

The biological basis of parent-infant attachment: Foundations and implications for further development²

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Abstract

Attachment is one of the most important theories that has ever been produced in the field of Psychology. It explains not only the relationship that a child has with its mother, but also how a child is structured and developed into a psychic being. Understanding the Attachment Theory helps elucidate how the interactions that take place in the parent-infant relationship impact the rest of the child's life by predicting its neural, emotional, and social development. For this reason, it is important to explain the foundation of this important relationship. This article reviews some of the literature that, based on research from the fields of psychology, biology, and genetics, shows evidence on how this special tie is founded on genetic and endocrine substrates that, in interaction with the environment, function to create the expression of an individual.

Keywords

Attachment, parent-infant, responsiveness, biological, evolutionary explanation, genetic, endocrine, oxytocin, cortisol

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Bases biológicas del apego paterno-infantil: Fundaciones e implicaciones para el desarrollo futuro.

Resumen

La Teoría del Apego es una de las teorías más importantes que se ha producido en el campo de la Psicología. Ésta explica no sólo la relación que un niño o niña tiene con su madre, pero también cómo un niño o niña se estructura y desarrolla en un ser psíquico. Entender la Teoría del Apego ayuda a elucidar cómo las interacciones que se dan en la relación padre-infante impactan el resto de la vida del niño o niña al predecir su desarrollo neural, emocional y social, y por esta razón, es importante explicar la fundación de esta importante relación. Este artículo revisa algo de la literatura que, basada en investigaciones desde los campos de la psicología, biología y genética, muestra evidencia de cómo esta unión especial está fundada en sustratos genéticos y endocrinos que, en interacción con el ambiente, funcionan para crear la expresión de un individuo.

Palabras clave

Apego, padre-infante, responsividad, biológica, evolutiona explicación, genética, endocrina, oxitocina, cortisol.

A base biológica do apego pais-filhos: Fundamentos e implicações para um maior desenvolvimento

Resumo

O apego é uma das teorias mais importantes que já foram produzidas no campo da Psicologia. Ele explica não só a relação que a criança tem com a mãe, mas também como uma criança é estruturada e desenvolvida em um ser psíquico. Entendendo a Teoria do Apego ajuda a elucidar como as interações que ocorrem na relação pais-bebê impactam o resto da vida da criança, prevendo o seu desenvolvimento neural, emocional e social. Por esta razão, é importante explicar a base desta relação importante. Este artigo analisa parte da literatura que, com base em pesquisas das áreas de psicologia, biologia e genética, mostra evidência de como este laço especial baseia-se em sustratos genéticos e endócrinos que, em interação com o meio ambiente, a função para criar a expressão de um indivíduo.

Palavras chave

Apego, pais-filhos, capacidade de resposta, explicação biológica, evolutiva, genética, endócrina, oxitocina, cortisol.

Introduction

Attachment, as has previously been defined (Bretherton, 1992) refers to a special human need to form close affectional ties, which bond parents and infants in a way that the parent not only functions as a caregiver, but also as a secure base that the child can use as a safe way to explore the world around him, and as he or she grows older, the inner world as well. Although it has always been said that the ultimate function of attachment is the protection of the infant or child from any potential danger, research shows that the objective of the attachment relationship goes way beyond, showing its potential to explain the child's posterior functioning: the development of schemas or perceptions about the world, the child's emotional well-being (Volling, McElwain, Notaro, & Herrera, 2002; Waters et al., 2010) psychological health (Anglin, Cohen, & Chen, 2008; Brumariu & Kerns, 2008) and the determination of the quality of posterior relationships with others (Levy & Kelly, 2010) including the way he or she will act as a parent in the future (Van Ijzendoorn, 1995; Grienberger, Kelly, & Slade, 2005).

History of attachment theory: the concept, different types, and antecedents of attachment

Both Bowlby and Ainsworth, considered to be the founders of Attachment Theory, recognized the importance of

attachment as this parent-infant tie and, by studying the theoretical developments of researchers like Konrad Lorenz with the imprinting in geese, and Harry Harlow with the emotional deprivation of orphan rhesus monkeys (Bretherton, 1992) viewed the evolutionary basis of attachment, pointing to the similarities of humans and animals, in their need for contact and physical connection that went beyond the need for food. Ainsworth, in her own unique way, studied its development in Uganda, establishing that attachment is universal and that it is observed throughout many different cultures.

Ainsworth and Bell (1970) described a laboratory procedure developed by the former author, called the *Strange Situation*, to evaluate the attachment pattern that was present between an infant and the mother, by observing them interact in a series of eight steps and especially during moments of separation and encounter. The steps of the procedure included: a) the experimenter introduces the mother and infant to the room and leaves; (b) the mother and child are in the room, while the child explores without any participation from the mother; (c) the experimenter discretely enters the room, at first he remains in silence, then talks to the mother, and finally approaches the child; (d) first episode of separation: the mother discretely exits the room and the child is left for some minutes with the experimenter; (e) first encounter episode: the mother enters the room, and comforts the child; the experimenter exits the room, the mother elicits play behavior in the child, and then, saying goodbye, leaves the room; (f) second separation episode: the child is left alone in the room for no more than three minutes; (g) the experimenter enters the room trying to interact with the infant, and

finally; (h) second encounter episode: the mother enters the room, lifting and holding the infant while the experimenter discretely exits the room. These eight steps of interaction between a mother and a child, and especially, the way in which the baby behaved in the moments of separation and of reencounter helped Mary Ainsworth come up with a classification of different patterns of attachment. She labeled as Secure those infants who explored the environment in the presence of the mother, and seemed somewhat anxious in the presence of the stranger. These also appeared upset after the separation from the mother, and in the moment of reunion stopped crying and felt reassured by the mother's presence. Secure infants generally returned to their usual behavior of playing and exploring after separation and encounter. Other infants would explore without noticing the presence of the mother or did not use her as a base for exploration; they found no preference for her over the stranger, and after separation would seem to not notice her absence or if they did, they would look for the mother although in a less anxious or distressed state, and on reunion would just avoid her. These children were referred to as Insecure-Avoidant. And finally, the other type of children seemed to not want to explore the environment around them, needing to be close to the mother at all times. They seemed anxious and apprehensive, looking at the mother constantly when trying to explore, as if needing to "keep an eye on her" to not abandon them, and appeared exceedingly troubled after separation, when they would cry and scream showing a need for contact. Nevertheless, after the mother returned and were being held, although expected to feel comforted, they would not calm down, but instead, they would even be seen as though angry

with the mother, not letting her hug them, being rigid, or pushing away from her to be let down again. Because of this manifestation of ambivalence or inconsistency, these children were classified as Insecure-Ambivalent (sometimes also referred to as Resistant). Eventually, another type of attachment was described (Main & Solomon, 1990), given that some children in the Strange Situation would behave differently. Children who did not use any of the other three strategies in a consistent manner, but showed behaviors that did not have a clear objective, an observable goal or intention, or even manifested headbanging, freezing and other bizarre behaviors, were defined as Disorganized/Disoriented. These infants had equally disorganized, distorted or atypical parenting, which represented for them, both a source of comfort and distress (Benoit, 2004).

The manner in which infants react in situations of separation is a representation of the way in which they are learning to regulate their emotions; a process that is learned through the interactions with the caregiver. It has been shown (Volling, McElwain, Notaro, & Herrera, 2002) that the quality of parental responsiveness (e.g., the way in which the parents attend to the children's emotional and biological needs) impacts the regulation of emotions in children by going through a process in which the parents serve the function of regulating the child's emotions first, until finally the child learns how to do it himself. Thus, a secure child has caregivers who respond to his distress in sensitive, caring and warm ways, giving the infant the feeling that he can trust the caregivers to be ready, accessible, and sensible to his needs. In this sense, a secure child has more flexible emotion regulation skills. An

avoidant child has caregivers who respond in cold, insensitive or even rejecting ways, showing the child that he cannot count on the caregivers to be ready, accessible, and sensible to meet his needs; therefore, expressing emotions does not serve any purpose. Thus, eventually the child develops a strategy in which he learns to minimize emotional expression. An ambivalent child has inconsistent, contradictory parents who respond in very different ways every time he or she feels distressed, and continuously threaten the child to abandon, or reject him, therefore showing the child that he has to worry about his caregiver's presence or well-being, leaving the child with the constant feeling of uncertainty and uncontrollability. In this way, the child learns to maximize the display of emotions in the hopes that the caregiver will pay attention and meet his needs. Disorganized children have inconsistent, contradictory parents, many times neglectful and abusive, who respond in frightening, sexualized, and atypical ways to the child, both in reaction to the child's positive and negative emotions, leaving the child with the feeling that he never knows how the parent will react, thus showing bizarre behaviors that represent disorientation and high stress (Benoit, 2004; Volling, McElwain, Notaro, & Herrera, 2002).

Evolutionary basis of Attachment: Instincts and hormones

As many other behavioral systems, attachment has its own and unique evolutionary explanation. The human infant, being one of the most vulnerable among all infant mammals, has a great need for

protection and care. Given that in infancy he cannot get up, start walking, feed himself or run in order to protect his own life like many other animals do, his dependency is high, his vulnerability is higher, and his need for a responsive and warm caregiver, is even greater. But, how does the infant guarantee that he is going to be cared for? What has shaped mothers to be responsive and maternal?

The infant needs to display a number of behaviors or responses that, similar to those of the other mammals, are instinctual. Many of them are shared with other primates; are developed during a critical period of time; and ensure that the mother will direct her own responses to him. When an infant has a need and cries, the cry functions as a signal to the mother in order to get her attention and turn towards the child to meet the need. As Bretherton (1992) very clearly wrote after reading one of Bowlby's papers:

The attachment behavior is made up of a number of component instinctual responses that have the function of binding the infant to the mother and the mother to the infant. These component responses (among them sucking, clinging, and following, as well as signaling behaviors of smiling and crying) mature relatively independently during the first year of life and become increasingly integrated and focused on a mother figure during the second 6 months (p. 762).

Other authors, like Sarah Blaffer Hrdy (as cited by Cashdan, 2000) state that "selection has shaped infants ... (to be) unusually fat at birth (because) it enhances its later chances of survival and at

the same time signals its mothers that it is in good condition and worth rearing” (p. 217). The same author states that innate maternal responses lower a human mother’s threshold for responding to her infant which makes mothers especially interested in babies, therefore displaying attention and caring behaviors. Research has shown that these expressions are mediated through hormonal changes, both in the mothers and fathers (Storey, Walsh, Quinton, & Wynne-Edwards, 2000; Thompson & Trevathan, 2008) and also in other animals (Ahern & Young, 2009). Parental responsiveness in humans has been traced to hormonal levels as made known by Storey et al. (2000) who showed that men who reported having more pregnancy symptoms (weight gain, nausea, increase in appetite, fatigue, decrease in appetite, weight loss, and emotional changes) while their spouses were pregnant, showed higher prolactin levels and lower testosterone levels, which correlated with their partner’s hormonal levels as well (in women, higher prolactin and cortisol). The research confirms that an inverse relationship between prolactin and testosterone in men is related to higher paternal responsiveness and lower tendencies to engage in behaviors that are contrary to behaviors representative of parental responsiveness, like aggression and competitiveness. A very interesting finding of the study is that hormonal changes in women were dependent on time/period (prenatal, perinatal, or postnatal), while men’s changes were dependent on the level of intimacy they had with their spouses. Therefore, men who were more intimate in the relationship they had with their spouses showed the hormonal changes along with their wives (manifesting pregnancy symptoms), and were more responsive, but men who were not

very intimate or close to their spouses, did not show hormonal changes.

Aside from prolactin, other hormones are presumed to be involved, among other important social behaviors, in mother-infant pair bonding. Bartz and Hollander (2006) after a vast literature review on the most recent studies done on neuroscience of affiliation, found that oxytocin is one of these neuropeptides involved. The authors reviewed the findings of other studies where injections of oxytocin in the cerebral ventricles of rats that never had pups before, facilitated maternal behavior, whereas injecting the antagonist of the hormone inhibited the onset of the maternal behavior. Thompson and Trevathan (2008) recognize that cortisol, an adrenal hormone released in response to physical and emotional arousal, and sometimes referred to as the stress hormone, is also implicated in the expression of attachment behaviors and parenting in the caregiver. The authors have followed studies of other researchers, showing that highly fearful, insecurely attached and disorganized infants have higher cortisol reactivity than others that are more securely attached. Cortisol dysregulation has also been found to be present following early social deprivation. Wismer Fries, Shirlcliff and Pollak (2008) found that post-institutionalized children who experienced severe neglect had higher basal cortisol levels. The study also found that children who experienced a lengthy stay at the orphanage did not show greater cortisol levels in comparison with children who had shorter stays, demonstrating the fact that the length of stay did not predict the stress response, but the neglect and abuse experienced at the institution did. This predicts inefficiency in regulating the Hypothalamic Pituitary Adrenal (HPA) Axis

(which is an intricate set of direct influences and feedback exchanges between the hypothalamus, the pituitary gland and the adrenal gland, controlling the reactions to stress and regulating other body processes like digestion, immunity to viruses, mood and emotions). This inefficiency in the regulation of the HPA Axis system puts the children in a constant state of “alarm”, even though they are now living in a loving environment, as if to be prepared to expect the worst. As stated by Wismer Fries et al., these results show the effects of early deprivation on subsequent behavioral and emotional functioning, attributable to changes in the HPA Axis.

In animals, one study (Ahern & Young, 2009) has also shown the importance of parental behavior, quality (and quantity) of time invested in caring for infants, and the impact that it can have on posterior development as critical factors in infant development. The research by Ahern and Young (2009) was done by studying the monogamous prairie vole, which is said to be an animal that resembles the social interaction and social family formations of humans. These rodents are small, genetically diverse and generally monogamous, with a compound repertoire of social behaviors; virgins exhibit nurturing behavior towards unrelated pups, adults form selective social attachments or pair bonds, and breeding pairs show biparental care of offspring (Ahern & Young, 2009). This study showed that single-mother-reared pups (in contrast to bi-parental-reared pups) were less attended, received significantly less care and less “licking and grooming” behaviors from the mother, matured more slowly, and later on, showed slower partner preference formation, and less alloparental behaviors as adults, spending more time away from their own pups. The study made by Ahern

& Young did not show main effects for single-mother vs. bi-parental-reared pups regarding the neuropeptides involved in these behaviors (oxytocin, vasopressin and corticotropin-releasing factor), but did confirm that the patterns of interaction early in life not only affect the immediate social life of the child but also show that there is an intergenerational transmission of attachment behaviors, as always defended by van Ijzendoorn (1995).

From a different yet interesting perspective, also confirming the impact of the neuroendocrine system in attachment processes, the study of Tyrka et al. (2008) on parental loss is found. This study resulted in the finding that early parental loss can lead to alterations in the normal functions of the Hypothalamic-Pituitary-Adrenal (HPA) function as an adult. Adults who, as children, had experienced parental loss (e.g., death) evidenced higher levels of HPA functioning, resulting in higher cortisol levels while the ones who had experienced parental desertion or abandonment and institutionalization evidenced lowered cortisol reactivity. The findings can be explained based on the duration and intensity of the stressors. While children who suffer the loss of a parent due to death can suffer a great trauma, they hold the certainty that the parent is not coming back, therefore experience this trauma as an acute stressor, and develop later a heightened reactivity of the stress response. On the other hand, children who undergo the disappearance of a parent, the occurrence of abandonment, placement in institutions (generally, accompanied by other multiple stressors like maltreatment), experience these multiple stressors over a long period of time. Not only they hold the expectation of the parent(s)’ return, but the constant experience of diminished

parental care at an institution, are not undertaken as acute stressors but as chronic stressors, consequently regulating the stress response, evidencing attenuated cortisol activity. It is also essential to note that males were the ones who showed the greater alteration in neuroendocrine activation which is explained by the researchers based on the fact that, taken as a whole, possibly on the same basis of evolutionary traits, fathers are generally the ones leaving the home, abandoning the spouse and offspring. Gender differences in attachment behavior are also shown by David and Lyons-Ruth (2005) who point to the fact that gender differences can be indicative of the possibility of higher risks of developing insecure attachments in boys (more than girls) due to the innate, biological differences between the sexes. The researchers designed an experiment in which the responses of infants were to be measured in reaction to the expression of frightening behaviors in their mothers, and discovered that female infants tend to react with disorganized but secure approaching behaviors, while male infants tend to react with “disorganized-insecure behaviors characterized by combinations of pronounced avoidance, resistance and conflict”. The authors state that these findings corroborate previous theories that affirm that females in general take a more socially-directed strategy (e.g., reliance, conformity, connection), whereas men, take a more active strategy (e.g., hostility, interference) in the face of fear.

Evolution, nonetheless, explaining a potent and instinctive factor of human behavior, is also shaped by culture, and social relationships. This is seen in the study by Levy and Kelly (2010) who demonstrated that, although a commonly sustained evolutionary perspective of jealousy is

that a male is more jealous of sexual infidelity because he does not want to invest in an offspring that is not his, and that a woman is more jealous of emotional infidelity, because this might mean that she can lose the resources provided by her partner; Levy and Kelly found that this is shaped by early attachment relations, in which people (from any gender) with a more avoidant style are much more likely to be jealous of sexual infidelity, whereas people (men and women) with secure attachments report more jealousy elicited by the possibility of emotional infidelity. The latter provides the idea that even with more biologically, instinctual-driven behaviors, there is always the need to take into account the power of the environment; nonetheless, given that the environment also acts by interacting with genes, this topic will be referenced later, after discussing the genetic basis of attachment.

Genetic basis of Attachment

Advances in the field of Genetics have started to yield findings regarding some of the genetic contributions to the understanding of attachment. Many genetic studies have found a specific allele that can point to certain risks, but have noted the importance of the environment in that special interaction, that can exacerbate or compensate for the genetic risk. Geneticists and researchers like Fox, Hane and Pine (2007) have pointed to the importance of the 5-HTTLPR, a serotonin (5-HT) transporter gene that regulates the destiny of this neurotransmitter, when it is released from the presynaptic neurons into the synaptic gap, therefore, the transponder gene alters the activity of serotonin in the system. Serotonin is a

neurotransmitter involved in mood, sleep, dreaming, motivation, attention, and other important states. This 5-HTTLPR has two functional alleles: a long and a short; and the evidence points to the fact that being homozygous for the short allele or heterozygous poses a risk for maladaptive behavior or psychopathology, including depression, behavioral inhibition, and social isolation, especially when the carrying of this gene interacts with a maladaptive environment, like constant stressful life events, and low social support. The researchers cite other studies in which individuals homozygous for the short allele of 5-HTTLPR and exposed to a certain number of stressful life events were more likely to experience a major depressive episode; children carrying the short allele with a history of abuse were more likely to experience depression; also, children with lower activity variants of the gene whose mothers experienced low social support, were more likely to display behavioral inhibition in their middle childhood years, while children with high-activity forms of the gene were somehow protected from manifesting the behavioral inhibition. On the same gene transponder, Barry, Kochanska and Philibert (2008) by taking molecular genetic measures of 88 typically developing infants focusing on the polymorphism in the serotonin transponder gene (5-HTTLPR, short and long) and observing the mother's responsiveness to their infants at 7 months in lengthy naturalistic interactions, found that being homozygous for the short allele altered the development, and the quality of attachment patterns in babies, but in a very close interaction with the maternal environment, namely the mother's quality of responding to the child's signals of play, social interaction and distress. Babies who were at high genetic risk (e.g., having

a short allele) and had a mother who was not very responsive to their signals developed insecure attachments, while on the other hand, babies also homozygous for the short allele, but with highly responsive mothers, were more likely to be securely attached to them. Interestingly enough, all of the babies who were classified as having a disorganized attachment, carried the short allele for 5-HTTLPR. This notion that babies at genetic risk can develop a disorganized attachment or not depending on the responsiveness of the mother, not only states that the gene is expressed when in interaction with a specific environment, but also that the environment can be shaped through the expression of the gene, for instance, in the child's temperament. If a child carrying the gene is more excitable, more sensible to environmental changes, and, therefore, more irritable, more prone to tears, and difficult to reassure or comfort, the mother can then start to respond in insensitive ways, paying less attention to his crying, or being more irritable herself, augmenting the risk of the expression of the gene, in a vicious cycle that dooms the child to the display of maladaptive behaviors and psychopathology. A genetic study done on animals, like this of Barr and colleagues (2008) also show that certain gene polymorphisms that are shared between rhesus macaques and humans, like the mu-opioid receptor gene (OPRM1), moderate the expression of attachment behaviors both in infants and mothers by altering the release of opioids or the blockage of opioid receptors. The study shows that during mother-infant interaction, rhesus macaques experience rewarding effects because of the release of endogenous opioids. On the other hand, after a separation from its mother, these opioids diminish resulting in the elicitation of a distress vocalization response,

that serves the function of signaling the location of the infant for the mother to find and protect from other predators. Infant rhesus monkeys that carried the OPRM1 77G allele exhibited stronger attachment to their mothers even in the baseline condition (without experiencing experimental separation), which shows a resemblance to the insecure-ambivalent infants described in the Strange Situation procedure. These human infants seemed anxious, apprehensive and did not want to leave the mother's side even before the mother left or the stranger entered. Again, these studies underscore the fact that many genetic markers are present, moderating the display of certain attachment behaviors, which can be exacerbated or compensated by more immediate environmental factors. These immediate environmental factors, at least when talking about infants, refer in general to the caregivers' personality, reactions, and ways of responding to the infants in regards to their needs.

Caregivers: The closest environment

Since the beginning of the development of Attachment Theory, mothers have been thought of being the primary caregiver, with the fathers "playing second fiddle" to the mother in the rearing practices, being the provision of emotional support to their wives' mothering, their most important role (Bretherton, 1992). It is clearer now that children do develop an attachment relationship with their fathers, but the internal working models of the father-infant relationship take longer to develop than those of the mother-infant relationship (Braungart-Rieker, Garwood, Powers, & Wang, 2001), since

the quantity and quality of the interaction that the infant has with the mother is generally greater than with the father. Newer studies have consistently shown the importance of fathers in the development of psychologically healthy children. Infants interacting with a more emotionally available father (e.g., more sensitive and more emotionally expressive) were more likely to express positive affect. In the same way, the special emotional expressions of emotionally available fathers involve the use of different and unique forms of play that the father initiates with the child; for instance, physically playful stimulation (generally the fathers' preferred form of play with the children) which is pleasurable for the infant, and gives the child the opportunity to experience a different way of feeling that is not normally given by the mother. According to the study performed by Volling, McElwain, Notaro, and Herrera (2002) infants display more positive emotional expressions (e.g., smiling, laughter) with their fathers than with their mothers. The researchers state that, although in this study, fathers as a group were not as emotionally available (e.g., as sensitive and nonintrusive) as were the mothers, infants exhibited higher levels of emotional competence (e.g., more positive and less negative affect, more focused attention during a teaching task) in the presence of more emotionally available fathers than those with less emotionally available fathers. Given that the regulation of emotions in the first years of life is a progression from heteronomy to autonomy, "of moving from a dyadic coregulation between the infant and the caregiver in the first year, to an emergence in toddlerhood of autonomous self-regulation with caregiver-guided assistance, to the eventual internalization of emotional control in the preschool years" (p. 447), then, having

an emotionally available parent, who can first show the infant how to effectively deal with emotion-eliciting situations, impacts the child's developing capacity to manage actions, thoughts, and feelings in an adaptive and flexible manner, and eventually impacts the child's ability to experience, identify and regulate emotion in a more autonomous way (Volling, McElwain, Notaro, & Herrera, 2002).

As is possible to note, the infants' relationships to both mother and father are important in the child's development, and studies like that of Caldera and Lindsey (2006) state that more important than just having a good interaction with the mother and the father independently, is for an infant to experience a well-functioning coparenting system, "characterized by the parents' mutual support of each others' child-rearing behaviors, (which) may contribute to (the) children's concordant attachment to mother and father by providing a consistent child-rearing environment" (p. 276). On the other hand, a negative or discordant coparenting relationship could be a source of stress for the couple, leaving them less emotionally available and sensitive towards the needs of the children. This study found that members from more supportive coparenting dyads displayed more responsive behavior towards their child, but when parents compete with each other for the child's attention, trying to dominate the interaction with their child, they may weaken their child's sense of security in his or her relationship with each parent, and the child is less likely to be congruent in his or her attachment to the mother and father; therefore, competitive coparenting was associated with the infant's formation of a secure attachment to one parent and an insecure attachment to the other. An

interesting conclusion from this study is that it supports a systemic view of the family, in which each member is part of a subsystem (i.e., mother-father) that can have an impact on the others (i.e., mother-infant, father-infant).

Aside from the influence of a good coparenting relationship, some caregiver characteristics, like support, sensitivity, and environmental resources, have been found to predict the outcome of the development of attachment relationships in several studies. A study conducted by Braungart-Rieker et al. (2001) revealed that infants of mothers who were more sensitive (e.g., able to perceive the infant's signals accurately, and vary their behavior accordingly) showed more affect regulation (e.g., thumb-sucking, hair-rubbing, focused-gaze) at 4 months, and were more likely to be classified as securely attached at 12 months. Although the study did find that affect regulation was important to mediate the impact of sensitive parenting on attachment, it found that avoidant infants regulated affect as well as secure infants, but had more insensitive parents, which led to the establishment of avoidant strategies (e.g., self-comforting behaviors) to regulate their emotions. Resistant or ambivalent infants, had both insensitive parents and more difficulties in regulating affect, reflected in heightened and dysregulated emotionality. Emotion regulation has also been shown to be related to mother-child concordance in regards to emotional expression. Waters et al. (2010) showed in their study of 73 mothers and their 4-year-old children, that a higher mother-child concordance (e.g., how much mother's attributions of the child's emotion were concordant with the child's own self-reports) was associated with more secure attachments and

also, to the mother's beliefs that it was important to attend and validate the child's emotions. In other words, emotionally validating mothers (e.g., who accepted the child's perspective, expressed empathy for the child's feelings and placed the child's viewpoint at the focus of the conversation), form secure attachments with their children, and are more guided towards conversing about emotion-eliciting situations and how to cope with them, therefore are more likely to understand their child's emotions and coincide with their child's labeling of their own feelings (i.e., mother-child concordance). When a mother shows her child that emotions are important and that it is good to talk about them, then the child is able to converse and not avoid talking about both positive and negative emotions. Confirming the importance of the caregiver's sensitivity and responsiveness, the research made by Cole (2006) yielded interesting results after studying the impact of the placement of orphans, or separated infants, both with kin and unrelated foster caregivers. What is interesting about the study is that the results showed there was no statistically significant difference for the development of secure attachments (e.g., attachment bond characterized by the certainty that the attachment figure is sensible and available to meet the infant's needs whenever confronted with threat or danger) between kin and unrelated foster caregivers (67% of secure attachments in kin, and 68% of secure attachments in unrelated caregivers) substantiating the fact that what is important is not being related by blood, but having a responsive, sensitive, and accessible attachment figure, who meets the emotional and physical needs of the infant. On the other hand, insensitive, unavailable and inaccessible parents, show their children that they cannot be counted

on, leaving the children the sensation of uncertainty or abandonment; these characteristics could come from the parent's personality traits or unresolved issues, depression, anxiety, and stress, which could have resulted from past perinatal losses (Armstrong, Hutti, & Myers, 2009), or from multiple miscarriages (Stanton & Simpson, 2001), have more difficulty with the development of emotional ties with their new children, possibly resulting in decreased attachment, and in the low responsiveness in the caregiver. In more serious cases, the experiences of previous losses, like multiple miscarriages and the difficulty in taking care of an unhealthy infant, may result in the decreased sense of self-care while pregnant, or in the later diminished sense of care, compassion or connection with posterior children, that could even result in infanticide (Stanton & Simpson, 2001).

Implications for development: Impact on childhood and adulthood

Although some of the implications of attachment can be inferred from what was described in relation to its biological basis; a section of this paper must be dedicated to the illustration of some of the different consequences that an attachment pattern –any attachment pattern, be it secure, insecure or disorganized- has in the life of an individual. Since the establishment of Attachment Theory, the importance of this affectional bond that ties a parent (or significant caregiver/attachment figure) to an infant has been described, by showing that it not only determines the life of the infant in the most biological sense, via

the provision of food, warmth, and sensory-motor stimulation (Hofer, 2006) but it also determines the quality of the child's psychological world, his sense of self, the perceptions of others, the development of his personality, the features of his interpersonal relationships, in two words, his mental health.

Attachment is a process, and not only a system of behaviors that only has the function of searching proximity for the sake of physical protection, but it is a self-referential process that allows the individual to build a consistent, stable and continuous sense of self (Guidano, 1999). The parents are the closest environment for an individual during the first years of life, years in which the greatest number of learning also occurs. Thus, when the parents interact with the child, by playing, teaching, talking, and other typical activities, through the way the parent speaks, looks at the child and touches the child, they are providing information on who the child is, on what makes him who he is, and on what the world thinks and feels about him. The information given by the parent, both verbal and non-verbal, is experienced as the truth, and, therefore, becomes a thread that binds the organizational elements of the individual in a whole, congruent, and coherent self. As the individual grows, more complex information and processes are lived, in a way that is consistent with this self, in order to maintain it as coherent and therefore continuous in time.

When parents are loving, sensitive, validating, and warm, children are more likely to be open to experiences, and to express emotions (Volling, McElwain, Notaro, & Herrera, 2002; Braungart-Rieker et al., 2001; Waters et al., 2010; Benoit,

2004). These will be children who will grow up to be adults who establish relationships based on trust, respect and validation of the other; they are empathic and will recognize their own limitations and strengths. When parents are rejecting, indifferent, or cold, the child experiences it as though it is a loss, developing a sense of loneliness, a lack of emotional expression (Volling, McElwain, Notaro, & Herrera, 2002) and self-sufficiency, a sense that he can only rely on himself to embrace the world; this feature can even be found at a very young age, with infants at 4 months showing a "suppression of attachment-related emotions... heightened levels of self-regulation in the face of a less sensitive mother... an early sign of developing an avoidant style" (Braungart-Rieker et al., 2001). Moreover, other studies (Pedrosa Gil et al., 2008) have showed that paternal indifference predicted more difficulty in identifying feelings, constituting the main element of Alexithymia, which has commonly been associated with psychosomatic disturbances as Fibromialgia. As adults, these avoidant children will grow up to be seen as narcissistic due to the sense of self-sufficiency, and thus will have difficulties in establishing relationships. When parents are inconsistent, incongruent, and ambivalent in their child-rearing practices, in the way they educate, communicate, and discipline, many times with strategies that are based on threats of abandonment, the child will develop a sense of uncontrollability, and due to the threats, will develop fear and heightened emotionality (Braungart-Rieker et al., 2001) to obtain the attention needed, and clinginess, as a way of avoiding abandonment by the primary caregiver. Studies show (Brumariu & Kerns, 2008) that due to this worry and preoccupation of being abandoned, ambivalent children are more

at risk of developing social anxiety in middle childhood. As adults, they will establish relationships in which the partner is more paternal or maternal to find protection, or relationships based on distrust and insecurity, and constant fear of abandonment, being likely to set different ways to test their partners for possible infidelity, or constantly question their ulterior motives for leaving them.

The impact of attachment on an infant's life is directly related to the parents' characteristics, and their relationship to the child, but also to the child's experience of parental loss or separation, with its impact on neuroendocrine regulation, and neurotransmitter activity, which in turn, elevates the likelihood of developing a psychological disorder like depression, and chronic stress. If the events of parental loss and separation are experienced in the first years of life (infancy and early childhood) and for longer periods of time, the likelihood of developing schizotypal personality disorder (SPD) can increase. Anglin, Cohen and Chen (2008) showed in their study of 766 youth followed up at mean ages of 16, 22 and 33, who had histories of separations from the mother in the early years, that participants who were separated from their mothers for at least a month during the first five years of life exhibited a significant increase in SPD symptoms (e.g., odd eccentric behavior and beliefs, suspiciousness, unusual perceptual experiences and inappropriate affect and behavior). Although the researchers found a significant relationship for participants with histories of separation occurring in the first 2 years of life, this relationship was less significant for those participants separated after 2 years of age. Also, this study showed that this relationship is more significant for males than for females, and

also more significant for participants of lower socio-economic status.

Conclusions

Attachment theory, since its earlier days, has had a significant impression in the fields of psychology, psychiatry, psychoanalysis, medicine, neurosciences, nursing, social work, and most recently, genetics. A great amount of research confirms that attachment, as a bond that ties a parent to its child, is so biological in its basis that can be evidenced in the behavior of certain animals, especially primates and some rodents, and has its basis in certain genes, hormones like prolactin and oxytocin, and neurotransmitters like serotonin to help the infant survive by seeking proximity to the attachment figure. The biological basis of attachment is said to interact with the closest environment of the infant which is represented in the quantity of time spent and quality of the relationship with the attachment figure to produce a profound impact in the infant's life and later social and emotional development.

In its immense and profound need to survive, a child will always develop an attachment relationship with his or her caregiver(s), no matter what the caregiver's characteristics are. The outcome of the relationship and of the child's socio-emotional development will depend greatly on the caregiver's characteristics, basically, his or her emotional availability, emotional sensitivity and responsiveness to the child's needs and signs of distress. In situations of parental separation, emotional

deprivation, institutionalization, abuse or neglect, children will be more likely to develop symptoms or disorders that will affect their coping skills, social interactions and even their own characteristics and relations as a parent, which confirms not only the importance of attachment in the immediate future of the child but also on the future generations.

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