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EXPLORING THE ROLE OF OXYTOCIN IN ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD): A LITERATURE REVIEW

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ABSTRACT

In addition to significant social difficulties, attention deficit hyperactivity disorder (ADHD) is a common mental illness characterized by impulsivity, hyperactivity, and inattention. Pharmacological interventions, the mainstay of traditional treatments, can have serious side effects and adverse consequences. Moreover, recent research has started to investigate another potential treatment for regulating ADHD. Oxytocin is known for its function in social cognition, behavior, emotional control, stress reduction, and social bonding. A few studies directly connected the oxytocin levels and OXTR gene variants with ADHD symptom control particularly in humans. This review summarizes current research and emphasizes the special potential of oxytocin as a target for ADHD treatment. By highlighting the need for more targeted research to confirm the benefits of oxytocin, new therapeutic avenues that may be less harmful than currently prescribed drugs become accessible.

Keywords: Oxytocin (OT)- Attention-deficit/hyperactivity disorder (ADHD) - Novel therapeutic approaches.

INTRODUCTION

In 1905, Sir Henry Dale noticed that when pregnant cats were given extracts from the human posterior pituitary gland, their uteruses contracted. The Greek word "oxytocin" (OT), which he coined, means "swift birth." **(Magon and Kalra, 2011).** Over the past ten years, there has been a notable upsurge in the study of oxytocin, especially in its potential for treating mental illnesses and its function in social cognition regulation. Since it is a model of pituitary neurosecretion and controls uterine contractions during delivery and nursing lactation, For a very long time, scientists have been deeply studying the oxytocin system. Beginning in the mid-1960s, oxytocin was the focus of behavioral research, with an early focus on its effects on memory and learning. **(Shamay and Young, 2016).** Oxytocin, also known as pitocin, oxytocinum, syntocinon, endopituitrina, oxitocina, oxytocic hormone, and orasthin, has a significant effect on the regulation of parturition and lactation. It binds to receptors on the myometrium and starts to hydrolyze diacylglycerol and phosphatidylinositol, which releases intracellular Ca2+ and induces contractions in the uterus **(Kabilan, 2014).** After administering the medication parenterally for 40 minutes, it can attain a steady state. Small amounts may pass through the placenta in addition to being dispersed throughout the mother's extracellular fluid. Oxytocin OT influences (pro-social) behaviors in humans **(Decety *et al.,* 2016)**. ADHD, or attention-deficit/hyperactivity disorder, is a prevalent long-term mental illness **(Wernicke *et al.,* 2020).** Among the signs of ADHD are hyperactivity, impulsivity, and/or inattention. Most of the time, it begins in childhood, though it may persist until maturity. On the other hand, adult-onset ADHD is also discussed. **(Hurlemann and Scheele, 2016)**. Negative emotionality, impatience, low frustration tolerance, and difficulty regulating emotions are all frequently linked to ADHD. Moreover, there is a decrease in positive feelings along with challenges controlling elation, zeal, and exuberance**.** The peptide hormone oxytocin, which is produced in the hypothalamus, is released into different parts of the brain and serves as a neurotransmitter. Oxytocin receptors are found in many different parts of the brain, including the nucleus accumbens, amygdala, and hypothalamus. The pathophysiology of attention deficit hyperactivity disorder, anxiety, depression, schizophrenia, autism, Alzheimer's disease, and Parkinson's disease has been connected to these receptors. Animal studies have demonstrated the role of oxytocin in social, behavioral, pair, and mother-infant bonding. Furthermore, oxytocin affects a range of behaviors and, if it has any neuroprotective properties, protects developing neurons during childbirth. **(Ghazy *et al.,* 2022).** The study of oxytocin has significantly increased over the last ten years, particularly due to its potential for treating mental illnesses and its role in regulating social cognition. Since it is a model of pituitary neurosecretion and controls uterine contractions during delivery and nursing lactation, For a very long time, scientists have been deeply studying the oxytocin system. Beginning in the mid-1960s, oxytocin was the focus of behavioral research, with an early focus on its effects on memory and learning. **(Shamay and Young, 2016)**. Exquisite molecular and cellular research conducted in the recent past has started to unveil the exact pathways via which oxytocin influences signal-to-noise in brain circuits to expedite information processing. These animal studies all suggest that oxytocin may play a part in

the process of making social cues more salient and reinforcing, which may be important to regulate in a therapeutic context. **(Owen *et al.,* 2013)**. As per the World Health Organization (WHO), attention deficit hyperactivity disorder (ADHD) is a highly common mental illness that primarily affects boys in their childhood and continues into adulthood. The developmental disorder known as ADHD is typified by recurrent patterns of impulsivity, hyperactivity, inattention, and a mixed type.Inattention in ADHD, may occur due to a combination of executive attention, alerting attention, and abnormalities in specific neuronal networks involved in attentional processes **(Sroubek *et al.,* 2013).** In addition to these symptoms, social difficulties such as loneliness, anxiety, and sadness, as well as rejection by peers, are experienced by patients with ADHD. **(Nijmeijer *et al.,* 2008).** The results of the studies showed that while there is no cure for ADHD, its symptoms can be managed with drugs such as antidepressants, stimulants (such as methylphenidate and amfetamines), and non-stimulants (such as atomoxetine, clonidine, and guanfacine). (**Catalá-López, 2015**). Like any medication, these drugs could come with potential side effects. consequently, recent studies have intensified efforts in exploring novel therapeutic targets aiming to broaden the treatment options. As a result, few studies highlighted the pivotal role of oxytocin in ameliorating mental disorders among ADHD patients **(Ayaz *et al*., 2015)**. However, people with ADHD often have a range of social challenges, with social cognition, emotional control, stress response, sadness, and empathy being particularly problematic. The oxytocinergic system may be crucial in improving these social and emotional deficiencies, according to preliminary research. Therefore, the main goal of this investigation is to thoroughly evaluate and summarize the body of knowledge regarding the function of oxytocin and its gene receptors in the regulation of emotional and social deficits linked to attention deficit hyperactivity disorder (ADHD). By implementing this research project, we hope to clarify the possible therapeutic advantages of focusing on the oxytocinergic system to alleviate the various social and emotional challenges that people with ADHD confront.

1. Oxytocin role in social deficits:

1.1. Oxytocin role in social recognition:

Social recognition is a complicated behavior that is necessary for the identification, interpretation, and storage of socially significant data. Throughout childhood and adolescence, social recognition develops and is impacted by a wide range of psychiatric diseases **(Lopatina *et al*., 2018).** A structurally related peptide called oxytocin (OT) controls many complex social behaviors, such as aggressiveness, territoriality, social bonding, and maternal behavior **(Freeman and Young, 2013).** Prior research revealed a connection between the social recognition function and oxytocin (OT), as demonstrated by studies on animals, including one on mice by **(Oettl *et al.,* 2016)** demonstrated that oxytocin (OXT) alters the initial stages of smell perception, possibly raising the importance and awareness of smells in social situations. Additionally, mice that have had their oxytocin receptor (OXTR) removed from the anterior olfactory nucleus (AON) take longer to explore a given topic conspecifically. This suggests that the absence of oxytocin affects how odors are presented, which results in less efficient information gathering. (**Oettl *et al*., 2016).**

Another study conducted on monkeys by **(Freeman *et al.,* 2014),** showed that OXT plays a role in modulating visual attention, processing, and sensory stimuli, among other activities related to social recognition. The subcortical and early cortical visual areas, along with the cholinergic nuclei governing sensory processing in these modalities, are rich in OXTR. It has been shown that OXT can improve some of the associated deficits in social interactions, and the OXT system is thought to be helpful in treating social disorders like autism and ADHD, even though oxytocin's role in social recognition has not received much attention in human studies **(Oettl *et al.,* 2016).**

1.2. Oxytocin role in fear:

According to **(Kirsch *et al.,* 2005)** oxytocin significantly alters the neural circuitry associated with fear in humans by decreasing the amygdala's activation and its connection to brainstem areas that control the autonomic and behavioral expressions of fear. This may contribute to oxytocin's therapeutic application in illnesses requiring abnormal fear processing by suggesting a brain mechanism by which it influences fear responses. This is corroborated by a study **(Domes *et al.,* 2007)** that used functional magnetic resonance imaging to compare the brain responses to intranasally administered oxytocin versus placebo about facial emotions of fear, anger, and happiness. The findings demonstrated that, regardless of the valence of the emotions, oxytocin lessens the amygdala's reaction to emotional faces. The results corroborate the study on fear response modulation by Kirsch et al. by demonstrating that oxytocin decreased right-sided amygdala responses in all three face categories. This suggests that oxytocin has a broad modulatory effect on the amygdala's reactions to facial expressions.

1.3. Oxytocin role in impulsivity:

As the primary symptom of ADHD, impulsivity can be defined as the lack of behavioral control and has a substantial influence on people's actions and decision-making **(Winstanley *et al.,* 2006).** Notably, it has been indicated that Oxytocin, which is well-known for promoting social bonds and managing stress, has been closely examined for its possible impact on impulsivity**.** Recent studies focused on this relation, and one of these studies; study, which detected notable OXTR gene single nucleotide polymorphisms (SNPs), rs2254298, for example, showed a strong correlation with traits associated with impulsivity. Compared to individuals with other genotypes, those with the GG genotype of rs2254298 showed significantly less impulsivity, indicating that this SNP may affect the expression or functionality of the OXTR gene. **(Bozorgmehr *et al.,* 2020)** gave intranasal oxytocin injections to a group of youthful, healthy men in order to investigate the behavioral impact of oxytocin on impulsivity. The participants' answers to a go/no-go task, a well-liked cognitive test used to gauge impulsivity, were then evaluated. The results showed that giving oxytocin significantly decreased commission errors and enhanced response inhibition and reaction latency. These findings imply that oxytocin may improve the brain circuits that control impulses by altering the expression of oxytocin receptors.These results were supported by **(Demirci *et al.,* 2016)** study, which conducted on male children and adolescents with ADHD, discovered that impulsivity scores had an inverse relationship with serum oxytocin levels. Higher impulsivity was

correlated with lower levels of oxytocin, indicating that oxytocin may be involved in the regulation of impulsive traits seen in ADHD.

Table 1. Summary of Studies of using oxytocin treatment in mental disorders including ADHD.

Authors	Mental disorder	Symptoms targeted	Oxytocin treatment outcome
(Guastella *et al.*, 2010)	autism spectrum disorders	Social cognition, and emotional recognition	The study found that social communication and interaction with autistic people are enhanced by the use of internasal oxytocin, also known as "nasal spray."
(Kalyoncu *et al.*, 2017)	ADHD	facial emotion recognition	Children with ADHD who have the CT/TT genotype did worse on the task of recognizing facial emotions.
(Siu *et al.*, 2021)	ADHD	Social Problems and IQ	People with ADHD who had high DNAm values in OXTR also had lower IQs and more social problems.
(Park *et al.*, 2010)	ADHD	social cognition	Better social cognitive ability was correlated with the AA genotype rs53576.
(Chagnon *et al.*, 2015)	Anxiety and depression	anxiety/depression	Subjects with anxiety or depression showed higher levels of DNA methylation, but only if they had the AA genotype of the OXTR rs53576 SNV.
(Demirci *et al.*, 2016)	ADHD	Impulsivity	A negative correlation was observed between serum oxytocin levels and impulsivity scores, indicating a potential avenue for reducing impulsivity in individuals with ADHD..

1. Mechanism of oxytocin.

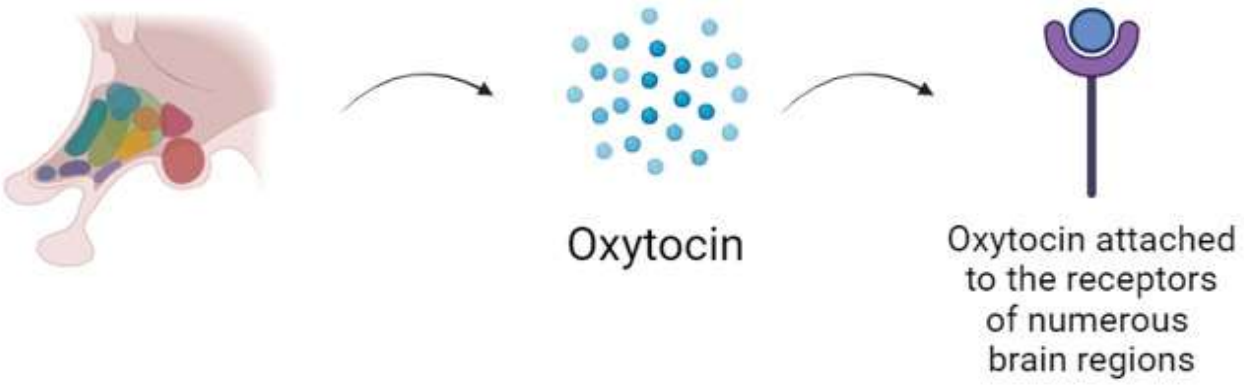

Figure 1: The pituitary gland releases Oxytocin to attach to specific brain regions

The hypothalamus produces oxytocin, which is stored and released by the pituitary gland. Oxytocin promotes the advancement of labor in a newborn woman figure (1). A key factor in regulating breastfeeding and parturition is oxytocin. Other names for it include orasthin, ocytocin, pitocin, oxytocinum, syntocinon, endopituitrina, oxitocina, and oxytocic hormone. It binds to receptors on the myometrium to start the hydrolysis of phosphatidylinositol and diacylglycerol. This causes intracellular Ca2+ to be released, which then encourages uterine contractions **(Kabilan 2014)**. When administered parenterally, the medication can achieve a steady state in 40 minutes. It is dispersed throughout the extracellular fluid of the mother and may cross the placenta in trace amounts. It is distributed across the extracellular fluid of the mother, and trace amounts may cross the placental barrier and reach the growing fetus. Fast metabolism is facilitated by the liver, the mammary gland, and the enzyme plasma oxytocinase. (**Troncy *et al*., 2008)** reveal that oxytocin has a half-life of 8 to 3 minutes in the blood, but it can take up to 19 minutes in rats and 28 minutes in guinea pigs in the cerebrospinal fluid (CSF). OT is eliminated by the liver and kidneys; the kidneys hardly ever excrete OT in its original form. **(Kabilan 2014).**

2. The Brain's Neurobiology of the OT System

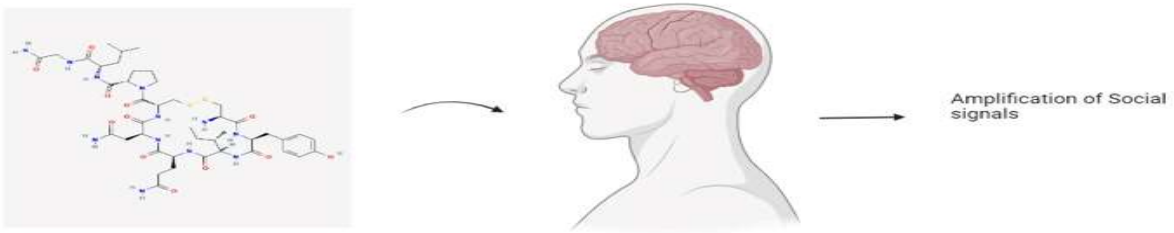

Figure (2): the effect of Oxytocin on specific brain parts leading to the amplification of social behaviors such as the development and maintenance of social interactions

By elucidating the molecular cascade that underlies numerous neuropsychiatric, neurodegenerative, and neurodevelopmental disorders, including the molecular and cellular pharmacology of oxytocin and the oxytocin receptor (OTR), oxytocin plays a role in neuropsychiatric illnesses. The source of central OT is the hypothalamus-neurohypophysial system (HNS), which consists of massive magnocellular OT neurons in the paraventricular (PVN) and bilateral supraoptic (SON) nuclei of the hypothalamus, as well as the nonapeptide AVP that is associated with them **(Armstrong, 2015).** Together with the magnocellular OT neurons, a small number of parvocellular neurons are situated bilaterally in the dorsolateral region of the PVN. Unlike the magnocellular OT neurons, these parvocellular OT neurons are not connected to the neurohypophysis. Thus, they are mainly connected to the midbrain, hindbrain, and spinal cord. Both parvocellular and magnocellular OT neurons make up the OT brain system **(Landgraf and Neumann 2004; Eliava *et al.* 2016).** The OT system is linked to social conduct control and has been identified as a possible therapeutic target in neuropsychiatric disorders characterized by abnormal social behavior **Figure (2)**. suggesting that these neuropeptides could be targets for treatment for a variety of neuropsychiatric disorders, such as **(Cid *et al*.,2021).**

3. Oxytocin effect on Attention Deficit Hyperactivity Disorder (ADHD)

About 7% of children and adolescents suffer from attention deficit hyperactivity disorder (ADHD), a neurodevelopmental disorder **(Thomas *et al*., 2015)** has been connected to notable deficits in social functioning **(Mash and Barkley, 2003).** Children with ADHD are more likely to face social rejection and find it difficult to build relationships based on reciprocity **(McQuade and Hoza, 2008).** The inability of children with ADHD to complete tasks involving the theory of mind (ToM), which is the capacity to attribute mental states, beliefs, and intentions to oneself and others, contributes to their deficiencies in interpersonal functioning **(Abu-Akel and Shamay, 2011)**. For example, research has indicated that children diagnosed with ADHD exhibit deficiencies in their capacity to identify facial expressions **(Buhler *et al*., 2011)**, While deficits in first- and second-order ToM have been reported in other studies. However, there are a number of significant limitations to these studies, including small sample sizes and high rates of co-occurring disruptive disorders. To a certain extent, an individual's ToM capacities are determined by the health of their dopaminergic and serotonergic systems and the ways in which these systems interact with other neurotransmitters and hormones. The neuropeptide oxytocin (OT) supports the emergence and maintenance of social interactions, intimacy, and the capacity to read others' emotions from their facial expressions. It is believed that oxytocin increases the relevance of social signals by altering attention-orienting responses to contextual social cues in the outside world. It secretes more when it interacts with other people. Correlations between peripheral OT levels in blood or saliva have been found in studies; however, these studies have a number of significant limitations, including small sample sizes and high rates of co-occurring disruptive disorders. One's capacity to modulate behavior (ToM) is influenced by the state of the dopaminergic and serotonergic systems, as well as by the ways in which these systems interact with other neurotransmitters and hormones. The creation and maintenance of social bonds, the display of intimacy, and the capacity to decipher emotions from the facial expressions of others are all dependent on a neuropeptide known as

oxytocin (OT). It is believed that oxytocin increases the relevance of social signals by altering attention-orienting responses to contextual social cues in the outside world. It releases more when interacting with other people **(Shamay and Abu-Akel, 2016).** Research has demonstrated a relationship between peripheral OT levels in blood or saliva and the degree of affiliative behaviors and social ties exhibited by individuals in good health as well as those suffering from a range of mental disorders. Dopaminergic and oxytocinrgic neurons interact reciprocally in the mesolimbic tract **(Baskerville and Douglas, 2010).**

4. Oxytocin receptor (OXTR) gene

The oxytocin receptor (OXTR), which is produced by the OXTR gene, is responsible for signal transduction after binding its ligand, oxytocin. The main purpose of this signaling is to control maternal behavior, but it has also been demonstrated that OXTR aids in the development of the nervous system. Therefore, it should come as no surprise that both the ligand and the receptor are involved in behavior modification, especially when it comes to activities related to stress, sexuality, and social interaction. Disruptions to the structures or functions of oxytocin and OXTR, like any other regulatory system, can lead to or alter a number of diseases linked to the regulated functions, in this case, mental health disorders (such as depression, schizophrenia, autism, and obsessive-compulsive disorders) **(Pierzynowska *et al*., 2023)**. Oxytocin is one pituitary neuropeptide that affects social behavior. It has been shown that single nucleotide polymorphisms (SNPs) in the oxytocin receptor gene (OXTR) partially explain the variation in social abilities observed in control populations **(Baribeau *et al*., 2017).**

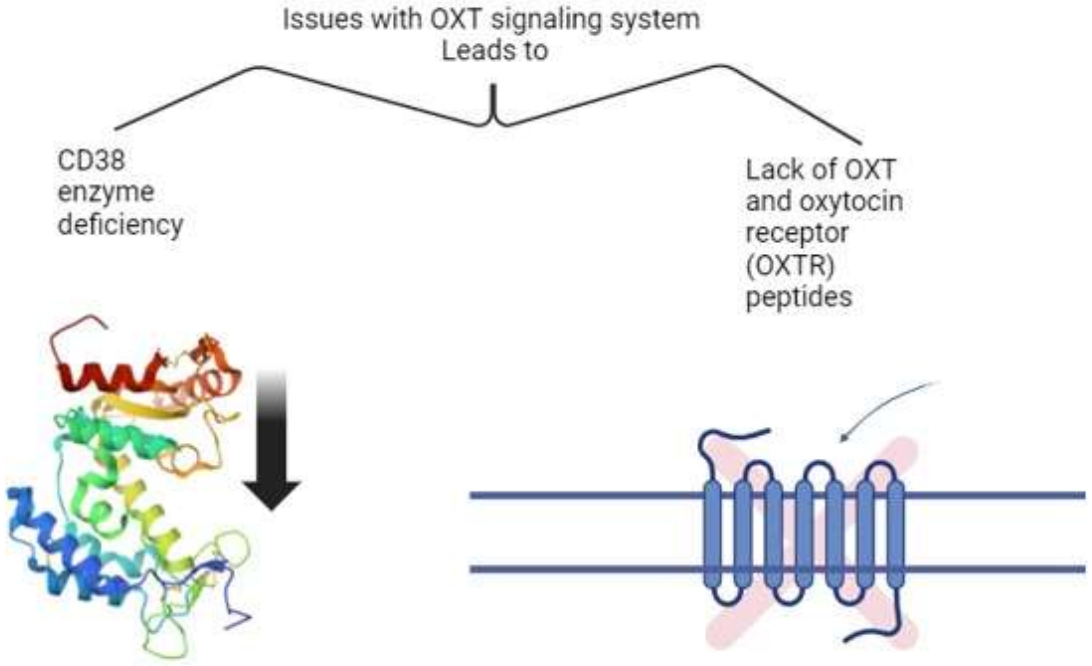

Figure 3: Shows the problems that are associated with the OXT signaling system

Research on animals has demonstrated that issues related to the OXT signaling system impact social cognition as shown in **Figure (3),** such as CD38 enzyme deficiency, and a lack of OXT and

oxytocin receptor (OXTR) peptides **(Higashida *et al*., 2012).** According to studies conducted on humans, there is a significant distribution of OXT and OXTR binding in the amygdala region **(Huber *et al.,* 2005).** Through neural mechanisms, OXT reduces amygdala activity, inhibits social anxiety, and affects social cognition **(Domes *et al.,* 2007).** It was proposed that OXTR gene polymorphisms cause failure in the OXTR system and impair social cognition by altering the release of the OXTR peptide (**Gordon *et al.,* 2011**), and pose a potential risk for ASDs **(Wu *et al.,* 2005; Liu *et al*., 2010).**

4.1. the impact of human oxytocin receptor genotypes

Differences in the oxytocin receptor (OXTR) gene may account for some of the individual differences in oxytocin-related social behavior. Two single nucleotide polymorphisms (SNPs) that have been suggested as feasible choices are rs53576 and rs2254298 **(Bakermans and Van, 2014)**. Genetic changes associated with the oxytocin system appear to impact the neurobiology of anxiety disorders and attention-deficit hyperactivity disorder, resulting in increased emotional, social, and functional impairment. Here, we examined the relationships between children's attention/hyperactivity disorders and anxiety issues and the OXTR rs2254298 and CD38 rs6449182 variants. The OXTR rs2254298 AA genotype was identified by the adjusted regression model as a risk factor for attention-deficit/hyperactivity disorder (PR: 2.37; PadjFDR = 0.006), attention problems (PR: 2.71; PadjFDR = 0.003), and anxiety problems (PR: 1.92; PadjFDR = 0.018) in the study, which involved 292 children. The attention-deficit/hyperactivity disorder risk factor CD38 rs6449182 G allele was found to be 1.56 (PR: 1.56; PadjFDR = 0.028). Additionally, the in silico method for determining regulatory roles discovered markers that affect transcription capacity and chromatin accessibility **(Camerini *et al.,* 2024).**

4.2. The connection between ADHD and the OXTR gene

Though social interaction and communication deficits in ADHD are demonstrated to be similar to those in ASDs, little research has examined the potential relationship between ADHD and the OXTR system **(Park *et al.,* 2010).** Therefore, in the ADHD and control groups of this study, the three OXTR gene SNPs—rs53576, rs13316193, and rs2268493—that have previously been associated with an increased risk of autism were examined. The relationship between these polymorphisms and social functioning in ADHD has been studied.

5. Oxytocin and social functions

Recently, there has been a lot of interest in the role that oxytocin plays in the pathophysiology and treatment of major neuropsychiatric illnesses.Oxytocin (OT) has emerged as a major player in the regulation of social behavior, and scientists are actively exploring the OT system as a pharmacological target for enhancing social cognition in therapeutic contexts. Nevertheless, the peptide's physicochemical properties, such as its poor blood-brain barrier penetration and metabolic instability, restrict OT's potential for therapeutic use. This means that new strategies for enhancing the OT system and the social brain circuit are required in order to apply the pharmaceutical therapy of social deficits. As part of my dissertation research, I evaluated and developed novel methods to pharmacologically improve social cognition in addition to defining a functional animal model with predictive validity for prosocial therapies **(Modi, 2012).** Oxytocin

can change how pain is felt because it is extensively involved in both peripheral and central psychological and physiological processes. Because of this, oxytocin has a lot of therapeutic potential. Since oxytocin offers a potentially novel way to regulate pain perception, more research is required to fully understand its therapeutic benefits **(Tracy *et al*., 2015).** In addition to solving puzzles requiring social interaction but not an immersive narrative, the active control group also completed investigations into biomarkers (cortisol and oxytocin), pain scores, and psycholinguistic associations. Compared to the control group, children in the storytelling group had a significant drop in cortisol and an increase in oxytocin in their saliva after the 30-minute intervention. Furthermore, they reported less pain and used more positive lexical signals when talking about their hospital stay **(Brockington *et al.,* 2021).** Further investigation revealed how oxytocin was extracted and injected in ex vivo animal models in order to study its function. As a result, data demonstrating the distinctions between the actions of vasopressin and oxytocin started to mount. It wasn't until 1928 that the peptide was applied in human studies. Burne and Burn investigated the effects of OT isolated from the pituitary gland in the human uterus during childbirth **(David and Vareed, 1929)**. Rosenfeld extracted the molecule in 1940 by centrifugation. Social interactions entail a variety of peer relationships in addition to the use of highly complex cues and communication between individuals within the same species **(Chen and Hong, 2018).** Recalling known peers, identifying and showing preference for others, and participating in more complex social interactions such as play, aggression, sexuality, and motherhood are examples of social activities. Recently, the effects of OT and AVP systems on social behavior have not been investigated in animal research. A detailed examination of social behavior is necessary to comprehend and suggest the best course of treatment for disorders such as ASD, ADHD, schizophrenia, and other illnesses that show social deficiencies **(Cid *et al*.,2021).** Due to their potential to treat neuropsychiatric disorders such as anxiety, depression, attentional hyperactivity deficit disorder (ADHD), substance abuse disorder (SUD), and autism spectrum disorder (ASD), two neuropeptides (NPs)—oxytocin (OT) and arginine vasopressin (AVP)—have gained attention recently. The majority of currently available medications have low success rates and a lengthy time lag between the start of the therapy and the first patient reports of improvement, making the development of novel pharmaceutical therapies for the aforementioned illnesses an important undertaking **(Cuijpers, 2020)**. There are several ways to recognize and quantify OT. Pituitary tissue, which was carefully selected to isolate only the posterior portion of the gland, has been used to detect peptides since its discovery in 1909 by Henry Dale. Using Biuret's reagent, the presence of peptides in the sample was verified following the macerate's processing to remove any blood residue **(Dale, 1909).** Since the peptide was not yet known to be a biomarker, it had to be extracted in order to be studied for its functions. However, in 1928, the peptide and vasopressin were separated at the Parke-Davis & Co Research Laboratory **(Rowe, 1928**). There is a growing concern that psychopharmacology is going through a dry spell. Alternatively put, consider this: pharmaceutical companies have made less investments in drug discovery since the discovery of the foundational medications for schizophrenia, depression, and anxiety disorders more than 30 years ago. Consequently, the pipeline's supply of novel mechanisms of action (like glutamatergic

agents and CRF antagonists) has reduced to a trickle **(Macdonald and Feifel, 2013)**. Increasingly, however, scientists are now focusing on the effects of externally delivered OXT on behavior and mental states as opposed to measuring peripheric hormone concentrations or inducing secretion through physiological stimuli, as was done earlier. As a low-risk method based on a nasal spray, intranasal administration of OXT (IAO) is the most widely used way of delivering the hormone. After being administered intranasally, neuropeptides have been shown to penetrate the blood-brain barrier, providing a useful method for studying how OXT affects the human central nervous system **(Heinrichs and Domes, 2008).** In rats and mice **(Neumann *et al*., 2013),** as well as in people **(Striepens *et al*., 2013; Wang *et al.*, 2013)**, An increase in central and plasmatic levels has been associated with IAO. OXT has been thoroughly investigated since its discovery in 1909 thanks to a variety of methodologies, and even after more than a century, its influence on behavior is still being assessed. Although immunochemical techniques have advanced, there are still certain obstacles to obtaining an optimal OXT measurement, putting the validity and scope of the necessary research at risk for this type of analysis **(Mera *et al*., 2021).** More specifically, an evolutionary-developmental approach informs research on early adversity, oxytocinergic functioning, and developmental outcomes; it also guides studies on adaptive diversity in life history-related characteristics and behaviors, OT responsiveness to context, and various aspects of adversity **(Ellis *et al.,* 2021).** Novel ligands targeting the OT receptor show functional bias and exploit receptor dimerization, offering multiple avenues for future investigation and therapeutic intervention. Innovative strategies that improve endogenous OT signaling might potentially provide a useful means of social behavior control. Deficits in social behavioral domains like empathy, emotion perception, and interpersonal communication are hallmarks of several neuropsychiatric illnesses, including schizophrenia and autism spectrum disorder (ASD) (**Eletmany *et al.*, 2022-2024**). It has been proposed that oxytocin (OT), a neuropeptide essential for controlling a range of social behaviors in vertebrates, could be a valuable target for treating social dysfunction. Thanks to a surge in scientific research, oxytocinergic signaling and the pathways that regulate its synthesis and breakdown in the brain have been the focus of an increasingly extensive examination in the field of OT research in recent years **(Gulliver *et al*., 2019)**.

CONCLUSION

This study proposed that oxytocin may be involved in social cognitive deficits and supported the hypothesis that affect recognition may differ amongst attention deficit hyperactivity disorder (ADHD) subtypes. Due to its part in the pathophysiology, oxytocin has received a lot of attention lately. The socio-communicational impairments linked to attention deficit hyperactivity disorder (ADHD) may improve with oxytocin treatment. This disparity highlights the need for more research to validate oxytocin's efficacy and mechanisms of action in the management of ADHD.

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