ISSN 2347-6893

VISUAL SEXUAL STIMULATION THROUGH THE AMYGDALA MAY AFFECT THE INDIVIDUALS EMOTIONAL STATE

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ABSTRACT

The nature of sexual stimulation in the brain is not well established. In this regard, the role of emotional brain (which is called as the amygdaloid complex) needs to be evaluated more precisely. The amygdala is a silent region in the temporal part of the brain which has enriched connections with the parts of the brain both involved in the cognition functions and sensory information process. These connections gives the amygdala to receive unique information from visual cortex about the environments as well as other parts of the body, merge these information and produce sufficient outputs to the different parts of the frontal cortex to exhibit a behavior relevant to the stimulation. The present study tries to review the data exist about this function of the amygdala.

Keywords

sexual stimuli; visual inputs; Amygdala; emotional State

Academic Discipline And Sub-Disciplines

Sociology; Psychology; neuroscience.

TYPE (METHOD/APPROACH)

Review article

Council for Innovative Research

Peer Review Research Publishing System

Journal: JOURNAL OF ADVANCES IN BIOLOGY

Vol .8, No.2

www.cirjab.com , editorsjab@gmail.com

INTRODUCTION

The amygdaloidal complex located in the medial temporal lobe is a brain structure that directly mediates aspects of emotional learning and facilitates memory operations in other regions, including the hippocampus and prefrontal cortex. On the other hands, the amygdala is a structure with extensive connections to brain areas thought to underlie cognitive functions, such as sensory cortices, the hippocampal complex, and the prefrontal cortex**.** The amygdala is most often discussed in the context of emotional processes; yet it is extensively interconnected with the PFC, especially the posterior orbitofrontal cortex (OFC), and the anterior cingulate cortex (ACC).Moreover, output from the amygdala is directed to a wide range of target structures, including the PFC, the striatum, sensory cortices (including primary sensory cortices, connections which are probably unique to primates), the hippocampus, the perirhinal cortex, the entorhinal cortex, and the basal forebrain, and subcortical structures responsible for aspects of physiological responses related to emotion, such as autonomic responses, hormonal responses, and startle [1]. The bidirectional communication between the amygdala and the OFC, as well as the connections with the rest of the PFC, provide a potential basis for the integration of cognitive, emotional, and physiological processes into a unified representation of mental states.

Sensory information enters the amygdala from advanced levels of visual, auditory, and somatosensory cortices, from the olfactory system, and from poly sensory brain areas such as the perirhinal cortex and the parahippocampal gyrus [2-4]. But much of our understanding of the outside world is through the sense of sight. The studies have shown that 65 to80percent of cognition and perception of the environment are performed through the sense of sight then this information will enter into memory. [5, 6] One of the Visual inputs can be Visual sexual stimuli. Visual sexual stimuli can be viewed as emotion-laden. In humans, different brain regions are implicated in the processing of emotion-laden visual stimuli including the hypothalamus, thalamus, medial prefrontal cortex, anterior temporal cortex, occipitotemporal cortex, amygdala, hippocampal formational, and ventral striatum. But the amygdala is more important in emotion-laden visual stimuli. Studies have shown that larger amygdala may act better in its role as a processor of emotional stimuli, specifically social/sexual cues, and in the attachment of significance to such stimuli [7, 8, 5]. Further evidence for the role of the amygdala in human sexual functioning is derived from the observation that stimulation of the amygdala can elicit human sexual responses [9,10] as well as from functional neuroimaging studies which have demonstrated amygdala activation in response to sexual stimuli [9, 11- 13]. Researches suggest that the temporal lobes are a critical region in the mediation of human sexual behavior, with the amygdala playing an integral role in regulating human sexual drive. [9, 12]

More recent studies have demonstrated that the amygdala's response to emotional stimuli is more general; moreover, it responds primarily to the strength or intensity of a pleasant or unpleasant stimulus [14 -18, 1]

On the other hand, studies have shown that the amygdala is different in men and women; these sexual dimorphisms of amygdala nuclei have been demonstrated in terms of volume, neuronal density, and density of specific neuronal populations. The studies have shown that the right amygdala was associated with greater functional connectivity in men than in women. In contrast, the left amygdala was associated with greater functional connectivity in women than in men [7]. Furthermore, the regions displaying stronger functional connectivity with the right amygdala in males (sensorimotor cortex, striatum, pulvinar) differed from those displaying stronger functional connectivity with the left amygdala in females (subgenual cortex, hypothalamus). These differences in functional connectivity at rest may link to sex-related differences in medical and psychiatric disorders. [7] These sex differences in the amygdala's function may be related to the structural and developmental sex differences that have been found previously for this structure, such as the high concentration of sex hormone receptors and the larger size of the amygdala in men than women [19].

In addition, the amygdala acts differently in terms of emotional memory and in responses to sexually arousing stimuli in men and women.

Memory for emotional events is generally better than memory for emotionally neutral events [16]. Several psychological studies have reported that men and women differ substantially with respect to emotional memory [15].In addition, the fact that emotional memories tend to be stronger for women may be linked to the greater prevalence of depression and some types of anxiety disorders in women [20].

These data indicate that improper visual inputs such disagreeable scenes, including scenes of sexually arousing stimuli can affect the brain system leading to devastating consequences in both sexes.

Given all the issues mentioned above, management of emotional responses particularly in the society is of great importance; in addition, religious teachings can be utilized to help us in this regard which can be effective factors in managing emotional responses caused by visual sexual stimulation.

The role of the amygdala in emotional Processing

The amygdaloid complex is located in the medial temporal lobe that has long been known to play a key role in emotional responses and emotional memory in both humans and nonhuman animals. Neurobehavioral theorists have frequently argued that the amygdala plays a central role in the emotional processing of sensory stimuli. [7]. The amygdala is not the only brain structure that has been identified as important for emotional processes in humans, but it is the most thoroughly investigated issue to date. The cognitive neuroscience research on the human amygdala has been drawn from neuroscience studies in nonhuman animals and behavioral paradigms derived from cognitive, social, personality, and clinical psychology. [21]

The amygdala is a brain structure that directly mediates aspects of emotional learning and facilitates memory operations in other regions, including the hippocampus and prefrontal cortex [22, 21]

On the other hands, the amygdala is a structure with extensive connections to brain areas thought to underlie cognitive functions, such as sensory cortices, the hippocampal complex, and the prefrontal cortex [23].

In this framework, functional interactions between the amygdala and prefrontal cortex mediate emotional influences on cognitive processes such as decision-making as well as the cognitive regulation of emotion. . [22, 24]

Neural representations in the amygdala may be more biased toward encoding mental state variables characterizing emotions (valence and intensity). PFC neurons may encode a broader range of variables in an entangled fashion, reflecting the complexity of the behavior and cognition that are its putative outputs [25, 22]. The bidirectional connections between the amygdala and the PFC could form the basis of many interactions between cognition and emotion. [26, 25, 22]

Within the lateral nucleus, the primary target of projections from unimodal sensory cortices, different sensory modalities are segregated anatomically. But, owing in part to intrinsic connections, multimodal encoding subsequently emerges in the lateral, basal, accessory basal, and other nuclei of the amygdala [27, 28]. Output from the amygdala is directed to a wide range of target structures, including the PFC, the striatum, sensory cortices (including primary sensory cortices, connections which are probably unique to primates), the hippocampus, the perirhinal cortex, the entorhinal cortex, and the basal forebrain, and to subcortical structures responsible for aspects of physiological responses related to emotion, such as autonomic responses, hormonal responses, and startle [1]. In general, subcortical projections originate from the central nucleus; and projections to cortex and the striatum originate from the basal, accessory basal, and in some cases the lateral nuclei [2, 29 - 34, 4]

The amygdala is most often discussed in the context of emotional processes; yet it is extensively interconnected with the PFC, especially the posterior orbitofrontal cortex (OFC), and the anterior cingulate cortex (ACC).

In addition, the PFC receives inputs that could inform it about internal mental state variables, such as motivation and emotions. Orbital and medial PFC are closely connected with limbic structures such as the amygdala; moreover, they have direct and indirect connections with the hippocampus and rhinal cortices [35-38].

Although there are diffuse bidirectional projections between amygdala and much of the PFC [33], the densest interconnections are between the amygdala and orbital areas and medial areas.

Amygdala input to the PFC often terminates in both superficial and deep layers. OFC output to the amygdala originates in deep layers, and in some cases also in superficial layers, suggesting both feed forward and feedback modes of information transmission (Ghashghaei, [33].

Some OFC output is directed to the intercalated masses, a ribbon of inhibitory neurons in the amygdala that inhibits activity in the central nucleus [33, 39]. In addition, the OFC projects directly to the central nucleus, providing a means by which the OFC can activate this output structure in addition to inhibiting it [40, 4, 28].

Finally, the OFC projects to the basal, accessory basal and lateral nuclei, where it may influence computations occurring within the amygdala [40, 28, 4].

Overall, the bidirectional communication between the amygdala and the OFC, as well as the connections with the rest of the PFC, provides a potential basis for the integration of cognitive, emotional, and physiological processes into a unified representation of mental states (amygdala prefrontal cortex).

The role of the amygdala in the perception of visual sexual stimuli

Sensory information enters the amygdala from advanced levels of visual, auditory, and somatosensory cortices, from the olfactory system, and from poly sensory brain areas such as the perirhinal cortex and the parahippocampal gyrus [2-4].

Visual sexual stimuli can be viewed as emotion-laden. In humans, brain regions that are implicated in the processing of emotion-laden visual stimuli include the hypothalamus, thalamus, medial prefrontal cortex, anterior temporal cortex, occipitotemporal cortex, amygdala, hippocampal formational, and ventral striatum. Furthermore, the anterior cingulate, occipitotemporal and orbitofrontal cortices, as well as the insula, ventral striatum, claustrum, nucleus accumbens, parietal lobules, thalamus, and hypothalamus have all been shown to respond to sexually explicit films in men.

A recent study has directly examined the role of the amygdala in human sexual functioning. Baird and colleagues compared amygdala volumes in groups of patients with or without sexual changes following temporal lobe resection for epilepsy and in age matched controls. On average, patients who reported a postoperative sexual increase had a significantly larger amygdala volume contralateral to the site of their respective surgery than patients with a sexual decrease, no change or controls. [9]

There was a significant positive relationship between contralateral amygdala volume and the maximum degree of sexual change. This suggests that a larger contralateral amygdala may contribute to the expression of increased or improved sexuality after temporal lobe resection [9 , 41]

A larger amygdala may function better in its role as a processor of emotional stimuli, specifically social/sexual cues, and in the attachment of significance to such stimuli. This would increase the likelihood of sexual response, resulting in a sexual increase [9, 41].

Further evidence for the role of the amygdala in human sexual functioning is derived from the observation that stimulation of the amygdala can elicit human sexual responses [9, 43, 44] .Further evidence for the integral role of the amygdalae in mediating human sexual drive is gained from functional neuroimaging studies which have demonstrated amygdala activation in response to sexual stimuli [9, 45, 43]. Specifically, consummatory sexual behavior (erection and orgasm) corresponds with decreased amygdala activity whereas appetitive sexual behavior (viewing of sexual stimuli) is associated with amygdala activation. [9 , 14, 15]

Accumulating evidence suggests that the temporal lobes are a critical region in the mediation of human sexual behavior, with the amygdalae playing an integral role in regulating human sexual drive. [9, 14, 15]

More recent studies have demonstrated that the amygdala's response to emotional stimuli is more general and that it responds primarily to the strength or intensity of a pleasant or unpleasant stimulus [17, 1, 18].

Different responses of the amygdala in women and men

Sexual dimorphisms of amygdala nuclei have been demonstrated in terms of volume, neuronal density, and density of specific neuronal populations [46]. Human studies have demonstrated larger amygdala relative to total cerebral size in men compared with women [47]

The right amygdala was associated with greater functional connectivity in men than in women. In contrast, the left amygdala was associated with greater functional connectivity in women than in men [7, 48]

Furthermore, the regions displaying stronger functional connectivity with the right amygdala in males (sensorimotor cortex, striatum, pulvinar) differed from those displaying stronger functional connectivity with the left amygdala in females (subgenual cortex, hypothalamus). These differences in functional connectivity at rest may link to sex-related differences in medical and psychiatric disorders. [7, 49]

Sex-related differences in the relationship between the amygdala and subsequent recall of the emotional films arose in the absence of a sex-related difference in arousal ratings or in free recall performance for the two sets of film clips. In men, enhanced activity of the right amygdala, but not the left, was related to enhanced recall for emotional film clips. In women, enhanced activity of the left amygdala, but not the right, was related to enhanced recall for emotional film clips. This basic finding was later confirmed in an event-related fMRI investigation of the neural bases of the evaluation and encoding of emotional stimuli [50].

Studies with rats with amygdala lesions have highlighted a key distinction between the role of the male amygdala in so-called appetitive and consummatory sexual behaviors. Appetitive sexual behaviors involve motivation to obtain a sexual reward (i.e., desire or wanting), whereas consummatory sexual behaviors involve obtaining a reward (i.e. copulation). [7]

Moving to studies of humans, researchers have drawn on these previous animal findings to guide their search for brain regions that may differ between men and women in the domain of sexual behavior.

These studies have used neuroimaging to examine the brain basis underlying a major sex difference in responses to appetitive visual sexual stimuli, namely, the greater male response to such stimuli. Numerous studies have demonstrated that men are more psychologically and physiologically responsive to visual sexually arousing stimuli and display a greater motivation to seek out and interact with such stimuli [51]. This specific sex difference is predicted by evolutionary and sociobiological theories that postulate that it is adaptive for males to react rapidly to visual information that signals an opportunity to mate with a fertile female because this tends to increase their probability of passing on their genes.

Scientists recently conducted an fMRI study investigating this issue [14, 15]. Of particular interest was whether men and women would differ in activity in the amygdala and hypothalamus, based both on prior converging evidence from animal studies and the key role of the amygdala in mediating emotional responses.

The scientists have shown that the amygdala and hypothalamus exhibited substantially more activation in men than in women when viewing the same sexually arousing visual stimuli.

In contrast to men, there was a lack of significant activity in the bilateral amygdala and the hypothalamus for women in response to sexually arousing photographs.

Remarkably, Greater activity for men in the hypothalamus (which receives substantial amygdalar output) was observed but greater activity in the amygdala itself was not found.

The greater amygdala activation for men reflects a greater appetitive motivation or desire elicited by visual sexual stimuli.

Men are generally more interested in and responsive to visual and sexual arousing stimuli than are women. Sex differences were specific to the sexual nature of the stimuli and they were restricted primarily to limbic regions, and were larger in the left amygdala than in the right amygdala. [51, 14, 15]

Functional neuroimaging studies have identified a growing number of sex differences in human brain function. In addition to cognitive differences, men and women also differ markedly in aspects of sexual behavior, such as the reportedly greater male interest in and response to sexually arousing visual stimuli.

The amygdala and hypothalamus have also been linked to male responses to sexually arousing stimuli in neuroimaging studies.

Sex differences in activations to sexual stimuli could arise from differences in processing mode between men and women (e.g.., different cognitive styles or neural pathways), from activations related to higher arousal, irrespective of biological sex, or from combination of these factors.

Strong positive correlations between emotional arousal and amygdala activity have been reported for both appetitive and aversive stimuli and arousal has been suggested as the primary factor influencing amygdala activity in response to olfactory and visual stimulation.

Psychological studies have identified a variety of sex differences in emotion-related behavior in humans. For example, women on average retain stronger and more vivid memories for emotional events than men [52, 50].

Another prominent human sex difference is the substantially greater role that visual stimuli play in male sexual behavior.

Recent neuroimaging studies using positron emission tomography (PET) and functional MRI (fMRI) have revealed that these and other sex differences in emotional responses are closely linked to differences in amygdala response. Recent findings highlight an emerging new role for the amygdala as a key structure that mediates differences in emotional and sexual responses between men and women.

These sex differences in the amygdala's function may be related to the structural and developmental sex differences that have been found previously for this structure, such as the high concentration of sex hormone receptors and the larger size of the amygdala in men than in women [19].

In addition to functional differences in amygdala response, such as in emotional memory and in responses to sexually arousing stimuli, the amygdala in men and women differs in terms of structure and in aspects of brain development. These structural and developmental differences likely contribute to the functional differences observed in neuroimaging studies.

One major difference between the sexes is the size of the amygdala. In the adult human brain, the male amygdala is significantly larger than the female amygdala, even when total brain size is taken into account [47].

Structural differences in brain anatomy often are associated with differences in brain function and response. For example, one recent study found a relation between the size of the amygdala in patients with epilepsy and sexual drive; patients with greater residual amygdala size after undergoing neurosurgery reported greater sexual drive and motivation [9].

The brain regions that differ in size between men and women tend also to be the same regions that contain high concentrations of sex hormone receptors, suggesting that male and female hormones play a role in determining the size of specific brain regions such as the amygdala during brain development [47].

Other structural differences in areas that receive strong neuronal connections from the amygdala, such as the hypothalamus, which is larger in men than women, may also contribute to sex differences in brain response that involves the amygdala.

Memory for emotional events is generally better than memory for emotionally neutral events [16].Several psychological studies have reported that men and women differ substantially with respect to emotional memory [14, 15].

Sexual arousal through sense of vision: from Islam's viewpoint

As mentioned earlier, visual inputs can have a remarkable effect on amygdala's sexual arousal. Amygdala functions as the first part of brain in processing visual sexual stimuli and it controls neural representation from amygdala to hypothalamus and physiological and hormonal responses associated with sexual arousal. Negative effects on amygdala may occur when the arousal is intense leading to great stimulation of amygdala.

Moreover, the psychological stress caused by visual sexual stimulation which has aroused amygdala and caused sexual excitement can be inhibited thorough satisfaction of sexual desire; however, if not controlled and responded well, it can cause physiological and psychological disorders as well as loss of efficiency and brain ageing, especially when the individual is constantly facing these stimulations unable to properly satisfy them.

Amygdala plays a crucial role in stimulation of sexual desire; amygdala is activated through watching or imagining a sexual scene which in result activates the reward system; this system initially stimulates the desire to gain reward and it does not stop until it gains the reward (mating). As a result, the person who is stimulated will feel this sexual system in his brain until he/she gains the reward. Interestingly, Islamic teachings offer some solutions to help us relieve the stress caused by sexual arousal and calm the amygdala: "if a man gets aroused by seeing a woman, he should associate with his wife." [53, 54]

Besides, as mentioned earlier, visual sexual stimulation is greater in men than in women; moreover, visual sexual stimulation naturally activates the amygdala-hypothalamus path more in men than in women; therefore, although sexual stimulation such as inappropriate dressing of men can be sexually arousing for both males and females, sexual stimulation due to inappropriate dressing of women can have a greater effect on males. Accordingly, theological and Islamic teachings which set some regulations regarding appropriate way of dressing for men and women when encountering strange people (not their husband or wife) in the community can help us manage sexual stimulation and arousal through sense of vision. If not managed properly, this stimulation can cause some psychological diseases and sexual deviations such as voyeurism in which a person derives sexual pleasure and gratification from looking at opposite sex. Interestingly, Islam and religious teachings inhibit a person from deliberate looking at a person's genital other than his/her wife/husband. [55, 56]

In contrast, there is another sexual deviation called exhibitionism in which a person derives sexual pleasure by exposing his sexual organs. This issue can also be managed by using some Islamic teachings such as: "do not show your private parts to anybody other than your husband or wife" [57] or "God has no mercy on he who exhibits his/her sexual organs." [58]

Based on what was mentioned above, if we impose similar sexually arousing inputs on men and women, men are expected to express greater sexual responses due to their higher sexual arousal and less sexual control.

Moreover, those teachings presented in Islam and other religions can be viewed from two aspects: first, what a person should do not to receivesexually arousing inputs; second, what a person should do to prevent sexually arousing stimulations; in other words, no to do sexually arousing deeds and behaviors [59, 60]. As mentioned above, according to brain structure of man and woman, the role of women seems to be greater in preventing sexual stimulations whereas men have a greater role in controlling sexually arousing inputs since he is more easily aroused than woman.

Obligation to Cover and Inhibition of Exhibitionism

It is interesting to note that, based on these teachings, both men and women should refrain from sexual stimulation in relationships other than marital relationships and they should also prevent from exhibitionism and sexual arousal through sense of vision by using appropriate dressing; however, the teachings put more emphasis on prevention of stimulation by women. [61- 63].

From another perspective, these teachings obligate men and women to inhibit sexually arousing look; however, they put a great emphasis on the fact that men should control their sense of vision inputs by refraining from sexually arousing looks which is interestingly consistent with the structure of men's brain and their sexual responses in facing visual sexual stimulations. [64 – 66].

CONCLUSION:

Collectively, the findings support the notion that the amygdala is a key structure mediating differences in emotional behaviors between men and women.

As noted previously, the greater prevalence of some psychological disorders may stem in part from sex differences in amygdala responses [7].The clear clinical implication of this link is that a better understanding of how amygdala function differs between men and women should help shed light on the biological basis for these disorders.

Sex differences in human behavior can arise from multiple causes; including alterations in brain development, differences in brain morphology, and the effects of sex hormones, or different social experiences of men and women.

Amygdala is a part of the brain which controls excitements and emotions and is activated in sexual stimulations which cause a great emotional response.

Larger amygdala in men than in women may cause a man to show greater responses when facing a sexually arousing scene. Those parts of amygdala in men which contain a high concentration of sex hormone receptors are larger.

In terms of physiological and psychological aspects, men express greater responses to visual sexual stimulations and the amygdala-hypothalamus path in their brain is more active compared to that of women.

To manage the excitements caused by receiving visual sexual stimulations, we can benefit from some religious teachings. Islam highly emphasizes the prevention from voyeurism and sexually arousing inputs; however, this emphasis is more put on a man which is consistent with more sexual arousal of men's amygdala than women.

One the other hand, religious teachings present some examples through which we can manage visual sexual stimulation of amygdala. Islam insists on maintaining proper dress; however, this insistence is more directed towards women who can manage visual sexual stimulation particularly since men are sexually aroused quite more easily than women do.

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