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Effects of oxytocin in humans: Impact on the basic psychological processes of cognition, emotions and behavior. Role for the autonomic functions

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Abstract. *Emotional intelligence enables individuals to be more effective in their personal and social life. The neural structures that support emotional and social intelligence overlap with the structures involved in autonomic functions and decision-making, i.e. ventromedial prefrontal cortex, amygdala and insular regions. Oxytocin (OT) facilitates social bonding by enhancing cognitive control from prefrontal regions to amygdala in order to regulate emotionality. It inhibits excitatory flow from the amygdala to brainstem sites mediating fear response and reduces social anxiety that results in a greater willingness to trust and bond to other people. OT has empathogenic properties and it's agonists may be a useful therapy in enhancing socially motivated learning and emotional empathy in disorders such as autism and schizophrenia. This neuropeptide may promote mother–infant attachment. OT levels are associated with interactive synchrony between parent and child and appear to play an important role in promoting responsive parental caregiving. Increased values of heart rate variability (HRV) are associated with positive emotions such as cheerfulness and tranquility. Heart rate variability is a reliable indicator of the psychological background, of approach-related motivation and hence of the autonomic nervous system balance.*

Key words: oxytocin, prosocial behavior, anxiety, heart rate variability.

Background

Emotional intelligence is a type of social intelligence that determines the capacity of a person for creating sustainable and flexible social relationships. The main features of emotional intelligence are the following: the ability to be aware of one's own emotions and to express them, to be aware of others' feelings and to establish interpersonal relationships, to manage and regulate emotions, to cope with the immediate situations and solve problems of a personal and interpersonal nature and to generate positive affect in order to be sufficiently self-motivated to achieve personal goals (Salovey, P., Mayer, J.D., 1990). Emotional intelligence enables individuals to cope with daily demands and be more effective in their personal and social life (Mayer, J., Salovey, P., 1993). Emotional intelligence marks the intersection between two fundamental components of personality: the cognitive and the emotional systems. Together with cognitive intelligence, emotional and social intelligence form important components of general intelligence. One of the major differences between the two is that the former is thought to relate primarily to higher order mental processes like reasoning,

while the latter focuses more on perceiving, immediate processing and applying emotional and social content. Cognitive intelligence is more cortically based, while emotional and social intelligence involve the limbic system for immediate behavior suited for survival and adaptation (Bar-On, R., 2001: 82-97).

The neural systems that support emotional and social intelligence overlap with the structures subserving autonomic activation and decision-making, i.e. ventromedial prefrontal cortex (VM), amygdala and insular regions. Two of the most important emotional intelligence competencies – self-regard (accurate self-awareness) and assertiveness (self-expression) are affected by brain injury in this neural circuitry. Patients with lesions to the VM prefrontal cortex manifest some autonomic disbalance and tend to exercise poor judgment in decision-making, which is displayed in the disadvantageous choices they make in their personal lives and in the ways in which they relate with others. There are a number of alterations of emotional experience, social functioning (Bechara, A., Tranel, D., Damasio, A.R., 2000: 192-214) and the ability to effectively cope with daily demands in these patients. Furthermore, lesions to the amygdala or insular cortices, especially on the right side, also compromise the same functions.

The process of judgment and decision-making depends on systems involved in: memory, which is supported by high-order association cortices as well as the dorsolateral prefrontal cortex; emotions, which are mediated by subcortical limbic structures and feelings which are supported by limbic system as well as the insula, surrounding parietal cortices and the cingulate cortex. Therefore, damage to the systems that impact emotions, feelings or memory usually compromise the ability to make advantageous decisions (Bar-On, R., Fund, S., Handley, R., 2003). The VM prefrontal cortex links these systems together. To perform well and be successful in one's professional and personal life apparently requires the ability to make emotionally and socially intelligent decisions more than just having a high IQ. One of the factors determining the emotional intelligence and the psychological state of humans is oxytocin that is the subject of our review.

Oxytocin receptors in the brain structures and in the periphery tissues

Oxytocin (OT) is a neuropeptide that is produced in the structures of the hypothalamus. It has many central effects mediated by the receptors in the brain and peripheral effects on the target organs.

The OT receptors are widely distributed in brain regions implicated in cognition and emotion (Hein, G., Singer, T., 2008) as well as in several central autonomic nuclei, including the dorsal motor nucleus of the vagus, nucleus ambiguus and nucleus tractus solitarius (Higa, K.T., Mori, E., Viani, F.F., Morris, M., Michelini, L.C., 2002). OT may also impact the autonomic control through its influence on neural structures such as the amygdala – a structure expressing high-density OT receptors (Tribollet, E., Dubois-Dauphin, M., Dreifuss, J.J., Barberis C., Jard, S., 1992) and orchestrating complex autonomic functions (Davis, M., Whalen, P., 2001).

The amygdala is referred to as a neural hub because of its high degree of connectivity, which is critical for the flow and integration of information between regions (Pessoa, L., 2008). It is strongly connected with other brain regions involved in emotional processing such as the orbitofrontal cortex (OFC), the supra- and subgenual parts of the anterior cingulate cortex (ACC), the brainstem and the thalamus (Pessoa, L., 2008). Several studies have shown that modulating amygdala activity can shift neural output towards other brain regions within this network. For example, Kirsch et al. (Kirsch, P., Esslinger, C., Chen, Q., Mier, D., Lis, S., Siddhanti, S., Gruppe, H., Mattay, VS., Gallhofer, B., Meyer-Lindenberg, A., 2005) established that OT reduces amygdala-brainstem coupling that is important for fear and arousal. Van Wingen et al. (van Wingen, G., Mattern, C., Verkes, R.J., Buitelaar, J., Fernández, G., 2010) showed that OFC-amygdala coupling was reduced