harassment, and abuse to wounding and homicide. The survey further categorizes crime into violence with injury and violence without injury (Office for National Statistics, 2018). In the United States, violent crimes include murder, rape and sexual assault, robbery, and assault (Bureau of Justice Statistics, 2018). Present definition of violent crimes in Taiwan include intentional homicide, robbery (including piracy and banditry), abrupt taking, kidnapping, forcible sexual intercourse, intimidation-extortion, and aggravated assault (National Police Agency, 2017). The definition of violent crimes in this study is restricted to intentional physical harm to another person, including homicide and aggravated assault. The predictors of violent recidivism vary among different violent offenders depending on their motives for committing violent crimes (Stalans, Yarnold, Seng, Olson, & Repp, 2004). We excluded violent crimes associated with the primary intention to gain money or property and those related to sex. The rationale for narrowing down the definition

of violent crimes was to avoid targeted aggressive behavior interfering with the analysis of motives, which could subsequently obscure associations between violent crime, childhood trauma, and oxytocin.

2.4 Childhood trauma and aggression

Studies have reported that most offenders have a history of childhood trauma (Altintas & Bilici, 2018; Farina, Holzer, DeLisi, & Vaughn, 2018; Fitton, Yu, & Fazel, 2018). Individuals with childhood trauma have a high risk of engaging in problematic behaviors such as smoking, heavy drinking, and risky sexual behavior, subsequently resulting in adverse effects on physical and mental health. Adverse mental health outcomes might appear in childhood, including conduct disorder, attention-deficit hyperactivity disorder, and oppositional defiant disorder (Keyes et al., 2012). Adverse effects of childhood trauma may continue into adulthood and may be correlated with depression, anxiety, posttraumatic stress disorder, eating disorders, sexual dysfunction, personality disorders, dissociative disorders, and substance use disorder (Kessler et al., 2010). A bidirectional dose–response relationship has been observed between childhood trauma and psychosis (Kelleher et al., 2013). Childhood maltreatment and traumatic events are also directly implicated in the development of anxiety in first-episode psychosis (Michail & Birchwood, 2014), which might subsequently contribute to aggressive behavior in adulthood.

A strong correlation between childhood trauma and aggression has been demonstrated in various medical and forensic settings, especially when childhood trauma is analyzed as a determinant of aggression in prisoners (Marco et al., 2009). In an analysis of 64,000 juveniles referred to the Florida Department of Juvenile Justice, it was revealed that juvenile offenders were significantly more likely to have adverse childhood events, as they were four times more likely to report four or more adverse childhood events than college-educated adults (Baglivio et al., 2014). An earlier onset of criminal activity was consistently predicted by higher degrees of risk, and juvenile offenders who experienced a higher frequency and more types of childhood trauma were significantly more likely to begin offending at an earlier age (Baglivio et al., 2015) and were more likely to be rearrested earlier (Wolff et al., 2015). Furthermore, juvenile offenders who were categorized as being at a high risk of reoffending were more likely to report three or more adverse childhood events than low-risk juvenile offenders (Wolff et al., 2015). A high prevalence of adverse childhood experiences was identified among violent offenders (Craparo et al., 2013).

Children being maltreated have a higher likelihood of being arrested for delinquency, adult criminality, and violent crimes compared with matched controls (Widom, 1989). A study of the cycle of violence revealed that childhood trauma has a significant relationship with subsequent violent criminal behaviors (Widom, 1989); however, most abused and neglected children do not become delinquent, criminals, and violent in real-life scenarios. This research gap needs to be filled when tracing the trajectory of childhood trauma to adulthood violence. The mechanism through which childhood trauma contributes to aggression has not yet been clearly identified. Human aggression has been proposed to be acquired through learning and the rehearsal and reinforcement of aggression-related events. This has been refuted by research on behavioral psychology. It has been posited that violence is unlearned rather than learned, as biological predisposition and social experience modify the aggression that is inherent in humanity (Fonagy, 2005). The socialization of natural aggression is related to self-control, which requires attentional mechanisms and symbolization and strongly depends on attachment relationships (Fonagy, 2005). Attachment is an instinct in which proximity to an attachment figure is sought when as child perceives a threat. Attachment can be severely affected by traumatic childhood experiences (Breidenstine, Bailey, Zeanah, & Larrieu, 2011). A sense of belonging, personal experience of integration with others, as well as being a part of the system or environment that evolved from secure attachment may alleviate the effect of childhood trauma on adulthood mental disorders in adulthood (Torgerson, Love, & Vennum, 2018). Insecure attachment has been found in children with aggressive behavior, and the activation of insecure attachment mechanisms may affect interpersonal relationships or result in the such externalizing behaviors (Fearon, Bakermans-Kranenburg, Van IJzendoorn, Lapsley, & Roisman, 2010).

The timing of exposure is a crucial factor that determines whether childhood trauma exerts a prepotent influence on brain alterations (Teicher et al., 2016). For example, exposure to maltreatment during early childhood was associated with an blunted amygdala response, whereas early adolescent exposure was significantly associated with an augmented amygdala response (Zhu et al., 2019), implying the presence of developmental differences in the association between maltreatment and the amygdala response to threatening or salient stimuli. Children in the early prepubescent period were unable to deal with their trauma exposure through fight-or-flight reactions and tended to remain attached to their abusive parents, thus reducing the amygdala's response to threat, which might have promoted their survival (Zhu et al., 2019). A strong amygdala response in adolescents may

be adaptive; such adolescents may be more able to reduce their exposure to incidents of abuse. Understanding the role of childhood trauma in different sensitive exposure periods and the potential adaptive importance of brain development and biological responses may help explain different interactions between oxytocin, attachment, and the aggression of individuals with childhood trauma experiences.

2.5 Oxytocin

Oxytocin, a hormonal neuropeptide produced by magnocellular neurosecretory cells of the supraoptic and paraventricular nuclei of the hypothalamus, is stored in Herring bodies at the axon terminal and is released by neurohypophysis of the posterior pituitary. In humans, it is associated with uterus contraction during labor and with milk production. Oxytocin was first discovered by Henry Dale in 1906, and its molecular structure was confirmed in 1952. From the *OXT* gene, the inactive precursor oxytocin protein is synthesized and carried by its carrier protein neurophysin I, and it is then hydrolyzed serially into the active oxytocin nanopeptide, which is released soon after being catalyzed by peptidylglycine alpha-amidating monooxygenase. Oxytocin is mainly metabolized by oxytocinase (Gimpl & Fahrenholz, 2001).

Oxytocin is referred to as the "love and cuddling" hormone; it facilitates bonding between parents and their babies and typically results in people engaging in prosocial behavior, promoting trust and attachment between individuals. Notably, basal plasma oxytocin levels were positively correlated with empathy (Demirci, Özmen, & Öztop, 2016), trust (Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005), and cooperation (Rilling et al., 2012) in humans. Recently, researchers reached a consensus that oxytocin modulates fear and anxiety by enhancing the approach to, or avoidance of, certain social stimuli and increasing the salience of social stimuli (Theodoridou, Penton-Voak, & Rowe, 2013). Furthermore, oxytocin deficiency may be involved in the pathophysiology of mental disorders such as depression (Matsuzaki, Matsushita, Tomizawa, & Matsui, 2012), autism spectrum disorder (Bakker-Huvenaars et al., 2018), ketamine use disorder (Huang et al., 2018), and schizophrenia (Liu et al., 2019).

Oxytocin is also involved in the regulation of the response to stress. Downregulation of the hypothalamic–pituitary–adrenal axis through cortisol release by oxytocin is proposed to mediate the reduction in hostility and situational aggression by reduced stress reactivity

(Ring et al., 2006). Oxytocin has been correlated with maternal aggression (Bosch et al., 2005) and plays a similar role to testosterone in male aggressive behaviors, partly because aggression is linked to anxiety. The exogenous administration of oxytocin in animal studies decreased the aggressive reactions of rats toward an intruder (Calcagnoli, Kreutzmann, de Boer, Althaus, & Koolhaas, 2015), whereas male oxytocin knockout mice had increased levels of aggression (Caldwell, Aulino, Freeman, Miller, & Witchey, 2017). However, these findings cannot be replicated in human studies, as related experiments on human participants are considered to be unethical. It is common to categorize human participants, especially those with psychiatric disorders, into high and low aggression subtypes and to assess an individual's life history, characteristics of aggression, or tendency to be aggressive by analyzing their convictions for violent crimes (de Jong & Neumann, 2018). As aforementioned, basal plasma oxytocin levels were negatively correlated with aggression in boys with attention-deficit and hyperactivity disorder (Demirci et al., 2016), young adult women with borderline personality disorder (Bertsch, Schmidinger, Neumann, & Herpertz, 2013b), and people with callous and unemotional traits and psychopathy (Rice & Derish, 2015).

The regulation of oxytocin is disrupted by childhood trauma. A dearth of oxytocin is considered to be "the most visible and obvious indicator of dysfunctional parenting" (Holden, 2014), suggesting that lower oxytocin concentrations could be observed in children who experienced trauma (Seltzer, Ziegler, Connolly, Prososki, & Pollak, 2014; Wismer Fries, Ziegler, Kurian, Jacoris, & Pollak, 2005). Decreased levels of oxytocin have also been found in adults exposed to early childhood maltreatment (Bertsch et al., 2013b; Heim et al., 2008a; Opacka-Juffry & Mohiyeddini, 2012). A low oxytocin level may be associated with neurostructural changes in those who experienced maltreatment; for example, a low oxytocin level is associated with larger hypothalamus and amygdala volumes (Mielke et al., 2018) as a result of the compensatory growth mechanism. However, this association with oxytocin remains controversial; another study showed that disruptions in oxytocin's regulation of social attachment during childhood can lead to a high oxytocin level (Anda et al., 2006). This allows traumatized children to recover and form more secure personal attachments during adulthood (Anda et al., 2006). Severity of childhood trauma may also have a role in modulating oxytocin concentrations; for example, healthy adults with a history of less severe forms of childhood physical abuse had higher oxytocin concentrations (Mizuki & Fujiwara, 2015), despite the inverse relationship between childhood trauma and oxytocin level. As shown in clinical studies, only traumatic events that occurred during

childhood led to lower oxytocin levels; this was not the case for recent trauma (Fragkaki, Cima, & Granic, 2018). In other words, the timing of trauma may affect oxytocin activity.

2.6 Hypotheses of the study

Health care and legal professionals have long debated the dynamic model underlying violent crimes at the individual level. Explanations of aggression have moved from possession to biological, psychological, sociological, economic, and cultural theories. Attachment is among the most validated psychological theories being raised for discussing the explanatory model of aggression. A break in the attachment bond between a child and those closest to them ultimately directs the child to a life of crime (Myers et al., 2008).

Biology-based approaches have been widely used to make postulations related to theories of aggression, especially in the era when advances in technology provide an unprecedented window into the brain activity of violent offenders, such as electroencephalography, computed tomography, positron emission tomography, and functional magnetic resonance imaging. Various brain circuits may be involved in aggression formulation, including the amygdala and prefrontal cortex (Dolan & Fullam, 2009). In addition to these anatomical findings, the activity of neurotransmitters, such as serotonin, dopamine, norepinephrenia, and γ-aminobutyric acid are proposed to have a positive correlation with aggression (Rosell & Siever, 2015). Impulsivity, a mutilfaceted construct, has a similar multidetermined etiology to aggression. Psychological approaches remain common in explaining impulsivity; however, those analyzing biological determinants provide a distinct view on impulsivity. The prefrontal cortex, orbitofrontal cortex, and amygdala are brain circuits that are ubiquitously implicated in impulsivity. Clinical evidence for the infleunce of neurochemistry, such as dopamine, serotonin, and oxytocin, on impulsivity has been presented.

Childhood trauma compromises homeostasis and leads to numerous long-term psychoneuroendocrine changes, which may affect physiological, emotional, cognitive, and social functioning, including the ability to regulate, affect, and relate to others and the subsequent development of empathy (Heide & Solomon, 2006). Childhood trauma is a key risk factor for aggression and impulsivity, which are the major hallmarks of violent crimes. Knowledge of risk factors alone is of limited value. Alterations in brain function are still

debated despite the fact that studies have proposed that attachment may contribute to brain function alterations.

Oxytocin plays a crucial role in attachment development and social cognition. Disruption of oxytocin regulation has been observed in those who have experienced childhood trauma. However, the interaction between oxytocin, childhood trauma, and the symptomatology of aggression remains unclear. This proposed prospective study investigated the relationship between oxytocin and childhood trauma in violent offenders. This retrospective study further clarified these relationships and contributed to the prevention of violent crimes. A theoretical framework that may explain the mechanism underlying childhood trauma leading to later aggression in violent offenders has been postulated as follows:

(a) The plasma oxytocin level is correlated with childhood trauma in violent offenders (violent offenders with childhood trauma have lower plasma oxytocin levels than healthy participants who have not committed violent crimes).
(b) Childhood trauma contributes to the aggression of violent offenders (violent offenders with experiences of childhood trauma have higher aggression scores than healthy participants who have not committed violent crimes).
(c) The plasma oxytocin level is correlated with aggression in violent offenders (violent offenders with lower plasma oxytocin level have higher aggression scores than healthy participants who have not committed violent crimes).
(d) The association between childhood trauma and aggression in those who commit violent crimes is mediated by oxytocin levels.

Chapter 3 Methods

3.1 Sampling and procedure

This study was conducted between November 1, 2018, and April 30, 2019, after approval was obtained from the Ministry of Justice. Violent offenders and nonviolent offenders were recruited from probation offices in Taipei, Shihlin, Taoyuan, and Hsinchu, whereas healthy participants who have not committed any crimes were recruited from the community through research advertisements. Explanations were delivered orally to the participants of interest regarding the purpose, content, process, and possible risks involved in this study. The rights of participants were explained to them before informed consent was obtained; particularly, they were informed that joining or not joining the study would not affect their judgments, sentences, and parole or probation periods. Written informed consent was obtained from each participant before the study evaluation began. Participants were free to withdraw from the study at any time. Participants received a questionnaire for collecting basic demographic data, details of current offenses, mental illness, aggression, impulsivity, and early trauma. Evaluation was conducted in a confidential, independent, and private space. Phlebotomy was performed by the research team physician and nurses. The blood analysis results and questionnaires data were recorded in the case report form for subsequent statistical analysis. Participants could receive their blood analysis results after the study was completed if they provided a mailing address. No treatment was provided to the recruited participants in this study. Recruited offenders continued to serve their sentences, and their probation periods remained unchanged. The legal and medical interventions of those participants were not changed as a result of being recruited into this study. This study was approved and monitored by the Joint Institutional Review Board of Taipei Medical University (N201807026).

3.2 Participants

Offenders who committed the offenses of homicide (Criminal Codes §271, §272, §273, and §274) were allocated to the violence group. Offenders who committed the offenses of drug abuse (Narcotics Hazard Prevention Acts §10 and §11) and offenses of driving under the influence of alcohol (Criminal Code §185-3) were included in the substances group and alcohol group, respectively. Offenders in the substances and alcohol groups had to not have a history of criminal convictions for violent offenses (Criminal Codes §271, §272, §273, §274, §277, §278, and §283). This was ensured by probation officers before participants

were referred for inclusion. Notably, individuals with behavior related to driving under the influence of alcohol have a heightened risk of having alcohol abuse disorder (Keating, Nelson, Wiley, & Shaffer, 2019), but not all of such participants were diagnosed as having this disorder. Furthermore, the criterion related to legal problems was eliminated in DSM-5, around half of the first-time driving under the influence of alcohol offenders no longer met the diagnosis of alcohol use disorder (Baley & Hoffman, 2015). In this study, participants in the alcohol and substances groups were those with offenses of driving under the influence of alcohol and drug abuse, respectively. Thus, these participants may or may not have had had alcohol use disorder and substance use disorder, respectively. Only participants without a history of having criminal convictions, illicit drugs use, and mental disorders were allocated to the control group in this study. All participants were aged 20 to 65 years, were men, had adequate mental competence, and were willing to provide written informed consent. Those who received hormone therapy were excluded. None of the participants had epilepsy, intellectual disability, dementia, neurocognitive disorder, or other serious medical illnesses.

3.3 Informed consent and ethical review

This study was approved by the Joint Institutional Review Board of Taipei Medical University through a full-board review (meeting date: August 14, 2018). The entire procedure was adequately explained to those who fit the inclusion criteria, and written informed consent was obtained before participants took part in the study. To protect the participants' privacy, all the data and blood samples were stored securely and could only be accessed by research personnel.

3.4 Measures

Participants were interviewed by research team psychiatrists for the screening and diagnosis of mental disorders. For outcome measurement, participants were then instructed to answer paper questionnaires. Phlebotomy was performed to obtain blood samples for plasma oxytocin measurement. All the measures in this study are discussed in detail as follows.

Basic demographic information

The first part of the questionnaire was related to participants' basic demographic data, including their height, weight, age, date of birth, place of birth, marital status, educational

history, occupational history, family history, medical history, psychiatric history, current medication use, alcohol and cigarette use, and self-report criminal convictions. Additional information on age at index offense, length of sentence, and length of imprisonment was collected through the questionnaires provided for participants in the three offender groups.

Childhood trauma

Childhood trauma was assessed through interviews and questionnaires. The Childhood Trauma Questionnaire-Short Form (CTQ-SF) (Bernstein et al., 2003) was used to assess the childhood trauma of participants. In a previous study, the CTQ-SF was translated into Chinese, and the translated version's reliability was confirmed (Cheng, Chen, Chou, Kuo, & Huang, 2018). The CTQ-SF is a screening tool for histories of childhood adversities and consists of 28 items measuring five types of maltreatment, namely emotional, physical, and sexual abuse, and emotional and physical neglect. Participants with scores exceeding the cutoff points for moderate exposure on each subscale (physical abuse: ≥10; emotional abuse: ≥13; sexual abuse: ≥8; physical neglect: ≥10; emotional neglect: ≥15) were classified as having a history of childhood trauma exposure (Heim et al., 2008b; Huang et al., 2018). Physical, emotional, and sexual abuse were categorized as major childhood trauma. Participants were asked to provide detailed clarification about their experiences of childhood trauma during the interviews for cross-validation.

Aggression

The aggression of participants were measured using the Modified Overt Aggression Scale (MOAS) (Yudofsky, Silver, Jackson, Endicott, & Williams, 1986) and the Buss–Perry Aggression Questionnaire (BPAQ) (Buss & Perry, 1992). The reliability and validity of the Chinese versions of the MOAS (Huang et al., 2009) and BPAQ (Maxwell, 2007) were assessed in previous studies. The MOAS is a 4-part behavior rating scale designed to measure four types of aggressive behavior, namely verbal aggression, aggression against property, auto-aggression, and physical aggression. Each section of the MOAS consists of five questions. Participants were asked to check whether each statement appropriately described their behaviors over the past week and the most severe incidents in their lifetimes. The BPAQ is a 29-item questionnaire for analyzing 4 underlying dimensions of aggression, namely physical aggression, verbal aggression, hostility, and anger. Each statement of the BPAQ is ranked on a 5-point continuum (0 = *extremely uncharacteristic of me*, 5 = *extremely characteristic of me*) with 5 for the highest level of aggression.

Impulsiveness

A validated Chinese version (Huang, Li, Fang, Wu, & Liao, 2013) of the Barratt Impulsiveness Scale Version 11 (BIS-11) (Patton et al., 1995) was administered to evaluate participants' impulsivity. The BIS-11 is self-report questionnaire designed to assess personality-related or behavioral constructs of impulsiveness. It is composed of 30 items and is scored on a 4-point scale, describing common impulsive or nonimpulsive behaviors and preferences. The BIS-11 is further categorized into three second-order factors, namely attentional, motor, and nonplanning impulsivity (Stanford et al., 2009).

Depression and anxiety

The Beck Depression Inventory (BDI) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and the Beck Anxiety Inventory (BAI) (Beck, Epstein, Brown, & Steer, 1988) were attached in the questionnaires for participants to provide self-report measures on depression and anxiety, respectively. The BDI is a 21-item self-report questionnaire for measuring the severity of depression, and each item of the scale yields a score of 0 to 3, with the overall score ranging from 0 to 63. The BAI is a self-report inventory that consists of 21 multiple-choice questions that are used to assess the cognitive and somatic anxiety of participants. Each item of the inventory has a scale value of 0 to 3, with overall scores ranging from 0 to 63. Both inventories were translated into Chinese, with validity confirmed in previous studies (Che, Lu, Chen, Chang, & Lee, 2006; Lu, Che, W. Chang, & Shen, 2002).

Oxytocin laboratory assessments

Plasma oxytocin levels were obtained in this study given the difficulties in measuring central oxytocin levels. It is not practical and unfeasible to sample the cerebrospinal fluids of offenders in probation offices. Although both compartments of the oxytocin system are anatomically separated by the blood–brain barrier, the peripheral oxytocin level has been proven to have a significantly positive association with the central oxytocin level in experimental settings (Valstad et al., 2017). Ten milliliters of venous blood was collected from each participant's antecubital region or hand by trained and qualified nurses. The samples were placed in tubes with red caps that contained silica particles and in tubes with purple caps that contained ethylenediaminetetraacetic acid. The tubes were gently inverted and then left undisturbed in ice boxes. Blood samples were kept on ice until centrifugation at 3,000*g* for 15 minutes at 4°C. Plasma was isolated, divided into 1-mL aliquots, and immediately stored at −80°C until assay. Plasma oxytocin levels were determined using the enzyme immunosorbent assay (Catalog number: EKE-051-01, Phoenix Pharmaceuticals,

Inc., Burlingame, California, USA) with an oxytocin detection range of 0 to 100 ng/mL. Mixtures of 50 μL of plasma samples, 25 μL of rehydrated primary antibody, and 25 μL of biotinylated peptide were incubated at room temperature (20°C–23°C) for 2 hours at each designated well, and the immunoplates were sealed with acetate plate sealers. The immunoplates were then washed four times with 350 μL of 1x assay buffer, and 100 μL of streptavidin horseradish peroxidase was added to each well. The immunoplates were then resealed with acetate plate sealers and incubated at room temperature for 1 hour before being washed four times with 350 μL of 1x assay buffer. Subsequently, 100 μL of 3,3',5,5'-tetramethylbenzidine was added to each well. After the immunoplates were incubated at room temperature for 1 hour, the acetate plate sealers were removed, and 100 μL of 2N HCl was added to each well to terminate the reaction. The immunoplates were then loaded onto a microtiter plate reader, and the results were read at a wavelength of 450 nm. Each plasma sample was assayed twice, and the mean of the two measurements was used for analysis, with intra- and inter-assay coefficients of variation both being less than 5%. No significant cross-reactivity or interference between oxytocin and the analogs was observed.

Covariates

Several covariates were defined in this study, including the basic demographic information of participants (e.g., age, height, body weight, education level, and marital status). Animal studies have revealed the modulation of oxytocin signaling by nicotine (Manbeck, Shelley, Schmidt, & Harris, 2014; Zanos et al., 2015); thus, cigarette smoking was also analyzed as a covariate in this study.

3.5 Statistical analysis

All data collected were first transcribed in a Microsoft Excel spreadsheet and then transferred on SPSS Statistics version 25.0 (IBM Corporation New York, USA) for coding and analysis. All data were checked to ensure the coding and entry onto the SPSS software platform were accurate. Data ranges for each variable were checked to ensure that they were within the range prescribed in the manual for each questionnaire. For the questionnaire data, missing variables were assessed, and no missing data were noted.

Descriptive statistics were applied to summarize the demographic characteristics and psychometric measurements of participants. Continuous variables are expressed as means with standard deviations, whereas categorical data are presented in numbers and percentages.

The Kolmogorov–Smirnov test was performed to determine the normal distribution of the age of participants. Levene's test was used to determine the homogeneity of variances. For the descriptive statistics, a one-way analysis of variance was used for evaluating continuous variables, and Pearson's chi-square test was used for evaluating categorical variables to compare demographic variables among the four groups. Bonferroni correction was applied in the post hoc multiple comparison analysis of demographic variables. The violence group and control group served as reference groups in distinctive models for the post hoc analysis.

Differences in outcome measurements between the four groups were examined preliminarily using the Kruskal–Wallis test. For outcome measurements with statistically significant differences, a one-way analysis of variance was performed to assess the differences between four groups. Post hoc Bonferroni correction for multiple comparisons was conducted to yield more conservative estimations and mitigate type I errors.

A bivariate Pearson correlation analysis was used to estimate the correlations between the outcome measurements, including CTQ-SF, MOAS, and plasma oxytocin levels, to prove our theory-based hypotheses. Outcome measurements were included in a mediation analysis if all the correlations were statistically significant. Age, height, body weight, education level, marital status, and cigarette smoking were accounted as covariates in the mediation analysis model. For the mediation analysis, the SPSS macro PROCESS v3.3 (model 4) was applied to analyze three significant outcome measurements.

Mediation effects were reconfirmed using a structural equation model, which was analyzed using the SPSS Amos 26.0 software program. Regression was used to calculate statistics for specific paths, and bootstrapping was used to generate a confidence interval for the mediation effects in those models. Path coefficients, denoting the connection strength of the variables, represent the response of a dependent variable to a unit change in an explanatory variable when other variables are held constant. Path coefficients are all in unstandardized form, as standardized coefficients generally have no use in substantive interpretations (Hayes, 2017). A positive path coefficient implies that a unit increase in a variable leads to a direct increase in the variable it is projected to, proportional to the size of the coefficient, and vice versa for a negative coefficient. The extent of change in a dependent variable (aggression) when one unit of the independent variable (childhood trauma) increases at the condition of an unaltered mediator variable (oxytocin) is considered to be due to the direct effect in the mediation analysis. The indirect effect is the extent to which

the dependent variable changes when the independent variable is held constant and the mediator variable changes by the amount it would have changed by had the independent variable increased by one unit. In other words, the indirect effect is the extent of mediation. The total effect is the sum, or modified combination, of the direct and indirect effects in this study. Measures of the coefficients of determination (R^2) at the model level were performed. The effect size of mediation analysis was determined through the calculation of completely standardized direct effects (c_{cs}) and indirect effects (c'_{cs}).

Bootstrapping, which is considered to be the most effective method to use with small samples and to have the lowest susceptibility to type I errors, was used to assess the stability of mediation effect (Preacher & Hayes, 2008). Bootstrapping is a nonparametric resampling procedure that does not assume a normal distribution for any variable and is the most appropriate method to obtain confidence limits for specific indirect effects under most conditions. Bootstrapping samples the distribution of the indirect effects by treating the obtained sample size as a representation of the population and then randomly resampling the sample and replacing it with the original sample by allowing any case once drawn to be thrown back to be redrawn as the new resampling of sample size. Both bias-corrected and percentile-method bootstrapping were conducted in this study with the data resampled 5,000 times. Model fit was examined using a root mean square error approximation (RMSEA) value of <0.06 in all models tested (Hu & Bentler, 1999).

The consistency of the path model and mediation effect across the four groups was assessed through multigroup analysis with pairwise tests of path coefficients. Critical ratios for differences between two parameters were calculated for the pairwise path coefficient comparison test by dividing the difference between the path coefficients by a coefficient of the standard error of the difference. One of the parameters (c-path in this study) was held constant when conducting the pairwise tests. Each off-diagonal entry in the matrix gave a statistic for testing the hypothesis that some two-model variables were equal in the population. The z-test value for the difference between the coefficients from two distinct models had to be ≥|1.96| for the difference between the paths to be significant. Statistical significance for all the tests was represented by a *p* value of below >.05.

Chapter 4 Results

4.1 Basic demographic information and characteristics of participants

A total of 178 participants (33 participants in the violence group, 37 participants in the substances group, 33 participants in the alcohol group, and 75 healthy participants without a criminal record [controls]) were enrolled. The demographic data of participants and the related characteristics are shown in Table 2. The age of participants was comparable among the four groups. Participants in the control group were taller than those in the substances group ($p < .01$) and alcohol group ($p < .001$). As shown in Figure 5, the proportion of graduates of higher education institutions was significantly lower in the violence group ($p < .001$) and substances group ($p < .001$) than in the control group, whereas proportions of primary school and middle school graduates were higher in the violence group ($p < .01$). Most of the participants in this study were single, with the highest proportion being in the violence group and lowest in the alcohol group ($p < .001$).

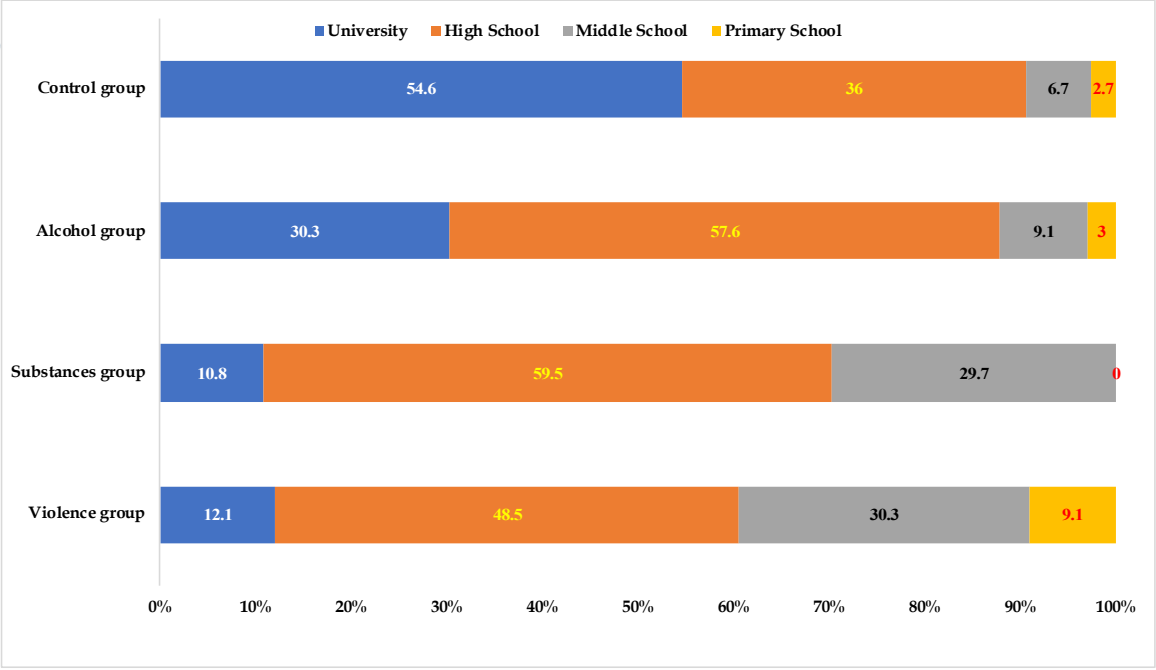


Figure 5. Differences in education level of all participants.

As expected, the prevalence of alcohol drinking was the highest in the alcohol group and the lowest in the control group ($p < .001$). The prevalence of cigarette smoking was the lowest in the control group and the highest in the violence group. Although most of the

Table 2

Demographic characteristics of all participants

	Violence group (*N*=33)	Substances group (*N*=37)	Alcohol group (*N*=33)	Control group (*N*=75)	*p*
Age (year, *M*±*SD*)	39.97±12.44	39.84±8.43	39.36±16.09	39.05±12.48	.98
Height (cm, *M*±*SD*)	170.18±7.15	168.19±6.66 ‡‡	166.70±7.21 ‡‡‡	173.15±5.75	< .001
Weight (kg, *M*±*SD*)	72.82±19.97	69.49±15.40	73.33±24.09	69.16±11.04	.55
Education (*n*, %)					< .001
University	4 (12.1) ‡‡‡	4 (10.8) ‡‡‡	10 (30.3)	41 (54.6) ***	
High School	16 (48.5)	22 (59.5)	19 (57.6)	27 (36.0)	
Middle School	10 (30.3)	11 (29.7)	3 (9.1)	5 (6.7) **	
Primary School	3 (9.1)	-	1 (3.0)	2 (2.7) **	
Marital Status (*n*, %)					< .001
Single	22 (66.6) ‡‡	23 (62.2) ‡‡	18 (54.6) ‡‡‡	48 (64.0) ***	
Cohabit	4 (12.1)	-	1 (3.0)	2 (2.7)	
Married	2 (6.1)	7 (18.9)	8 (24.2)	22 (29.3)	
Separated	2 (6.1)	-	- -	-	
Divorced	3 (9.1)	7 (18.9)	5 (15.2)	3 (4.0)	
Widow	-	-	1 (3.0)	-	
Age at index offense (year, *M*±*SD*)	29.82±11.26	33.03±11.07 ***	39.27±16.19 **	-	< .001
Length of sentences (year, *M*±*SD*)	12.85±7.95	6.09±6.47 ***	0.37±0.84 ***	-	< .001
Length of imprisonment (year, *M*±*SD*)	8.46±5.76	3.70±3.68 ***	0.20±1.13 ***	-	< .001
Alcohol drinking (*n*, %)					< .001
No drinking	11 (33.3)‡‡	18 (48.6)	4 (12.1) ‡‡‡	50 (66.7) ***	
< 1 time/week	5 (15.2)	4 (10.8)	8 (24.2)	23 (30.7)	
1-2 times/week	9 (27.3)	6 (16.2)	8 (24.2)	2 (2.7) **	
3-4 times/week	5 (15.2)	4 (10.8)	13 (39.4)	-	
5-6 times/week	-	1 (2.7)	-	-	
Almost everyday	3 (9.1)	4 (10.8)	-	-	
Overall self-rated health condition					.04
Very poor	3 (9.1)	-	-	-	
Poor	3 (9.1)	4 (10.8)	-	2 (2.7)	
Equivocal	8 (24.2)	13 (35.1)	15 (45.5)	27 (36.0)	
Good	16 (48.5)	18 (48.6)	15 (45.5)	39 (52.0)	
Very good	3 (9.1)	2 (5.4)	3 (9.1)	7 (9.3)	
Cigarette smoking (*n*, %)	26 (78.8)‡‡‡	32 (86.5) ‡‡‡	19 (57.6) ‡‡‡	6 (8.0) ***	< .001
Cigarette consumption (pack per day, *M*±*SD*)	0.64±0.52‡‡‡	0.65±0.40 ‡‡‡	0.36±0.39 ‡‡‡**	0.02±0.09 ***	< .001

*$p < .05$, **$p < .01$, ***$p < .001$ in post-hoc analysis using violence group as reference

‡$p < .05$, ‡‡$p < .01$, ‡‡‡$p < .001$ in post-hoc analysis using control group as reference

participants self-reported satisfaction with their health condition, significant group differences were noted in such ratings ($p < .05$), with a higher proportion of participants in violence group rating their health condition as poor.

Age at the index offense among those participants with criminal convictions, participants in the violence group were younger than those in the substances group, followed by those in the alcohol group ($p < .001$). Reflected by their criminal offenses, participants in the violence group had longer sentences and terms of imprisonment than those in the substances and alcohol groups ($p < .001$).

4.2 Childhood trauma, aggression, impulsivity, and mental disorders

4.2.1 Childhood trauma

The prevalence of childhood trauma among all participants is shown in Table 3. For the CTQ, the total scores among all offenders were higher than those of participants in the control group, with participants in the violence group having the highest scores ($p < .001$). Participants in the violence group surpassed all participants in terms of the prevalence of physical abuse ($p < .01$), emotional abuse ($p < .05$), and physical neglect ($p < .001$). Participants in the alcohol group had the highest scores for emotional neglect ($p < .01$) whereas participants in the substances group had the highest scores for sexual abuse, although the differences in their scores for sexual abuse did not reach significance ($p = .26$). Types of childhood trauma in participants of different groups are illustrated in Figure 6.

The violence group had the highest proportion of participants who screened positive for all types of childhood trauma, including physical abuse, emotional abuse, sexual abuse, physical neglect, and emotional neglect, among the four groups. The proportion of participants in the violence group classified as positive for a history of physical abuse was higher than in the control group ($p < .01$). Surprisingly, the majority of the participants in the four groups experienced physical neglect, with the highest proportion in the violence group and the lowest in the control group ($p < .01$). Almost 90% of the offenders were classified as having at least one type of childhood trauma ($p < .01$). The prevalence of major childhood trauma in the violence group was among the highest among all groups ($p < .01$). Notably, the mean number of trauma types was higher in the violence group than in the control group ($p < .001$).

Table 3

Prevalence of childhood trauma of all participants

	Violence group (*N*=33)	Substances group (*N*=37)	Alcohol group (*N*=33)	Control group (*N*=75)	*p*
CTQ-SF (*M*±*SD*)					
Total scores	58.85±14.67 ‡‡	57.89±18.61 ‡‡	56.97±16.46 ‡‡	46.87±9.89 **	< .001
Physical abuse	9.15±4.54 ‡‡	8.42±5.08	7.52±4.44	6.52±2.18 **	< .01
Emotional abuse	8.79±3.81	8.75±5.02	8.45±3.98	6.92±2.19	.02
Sexual abuse	6.12±2.43	6.22±3.04	5.94±2.19	5.48±1.13	.26
Physical neglect	13.91±2.71 ‡‡‡	13.28±3.01 ‡‡‡	13.58±2.97 ‡‡‡	11.16±2.06 ***	< .001
Emotional neglect	12.15±4.50 ‡	12.19±5.02 ‡	12.52±5.42 ‡‡	9.37±3.06 *	< .01
Positive for trauma (*n*, %)					
Physical abuse	13 (39.4) ‡‡	9 (25.0)	5 (15.2)	6 (8.0) **	< .01
Emotional abuse	6 (18.2)	6 (16.7)	3 (9.1)	2 (2.7)	.03
Sexual abuse	5 (15.2)	5 (13.9)	4 (12.1)	7 (9.3)	.82
Physical neglect	32 (97.0) ‡‡	31 (86.1)	30 (91.0)	54 (72.0) **	< .01
Emotional neglect	13 (39.4) ‡	10 (27.8)	10 (30.3)	9 (12.0) *	.01
≥1 type of trauma	32 (97.0) ‡‡	33 (89.2) ‡	30 (90.9)	55 (73.3) ***	< .01
≥1 type of major trauma	16 (48.5)	12 (32.4)	6 (18.2)	11 (14.7) **	< .01
Number of trauma types (*M*±*SD*)	2.09±1.71 ‡‡‡	1.69±1.70 ‡	1.58±1.44	1.04±0.88 ***	< .001

*$p < .05$, **$p < .01$, ***$p < .001$ in post-hoc analysis using violence group as reference

‡$p < .05$, ‡‡$p < .01$, ‡‡‡$p < .001$ in post-hoc analysis using control group as reference

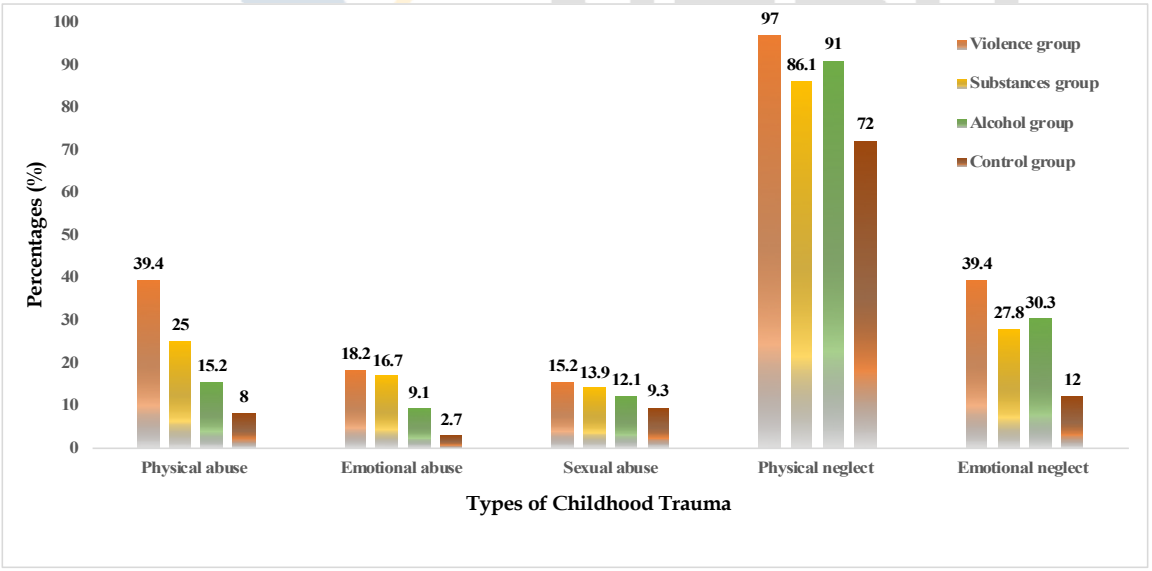


Figure 6. Types of childhood trauma in participants of different groups.

4.2.2 Aggression

The aggression scores of participants are shown in Table 4. The violence group had the highest total scores among all groups for a history of incidents of aggression (measured by the MOAS; $p < .001$). Participants in the violence group had more incidents of physical aggression ($p < .001$), verbal aggression ($p < .001$), aggression against objects ($p < .001$), and auto-aggression ($p < .05$) than other groups.

The scores of participants regarding aggression characteristics corresponded to their aggression incidents. In the measure of aggression characteristics, which was assessed using the BPAQ, differences between the four groups were noted in total scores ($p < .05$), physical aggression ($p < .001$), anger ($p < .05$), and hostility ($p < .05$). The violence group had the highest scores in all dimensions of aggression characteristics. Compared with controls, participants in the violence group tended to be more easily angered ($p < .05$), more hostile ($p < .05$), and have more physically aggressive ($p < .001$) behaviors.

Table 4

Aggression and impulsivity measures of all participants

	Violence group (*N*=33)	Substances group (*N*=37)	Alcohol group (*N*=33)	Control group (*N*=75)	*p*
MOAS (*M*±*SD*)					
Total scores	28.61±7.63 ‡‡‡	15.11±13.53 ‡***	11.52±12.22 ***	8.75±8.85 ***	< .001
Physical aggression	4.00±0.00 ‡‡‡	1.97±1.66 ‡‡***	1.09±1.49 ***	1.03±1.24 ***	< .001
Verbal aggression	3.00±1.12 ‡‡‡	2.00±1.60 ‡*	1.30±1.47 ***	1.15±1.20 ***	< .001
Aggression against object	2.39±1.50 ‡‡‡	1.11±1.56 **	1.15±1.46 **	0.91±1.15 ***	< .001
Auto-aggression	1.39±1.68 ‡	1.00±1.70	1.18±1.61	0.56±0.99 *	.02
BPAQ (*M*±*SD*)					
Total scores	74.18±22.52 ‡	62.24±17.59 *	61.97±20.11 *	62.27±15.08 *	.01
Physical aggression	24.27±7.65 ‡‡‡	20.24±7.38	17.06±7.09 ***	16.84±5.19 ***	< .001
Verbal aggression	12.12±4.23	10.57±3.28	11.15±3.44	11.51±3.40	.31
Anger	18.52±5.77 ‡	16.54±5.04	16.15±5.26	15.48±4.62 *	.04
Hostility	19.39±7.25	14.89±6.01 ‡	17.61±7.24	18.44±5.95 *	.02
BIS (*M*±*SD*)					
Total scores	65.48±8.34 ‡	69.54±10.53 ‡‡	65.15±8.34	60.53±8.34 *	< .001
Attentional	17.42±2.97	17.81±3.64	17.18±3.40	16.67±2.76	.31
Motor	22.21±3.66	24.94±5.14 ‡‡‡*	23.15±3.10	21.48±3.39	< .001
Nonplanning	25.85±4.84 ‡‡	27.19±4.39 ‡‡‡	24.82±4.16 ‡	22.39±4.10 **	< .001

*$p < .05$, **$p < .01$, ***$p < .001$ in post-hoc analysis using violence group as reference

‡$p < .05$, ‡‡$p < .01$, ‡‡‡$p < .001$ in post-hoc analysis using control group as reference

4.2.3 Impulsivity

Table 4 shows the impulsivity measures of participants. Participants in the violence group were more impulsive than those in the control group ($p < .05$). The substances group had the highest scores of impulsivity among all groups ($p < .001$). Group differences in second-order factors of impulsivity, including motor impulsivity ($p < .001$) and nonplanning ($p < .001$), were statistically significant.

4.2.4 Depression and anxiety

Participants in the alcohol group had the highest BDI scores of all participants ($p < .01$). Compared with other offenders, participants in the violence group had lower depression scores than those in the substances group or alcohol group, although the differences were not statistically significant. However, compared with the control group, participants in the violence group tended to have a greater sense of punishment ($p < .01$) and lower libido ($p < .01$). No difference in anxiety among all four groups of participants was noted, apart from the higher prevalence of hand tremor ($p < .05$) and trembling ($p < .01$) in participants in the substances group compared with controls. The results of the depression and anxiety measures are shown in Table 5.

Table 5

Depression and anxiety measures of all participants

	Violence group (*N*=33)	Substances group (*N*=37)	Alcohol group (*N*=33)	Control group (*N*=75)	*p*
BDI (*M*±*SD*)					
Total scores	9.15±7.08	11.81±10.56 ‡	12.12±8.41 ‡‡	6.93±5.31	< .01
Sadness	0.27±0.57	0.76±1.01	1.09±1.18 ‡‡**	0.41±0.64	< .001
Sense of punishment	1.18±1.21 ‡‡	1.35±1.25 ‡‡‡	0.76±0.94	0.44±0.81 **	< .001
Suicidal thoughts	0.21±0.48	0.32±0.67	0.45±0.67 ‡‡	0.11±0.31	< .01
Crying spells	0.64±1.24	0.97±1.34 ‡‡	0.67±1.02	0.21±0.72	< .01
Irritability	0.12±0.49	0.19±0.57	0.61±0.86	0.23±0.56 ‡*	< .01
Anorexia	0.39±0.56	0.46±0.77 ‡	0.39±0.56	0.16±0.37	.02
Hypochondriasis	0.21±0.55	0.70±1.00 ‡*	0.42±0.61	0.31±0.55	.01
Decreased libido	0.79±0.96 ‡‡	0.59±0.87	0.88±0.93‡‡	0.24±0.59 *	< .001
BAI (*M*±*SD*)					
Total scores	6.15±8.57	7.49±8.52	7.39±5.83	6.12±5.78	.68
Hand tremor	0.18±0.47	0.53±0.91 ‡	0.30±0.59	0.16±0.44	.02
Trembling	0.18±0.47	0.22±0.49 ‡‡	0.03±0.17	0.01±0.12	< .01

*$p < .05$, **$p < .01$, ***$p < .001$ in post-hoc analysis using violence group as reference

‡$p < .05$, ‡‡$p < .01$, ‡‡‡$p < .001$ in post-hoc analysis using control group as reference

4.3 Plasma oxytocin levels

The distribution of the plasma oxytocin levels of participants is shown in Figure 7. Overall, plasma oxytocin levels were not correlated with age ($r(176) = -0.96$, $p = .20$). Participants in the violence group had the lowest levels of plasma oxytocin, whereas those in the control group had the highest. The mean plasma oxytocin levels of the four groups are presented in Table 6.

Table 6

Plasma oxytocin level of all participants

	Violence group (*N*=33)	Substances group (*N*=37)	Alcohol group (*N*=33)	Control group (*N*=75)	*p*
M±*SD*	10.74±4.19 ‡‡‡	12.76±4.64	13.77±4.72	15.49±6.00 ***	< .001
95% CIs	[9.250, 12.220]	[11.217, 14.313]	[12.096, 15.448]	[14.108, 16.870]	

*$p < .05$, **$p < .01$, ***$p < .001$ in post-hoc analysis using violence group as reference

‡$p < .05$, ‡‡$p < .01$, ‡‡‡$p < .001$ in post-hoc analysis using control group as reference

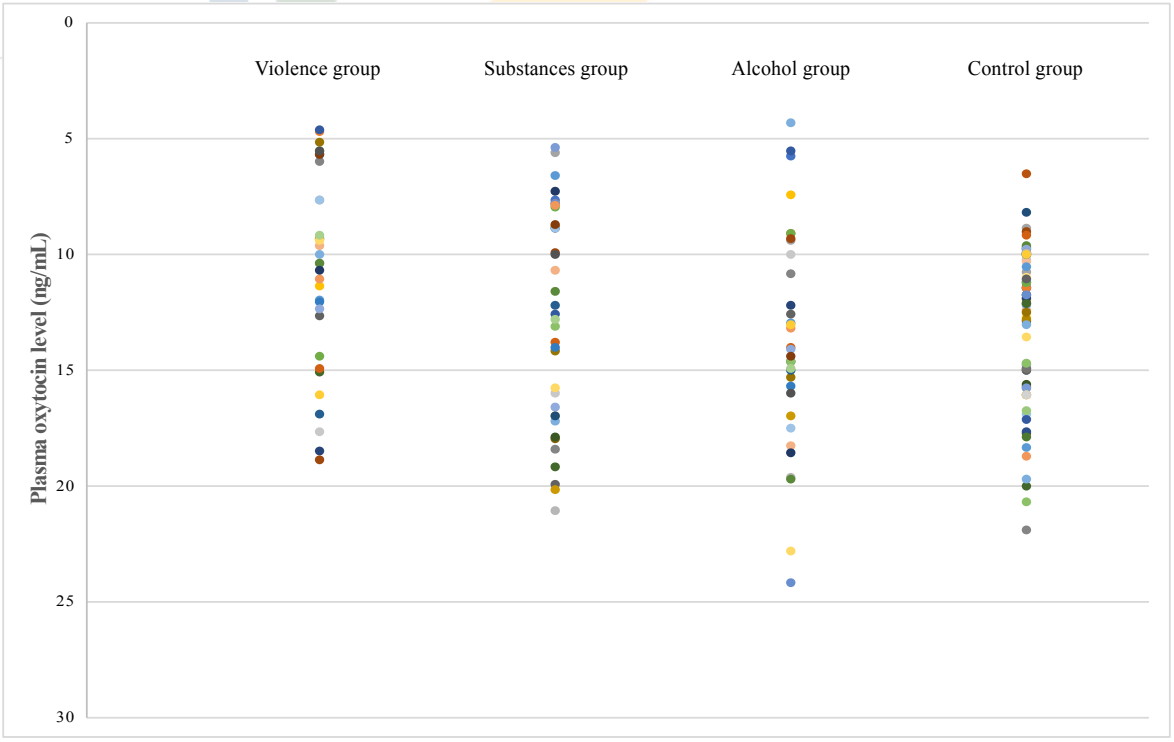


Figure 7. Plasma oxytocin levels in participants of different groups

4.4 Interaction between variables in a zero-order correlation

It has been hypothesized that childhood trauma indirectly influences aggression through the causally linked mediator of plasma oxytocin level. Hence, in the zero-order analysis, correlations between the childhood trauma, aggression, and plasma oxytocin levels of all participants were determined using Pearson's correlation. The interactions of proposed variables are summarized in Table 7.

Table 7

Bivariate Pearson correlations of childhood trauma, aggression, and plasma oxytocin

	Childhood trauma x Aggression		Childhood trauma x Plasma oxytocin		Plasma oxytocin X Aggression	
	r	*p*	*r*	*p*	*r*	*p*
All	.57	< .001	−.36	< .001	−.35	< .001
Violence group	.48	< .01	−.45	< .01	−.61	< .001
Substances group	.59	< .001	−.37	.02	−.37	.03
Alcohol group	.55	< .01	−.51	< .01	−.50	< .01
Control group	.49	< .001	−.30	.01	−.01	.94

4.4.1 Association between childhood trauma and aggression

Childhood trauma, which was measured using the CTQ, was significantly associated with aggression, which was measured using the MOAS ($r(176) = .57$, $p < .001$). The positive association between these two variables remained significant among the four groups, as shown in Table 7.

4.4.2 Association between childhood trauma and plasma oxytocin level

Plasma oxytocin levels were inversely correlated with childhood trauma in all participants ($r(176) = -.36$, $p < .001$). In the analysis of all subgroups, the correlation between plasma oxytocin level and childhood trauma remained significant, as shown in Table 7.

4.4.3 Association of plasma oxytocin levels and aggression

Aggression was inversely associated with plasma oxytocin levels in all participants ($r(176) = -.35$, $p < .001$) as well as participants subcategorized into

different groups generally, except for those in the control group. As summarized in Table 7, the correlation between plasma oxytocin and aggression was nonsignificant in participants of the control group ($r(73) = -.01$, $p = .94$).

4.5 Mediation analysis

4.5.1 All participants

The relationship between childhood trauma and aggression was mediated by plasma oxytocin levels. As illustrated Figure 8 and Table 8, the regression coefficients between childhood trauma and plasma oxytocin levels as well as those between plasma oxytocin levels and aggression were statistically significant. Age was tested as a covariate in the mediation analysis, and no statistically significant contribution was observed for that model ($\beta = -.10$, $t(175) = -1.27$, $p = .21$). As shown in Table 9, all other covariates that were proposed in this study, including height, body weight, education level, marital status, and cigarette smoking, did not interfere with the regression coefficients in the mediational model. An outlier analysis was performed to remove extreme values that deviated from other observations on childhood trauma scores, but no significant difference from the overall mediation analysis results was observed. The significance of the indirect effect was tested using bootstrapping procedures. Unstandardized indirect effects were computed for each of the 5,000 bootstrapped samples, and the 95% confidence interval was computed by determining the indirect effects at the 2.5th and 97.5th percentiles. The bootstrapped unstandardized indirect effect was statistically significant ($\beta = .05$, $SE = .02$, 95% CIs [.01, .10]). Hence, plasma oxytocin levels partially mediated the effect of childhood trauma on aggression.

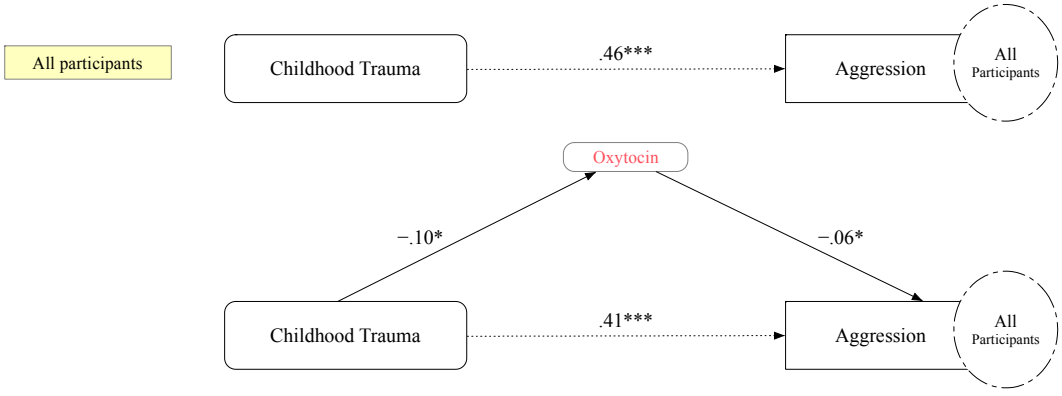


Figure 8. Path diagram illustrates the regression coefficients of the relationship between childhood trauma and aggression as partially mediated by plasma oxytocin level in all participants.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$, RMSEA = 0.04

Table 8

Mediational analysis of plasma oxytocin level

	β	95% CIs	*SE*	*t*	*p*
All participants					
CTQ-SF → Oxytocin	−.10	[−.13, −.06]	.02	−5.05	< .001
Oxytocin → MOAS	−.51	[−.90, −.12]	.20	−2.57	.01
Total effect	.46	[.36, .56]	.05	9.08	< .001
Direct effect	.41	[.31, .52]	.05	7.71	< .001
Indirect effect	.05	[.01, .10]	.02		
Effect size				c_{cs} = .35, c'_{cs} = .35	
Model summary				R^2 = .32, F = 82.44, p < .001	
Violence group					
CTQ-SF → Oxytocin	−.13	[−.22, −.03]	.05	−2.79	< .01
Oxytocin → MOAS	−1.01	[−1.65, −.37]	.31	−3.24	< .01
Total effect	.28	[.09, .47]	.09	3.07	< .01
Direct effect	.15	[−.03, .33]	.09	1.69	.10
Indirect effect	.13	[.02, .25]	.06		
Effect size				c_{cs} = .48, c'_{cs} = .26	
Model summary				R^2 = .23, F = 9.43, p < .01	
Substances group					
CTQ-SF → Oxytocin	−.09	[−.17, −.01]	.04	−2.39	.02
Oxytocin → MOAS	−.46	[−1.26, .35]	.40	−1.16	.26
Total effect	.40	[.21, .58]	.09	4.30	< .001
Direct effect	.35	[.15, .55]	.10	3.57	< .01
Indirect effect	.04	[−.02, .15]	.04		
Effect size				c_{cs} = .32, c'_{cs} = .33	
Model summary				R^2 = .35, F = 18.45, p < .001	
Alcohol group					
CTQ-SF → Oxytocin	−.15	[−.24, −.06]	.04	−3.33	< .01
Oxytocin → MOAS	−.86	[−1.85, .13]	.48	−1.77	.09
Total effect	.46	[.20, .71]	.12	3.68	< .01
Direct effect	.33	[.04, .61]	.14	2.36	.03
Indirect effect	.13	[−.01, .36]	.09		
Effect size				c_{cs} = .31, c'_{cs} = .30	
Model summary				R^2 = .30, F = 13.56, p < .001	
Control group					
CTQ-SF → Oxytocin	−.10	[−.17, −.02]	.04	−2.64	.01
Oxytocin → MOAS	.41	[−.17, 1.00]	.29	1.42	.16
Total effect	.45	[.26, .63]	.09	4.84	< .001
Direct effect	.49	[.30, .68]	.10	5.08	< .001
Indirect effect	−.04	[−.10, .02]			
Effect size				c_{cs} = .06, c'_{cs} = .06	
Model summary				R^2 = .24, F = 23.46, p < .001	

Table 9

Covariates in mediational analysis of plasma oxytocin level

	β	95% CIs	*SE*	*t*	*p*
All participants					
Age	−.10	[−.25, .06]	0.08	−1.27	.21
Height	−.00	[−.28, .27]	0.14	−.03	.98
Weight	−.07	[−.05, .18]	0.06	1.11	.27
Education level	−.77	[−.20, 1.73]	0.49	1.57	.12
Marital status	−.17	[−1.25, .91]	0.55	−.31	.76
Cigarette smoking amount	−2.49	[−4.77, 9.75]	3.68	.68	.50

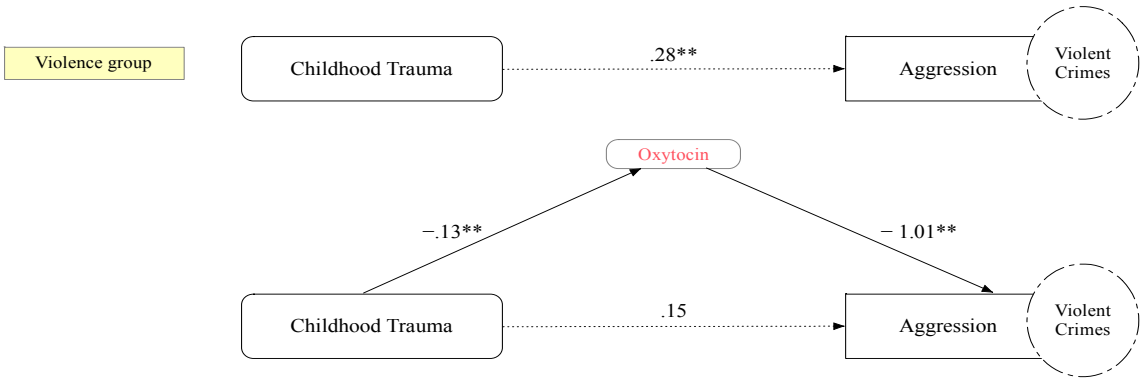
4.5.2 Participants in different groups

A mediation analysis was further performed for the four groups of participants. The overall mediation analysis of plasma oxytocin levels is illustrated in Figure 9 and summarized in Table 8.

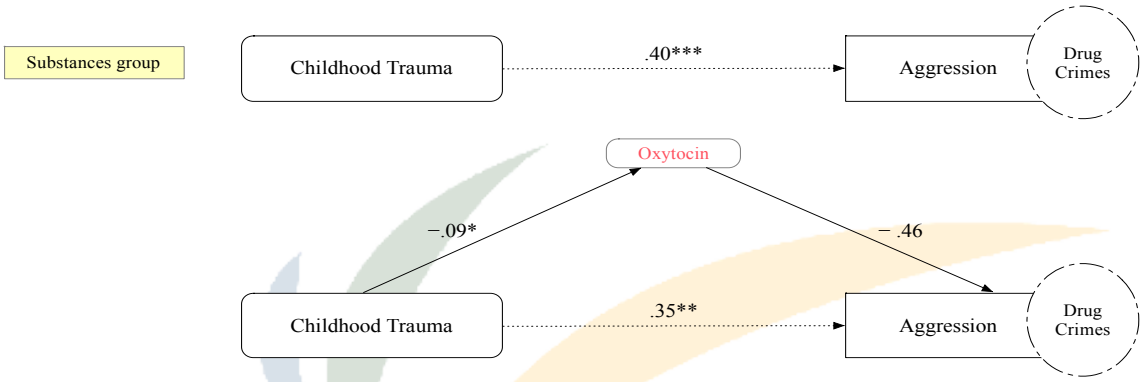
For participants in the violence group, the regression coefficient between childhood trauma and plasma oxytocin levels was statistically significant, as was the regression coefficient between plasma oxytocin levels and aggression. The bootstrapped unstandardized indirect effect was nonsignificant (β = .13, *SE* = .06, 95% CIs [.02, .25]). The effect of childhood trauma on aggression was fully mediated by plasma oxytocin levels among participants in violence group.

Prediction of lower plasma oxytocin levels by childhood trauma experiences was proved by the negative regression coefficient observed in participants of the substances group (β = −.09, $t(35) = -2.39$, $p < .05$). However, the contribution of plasma oxytocin levels to aggression was unable to be demonstrated (β = −.46, $t(34) = -1.16$, $p = .26$). Similar results were observed among participants of the alcohol and control groups. No mediation effect of plasma oxytocin levels on childhood trauma to aggression was observed among participants of the three groups.

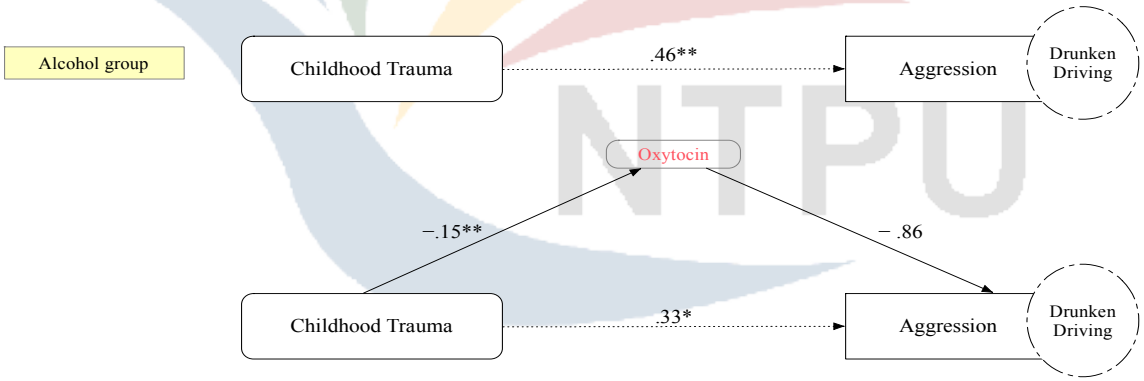
(A) Violence group



(B) Substances group



(C) Alcohol group



(D) Control group

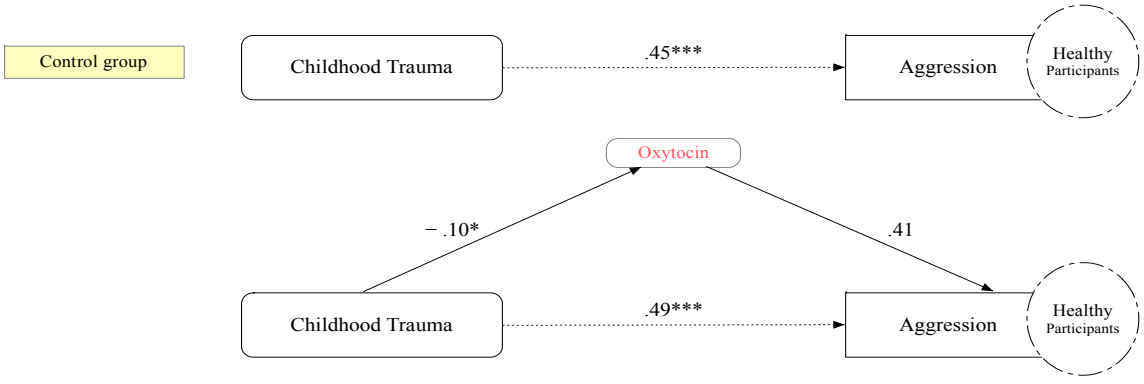


Figure 9. Path diagrams illustrate the regression coefficients of mediational models in participants of (A) violence group, (B) substances group, (C) alcohol group, and (D) control group.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

4.5.3 Bootstrapping

Bootstrapping was conducted to confirm the mediation effect of plasma oxytocin levels. The bootstrapping procedure indicated that the parameters estimated were stable in both the bias-corrected and percentile methods. The bootstrap results are summarized in Table 10.

Table 10

Bootstrap results for regression model parameters

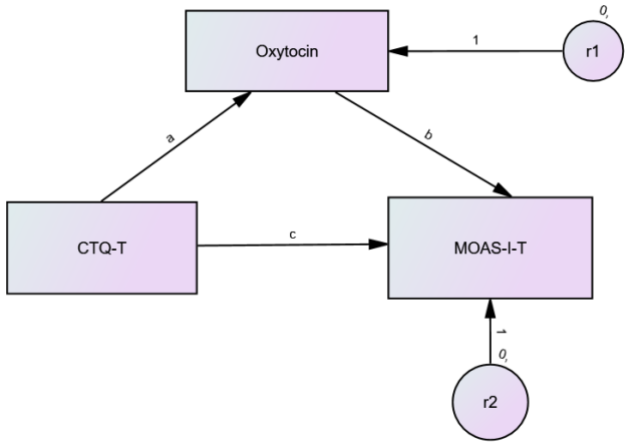
	Estimated	Bias-corrected 95% CIs		Percentile method 95% CIs	
		Lower	*Upper*	*Lower*	*Upper*
All participants					
CTQ-SF → Oxytocin	−.10	−.12	−.07	−.13	−.07
Oxytocin → MOAS	−.51	−.90	−.07	−.91	−.08
CTQ-SF → MOAS	.41	.32	.52	.32	.53
Indirect effect	.05	.01	.10	.01	.10
Violence group					
CTQ-SF → Oxytocin	−.13	−.13	−.20	−.20	−.05
Oxytocin → MOAS	−1.01	−1.68	−.10	−1.71	−.17
CTQ-SF → MOAS	.15	.04	.31	.04	.30
Indirect effect	.13	.03	.26	.02	.25
Substances group					
CTQ-SF → Oxytocin	−.09	−.16	−.03	−.16	−.02
Oxytocin → MOAS	−.46	−1.21	.21	−1.21	.21
CTQ-SF → MOAS	.35	.18	.57	.18	.58
Indirect effect	.04	−.01	.17	−.02	.16
Alcohol group					
CTQ-SF → Oxytocin	−.15	−.20	−.09	−.20	−.09
Oxytocin → MOAS	−.86	−2.10	.18	−2.25	.09
CTQ-SF → MOAS	.46	.07	.60	.06	.59
Indirect effect	.13	−.01	.36	−.01	.36
Control group					
CTQ-SF → Oxytocin	−.10	−.16	−.04	−.16	−.03
Oxytocin → MOAS	.41	−.26	1.02	−.24	1.04
CTQ-SF → MOAS	.45	.27	.69	.28	.70
Indirect effect	−.04	−.11	.02	−.10	.03

4.5.4 Critical ratios for differences between variables

It is crucial to understand whether the mediation model holds across levels of a moderator, where the levels of moderators represent distinct, mutually exclusive, and independent groups. A multigroup analysis with pairwise tests of path coefficients was performed to test the mediation model across the four groups in terms of plasma oxytocin levels. Critical ratios for differences between variables are shown in Table 11. Each off-diagonal entry in the matrix provided a statistic for testing the hypothesis that some two-model variables were comparable in the population.

Table 11

Critical ratios for differences between parameters



			Violence group		Substances group		Alcohol group		Control group		Fixed
			a1	b1	a2	b2	a3	b3	a4	b4	c
Group	Violence	a1	0								
		b1	−2.04	0							
	Substances	a2	.58	2.16	0						
		b2	−1.02	.52	−1.11	0					
	Alcohol	a3	−.31	1.98	−.93	.96	0				
		b3	−1.79	−.26	−1.87	−.68	−1.74	0			
	Control	a4	.54	2.16	−.06	1.11	.90	.94	0		
		b4	1.37	2.50	1.25	1.69	1.43	1.81	1.26	0	
Fixed		c	6.67	3.70	−6.57	−2.31	−7.07	−2.95	−6.74	.20	0

As aforementioned, the z-test value for the difference between coefficients from two distinct models must be ≥|1.96| for the difference between paths to be statistically significant at $p < .05$. In the cross-group comparisons, the path coefficients of childhood

trauma predicting plasma oxytocin levels (*a path*) were not significantly different from one another among the four groups. However, the path coefficients of plasma oxytocin levels predicting aggression (*b path*) demonstrated significant differences between the control and violence group. In other words, the paths were not equal across the control and violence groups.

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Chapter 5 Conclusion

5.1 Discussion

The results indicate that traumatic experiences in childhood have negative consequences, and that these consequences persist in adulthood. Overall, self-report childhood trauma scores were higher in all offender groups than among controls without criminal convictions. This finding is comparable with those of previous studies: individuals with experiences of childhood trauma have a higher risk of engaging in problematic behaviors, such as heavy drinking, delinquency, violence, and crime (Kessler et al., 2010; Widom, 1989). In particular, violent offenders had highest prevalence of physical abuse during childhood among all participants in this study. This finding is consistent with those of studies that have emphasized the high prevalence of adverse childhood experiences among violent offenders (Craparo et al., 2013; Fox, Perez, Cass, Baglivio, & Epps, 2015). In addition, the violent offenders in this study had a lower education level, were more likely to be single, and were more dissatisfied with their health condition than other groups. This partly highlights the dire consequences of childhood trauma in terms of the catastrophic effects on those who experienced it and for society as a whole.

Conventional social learning theory posits that victims of physical abuse often resort to violence to in an attempt to resolve conflicts (Widom, 2017). In the model used in this study to explain the cycle of violence, several theories were introduced that claim that violence is unlearned rather than learned. The disruption of social bonds that is deemed necessary for prosocial behavior, as explained by social control theory, and the inability to escape painful childhood trauma experiences, as explained in general strain theory, were illustrated through social experiences that could possibly temper or reduce the violence inherent in human nature. Self-control, which evolved from attentional mechanisms and symbolization, is severely affected by insecure attachment, which again results from childhood trauma (Breidenstine et al., 2011). Childhood trauma increased the risk of a person committing a crime by through the promotion of antisocial behavior during childhood and adolescence. Insecure attachment was further explained through the formation of violent behavior among people who had experiences of trauma during childhood trauma.

Despite the widespread prevalence of childhood trauma, less is known about its biological inferences. Humans are irrevocably shaped by their developmental environment

through the biological imprinting of early experiences (Fonzo, 2019). Although a history of childhood trauma appears to contribute to the use of violence, few studies have explored the nature of this relationship and its association with hormonal changes. The current study discussed the possible interaction between oxytocin level and childhood trauma and the correlation with aggression. A positive correlation between childhood trauma and aggression was demonstrated, whereas plasma oxytocin levels were inversely correlated with childhood trauma and aggression. Reduced endogenous oxytocin levels in people with experiences of childhood trauma were also observed in previous meta-analyses, supporting the hypothesis that early adversity persistently alters oxytocin production and release in adulthood (Donadon, Martin-Santos, & Osório, 2018).

The role of oxytocin in the mediation model is notable. The mediation analysis in this study demonstrated that those with higher childhood trauma scores had lower plasma oxytocin levels, which may have led to them having higher aggression levels. Oxytocin is involved in the regulation of the body's response to stress (Kubzansky, Mendes, Appleton, Block, & Adler, 2012); in addition, it affects social memory, emotional recognition, empathy, and attachment. Oxytocin lowers hypothalamus–pituitary–adrenal activity and cortisol levels. Cortisol increases the plasma oxytocin level; this results as a negative feedback system where stress increases the cortisol level, which in turn increases the oxytocin level, resulting in subsequent decreases in the cortisol level (Chambers, 2017). Secure attachment is correlated with higher oxytocin levels and decreased subjective stress during a highly stressful situation (Pierrehumbert, Torrisi, Ansermet, Borghini, & Halfon, 2012). Studies have shown that attachment can be severely affected by childhood trauma experiences (Breidenstine et al., 2011). The proposed hypothesis posited that disruption in secure attachment formation is mediated by oxytocin's facilitation of trust, empathy, and prosocial behavior (Insel & Young, 2001). Traumatized children, who have lower oxytocin levels than other children, have difficulties in developing a sense of security and have further impairments in seeking out new attachment figures when they perceive a threat from those closest to them. In one study, the fight-or-fight response increased activation of the amygdala in participants with low oxytocin levels, implicated by them having a lack of trust (Buchheim et al., 2009) in children who had experienced trauma, which further contributed to insecure attachment formation among these respondents. Activation of the insecure attachment mechanism leads to chaotic interpersonal relations and externalizing behavior, especially aggressive behavior (Fearon et al., 2010). It is possible that insecurely attached individuals who have experienced trauma do not have a normally functioning oxytocin

inhibition process, allowing stress responses to escalate to unproportionally high levels (Chambers, 2017). This phenomenon may also be caused by a failure to exhibit high oxytocin receptor levels in the amygdala among children with experiences of trauma. Supplementation of exogenous oxytocin has been shown to attenuate the amygdala's response to social stress and fear (Domes et al., 2007). Exogenous oxytocin induces a momentary state of mind change in which individuals classified as having insecure attachment experience attachment security (Buchheim et al., 2009) by reducing feelings of fear (Heinrichs, von Dawans, & Domes, 2009), thus altering the brain's cognitive–emotional schemas and resulting in changes in such individuals from perceiving others as untrustworthy to more trustworthy (Bartz, Zaki, Bolger, & Ochsner, 2011). This process also activates the neural circuits of the inferior frontal gyrus and ventromedial prefrontal cortex, which are associated with empathy (Riem et al., 2011; Shamay-Tsoory, 2010). Reduced amygdala activation under the influence of oxytocin has been shown to reduce amygdala danger signaling and is linked to the promotion of trust, an increase in sociability, and a decrease in social fear (Kirsch et al., 2005).

In this study, the effect of childhood trauma on aggression was partially mediated by plasma oxytocin levels in all participants; however, plasma oxytocin levels had a full mediation effect on participants in the violence group. The mediation effect of plasma oxytocin on the relationship between childhood trauma and aggression could not be verified among participants in the substances, alcohol, and control groups. Childhood trauma was significantly associated with increased aggression levels and was inversely correlated with plasma oxytocin levels in all four groups. In the cross-group comparisons, the path coefficients of plasma oxytocin levels predicting aggression were significantly different between the control and violence group. The main differences in the mediation analysis were those between the violence and control group. The partial mediation model for plasma oxytocin levels among participants of the control group had hidden factors that contributed to or prevented the occurrence of aggressive behaviors. In other words, the proposed hypothesis regarding the interaction of oxytocin level and the attachment of individuals with childhood trauma experiences did not fully explain the study results.

The concept of resilience was introduced to explain the discrepancy between different sequela faced by individuals with childhood trauma experiences. The timing of childhood trauma exposure may result in different developmental sequalae (Teicher et al., 2016). Earlier exposure to maltreatment was associated with a blunted amygdala response,

reducing the sensitivity to fight-or-flight reactions that promote survival (Zhu et al., 2019). Failure to establish an adaptational, strong amygdala response may be correlated with a reduced oxytocin level and a failure to centrally upregulate oxytocin receptors. Numerous of studies have focused on the adaptive coping styles and personal attributes, such as ego strength, tenacity, self-efficacy, and cognitive flexibility related to resilience that appear to mitigate negative sequalae in response to childhood trauma (Feder, Nestler, & Charney, 2009; McGloin & Widom, 2001). In addition to coping styles and personal attributes, resilience can be predicted by a gene × environment interaction with childhood trauma. In one study, only individuals surrounded by a positive family environment during childhood were found to have increased resilience in adulthood (Bradley, Davis, Wingo, Mercer, & Ressler, 2013), probably caused by a heightened sense of belonging (Torgerson et al., 2018). Although they had lower resilient functioning than those without childhood trauma, traumatized children nonetheless strived to be resilient. A strong moderating effect from having a positive social environment was identified in adults with a specific allele of the oxytocin receptor gene OXTR who had been exposed to early childhood trauma (De Bellis & Zisk, 2014). Childhood trauma has been shown to consistently exert strong and adverse effects on the resilience of those who experienced it, indicating that the path to aggression was mediated by oxytocin in this study.

5.2 Limitations

The findings of this study should be interpreted in light of several limitations. First, the validity and reliability of the retrospective self-reporting of childhood trauma are debatable due to the possibility of recall bias, the underreporting of which may lead to substantial measurement errors (Baldwin et al., 2019). Simple forgetting, nonawareness, and nondisclosure (Heim et al., 2008b) may reduce the credibility of retrospective self-reports of childhood trauma; however, studies have shown that false negatives are more frequent than false positives in such research (Hardt & Rutter, 2004), leading to downward biases in the estimation of association with other variables. Retrospective reports of childhood trauma are still valuable for examining its association with adulthood adversities, such as psychiatric problems (Newbury et al., 2018). In this study, participants were asked to provide in-depth clarification about their experiences of childhood trauma during the interviews for cross-validation to minimize the aforementioned reporting biases. A prospective study design with follow-up from baseline childhood trauma experiences and oxytocin level changes is necessary to confirm the correlations between these factors.

Standardized quantification measurements for validating aggression measurements are lacking. The quantification of aggression remains difficult in human participants. Both the MOAS, which measures the incidence of aggressive behaviors, and the BPAQ, which measures an individual's aggression-related traits, were used in this study to increase the consistency in measuring aggressive behaviors among participants.

Oxytocin is determined by not only childhood trauma but also other stressful events (Emeny et al., 2015), inflammation (Carnio, Moreto, Giusti-Paiva, & Antunes-Rodrigues, 2006), nicotine use (Zanos et al., 2015), and the hypothalamus–pituitary–adrenal axis (Cox et al., 2015). In interpreting the positive correlation between childhood trauma and plasma oxytocin levels, these unmeasured factors should be taken into account.

Using the peripheral plasma oxytocin level as a surrogate for central oxytocin function may raise questions about the accuracy of oxytocin measurement and its implications. The plasma oxytocin level may also be affected by peripheral organs such as the heart, gastrointestinal tract, and reproductive organs (Leng & Ludwig, 2016). The validity of using the plasma oxytocin level as a proxy for central oxytocin remains unconfirmed. However, a positive association exists between central and peripheral oxytocin levels (Valstad et al., 2017).

The plasma oxytocin levels of participants in this study were only measured once. It is difficult to collect blood samples across several days or at different times of the day in a population of offenders on parole. Although studies have shown that oxytocin has a stable trajectory across the day, individual differences were observed in early morning oxytocin levels but not in the overall pattern of change throughout the day (Fragkaki, Verhagen, van Herwaarden, & Cima, 2019).

The oxytocin concentration was assumed to be stable throughout the period of adulthood until old age. The stability of the oxytocin concentration with age remains controversial. In vitro, oxytocin was found to be an age-specific circulating hormone (Elabd et al., 2014), as oxytocin levels in the cerebrospinal fluid were positively correlated with adult female age and negatively correlated with infant age of rhesus macaques (Parker, Hoffman, Hyde, Cummings, & Maestripieri, 2010). However, this correlation has not been replicated in male animals. The age-related pattern of the oxytocin concentration is

influenced by reproductive status. Furthermore, plasma oxytocin levels are significantly higher in women than in men (Marazziti et al., 2019). Therefore, the enrollment of participants in this study was limited to men who did not undergo hormone therapy to avoid the confounding effects of gender on the findings. This designed restriction means that the results cannot be generalized to women.

Finally, given the study's cross-sectional design, this study failed to isolate the effects of timing of trauma exposure. This is an unresolvable obstacle, as obtaining self-reports prospectively from young children is ethically inappropriate. As with most cross-sectional studies, a causal relationship cannot be determined unless assumptions are made. After careful modification and validation through statistical analysis, with the assumption that the oxytocin concentration remained relatively stable across adulthood, this study attempted to determine a path between childhood trauma and aggression and reveal an interaction with oxytocin within this path.

5.3 Conclusion

This study explored the mechanism through which childhood trauma leads to later aggression in violent offenders. Fully elucidating the factors leading to violent crimes is difficult, because crime involves a complex interplay between the individual and society in which offenders grew up. Childhood trauma is correlated with aggression, whereas plasma oxytocin level is inversely correlated with childhood trauma. A theoretical framework has been postulated to explain the possible pathway, as experiencing childhood trauma decreased plasma oxytocin levels and subsequently contributed to higher aggression in violent offenders. Owing to limitations inherent in cross-sectional analyses, it is recommended that longitudinal relationships should be examined to confirm a definitive causality over time.

5.4 Future contribution

It is hoped that the results of this study lead to the introduction of theoretical models to explain the interactions between childhood trauma and aggression and develop further strategies for preventing people becoming violent offenders. The prevention and early identification of childhood trauma are crucial for reducing aggression in adulthood. A decrease in childhood trauma incidents could decrease the risk of alterations in oxytocin gene expression and secretion. For those with severe childhood trauma experiences, efforts

to activate secure attachment should be made promptly. Oxytocin might be a helpful tool for use as an add-on treatment; for example the intranasal administration of oxytocin could decrease aggression and impulsivity in violent offenders, thereby potentially lowering the rate of recidivism in such criminals.

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Appendix 1 *Test of Normality (Kolmogorov-Smirnov test)*

		Statistic	*df*	*p*
Age	Violence group	0.10	75	.05
	Substances group	0.15	33	.06
	Alcohol group	0.14	37	.05
	Control group	0.14	33	.11

Appendix 2 *Kruskal-Wallis Test*

	CTQ-SF	MOAS	Oxytocin
Kruskal-Wallis H	26.32	45.79	8.01
df	3	3	3
Asymp. Sig.	< .001	< .001	.04

Appendix 3 *Correlation matrix for positive childhood trauma types*

	Physical abuse	Emotional abuse	Sexual abuse	Physical neglect
Physical abuse	-			
Emotional abuse	.53**	-		
Sexual abuse	.36**	.24**	-	
Physical neglect	.10	.15	.17*	-
Emotional neglect	.50**	.49**	.25**	.22**

*p < .05, **p < .01, ***p < .001

著作權聲明

論文題目：　催產激素對兒時創傷及暴力／衝動之中介效果

The Mediational Effect of Plasma Oxytocin Level on Childhood Trauma and Aggression / Impulsivity

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系所組別：　犯罪學研究所

研究生：　吳佳慶

指導教授：　周愫嫻

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