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Review

Informational dichotomy of the mind; the role of sexual neuromodulators

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Abstract

Many basic physiological mechanisms of sexuality were initially studied on animal subjects and conclusions regarding human subjects extrapolated afterward. These ancestral reflexes are assumed to have ascended during human evolution to the cerebral level, where cognition would intermediate (being an environmental operator) both sexual and mental processes. Accordingly, the study of human sexuality suggests an additional/ particular documentation regarding mental existence and its implication, phenomena that are not characteristic of animals.

In a previously published paper we presented ideas regarding the structural dichotomy of the mind and its subsequent implications to sexuality. In this paper we present a general perspective regarding the informational dichotomy of the mind and sexuality, which will be followed by a forthcoming paper that addresses the relational dichotomy of the mind and brain.

Though these psychological implications may initially seem implausible, they represent in our opinion essential hypothetical perspectives that could further promote a better understanding of both cognition and sexuality.

Keywords: informational, dichotomy, mind; sexual hormones, sexual pheromones

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Introduction

Traditionally, sexual desire has been largely considered a mental-psychological event. In contrast, the sexual arousal process has been described primarily as a neurophysiological response/ reaction to external sexual stimuli (1, 2). Yet contrary to this classically-assumed dichotomy, recent evidence shows that sexual desire—like arousal—also constitutes a response to specific stimuli, and that the autonomic responses of sexual arousal and erection can be initiated and sustained by the voluntary decision-making processes of the mind (3, 4). As a consequence, sexual desire and sexual arousal appear more similar in process and interrelated than had originally been assumed, being activated and executed by a common psycho-physiologic support system within the brain (5, 6).

A common underlying psycho-physiologic support system for both cognition and sexuality suggests the possibility of mental competition between cognitive tasks and sexual activation/ response. As an example, excessive abstract preoccupation with, say, one's professional qualifications (a cognitive task) acts as a risk factor for primary reduced libido (a sexual response characterized by decreased libido in subjects with an overall healthy disposition), due perhaps to competition between cognitive and sexual information, with both types of information relying upon a single common (cortical-hypothalamic) neurophysiological support system (7). Due to these interdependencies, numerous mental disturbances are often associated with specific sexual disorders (8, 9). This presumed competition between cognition and sexuality would be responsible for the first dichotomy of the mind, which is relational in nature. This relational dichotomy is physiologically possible through the intervention of distinct (cognitive or sexual) cerebral neuromodulators, which achieve the role of assigning external sexual stimuli to either a cognitive or sexual interpretation (10, 11).

The second dichotomy refers to the informational dichotomy of the brain, which is generated by the intervention of sexual neuromodulators, acting either on the thalamic/ concrete domain of the mind (sexual pheromones) or on the hypothalamic/ abstract domain (sexual hormones) (5, 11).

Finally, a third dichotomy of the mind, a structural dichotomy, results from the anatomical organization of the brain into two distinct and competitive (left versus right hemispheres) neurological structures. This structural dichotomy and the resulting implication of sexual neuromodulators have been described in a previously published paper (4).

In this paper we address the informational dichotomy of the mind and the role of sexual hormones and pheromones therein. These ideas are followed with a brief summary of the relational dichotomy, with fuller elaboration to be presented in a forthcoming paper.

Discussion

- *Ascension of sexual function to cerebral level; the relational dichotomy*

From a phylogenetic perspective, somatic-environmental interaction was performed in primitive ancestors at the level of the spinal cord. Through the course of human evolution, both somatic and autonomic-sexual processes ascended from the spinal cord to the cerebral level, in the form of cognition and sexual desire/ arousal. This evolution is a consequence of the fact that both cognition and sexuality are by nature relational-environmental functions, being processed by common somatic peripheral afferents. Ascension of somatic spinal reflexes to the level of the brain (in the form of cognition) assumes the inevitable ascension of the corresponding autonomic spinal reflexes of sexuality. Indeed, several studies have documented both sympathetic and parasympathetic neurological areas within the brain that are directly involved in sexual control and response (of erection, ejaculation and orgasm) (12, 13).

From a psychological perspective, attentional focus and decision-making are able to opt between cognitive and sexual commitments. The mind, being relational-environmental in nature, must have access to both cognitive and sexual information originating from the environment. In fact external information is indivisible, for example, external representation/information of one's partner can be appreciated either cognitively or sexually, according to one's choice/ context. Thus, the external representation/information is unitary, but its dichotomy into either cognitive or sexual information must result in the brain through the influence of cognitive or sexual neuromodulators. Sexual hormonal and pheromonal modulators increase the likelihood of a sexual interpretation of the external information, while norepinephrine, histamine, etc. favor a cognitive processing of the same external information (14, 15).

- *Structural dichotomy of the mind*

The human brain is divided into two symmetrical yet competitive hemibrains. Multiple cerebral functions [hand preference (16), language (17), memory (18), emotion (19),

sexuality (20, 21)] are usually processed in only one hemibrain (the dominant hemisphere), while the opposite hemibrain serves especially for neurological connections with the corresponding peripheral receptors/ effectors (from the contralateral side of the body). Cognitive and sexual neuromodulators support the relational dichotomy of the mind, delineating external information received by our brain into cognitive and sexual "data." Taking into consideration only the sexual input, male and female sexual neuromodulators support a specific structural dichotomy of sexuality. Specifically, estrogens and female pheromones modulate environmental inputs toward the right hemibrain, while androgens and male pheromones activate especially the left hemibrain (22, 23).

Although female sexual neuromodulators (estrogens and female pheromones) activate the right hemibrain and male sexual neuromodulators (androgens and male pheromones) the left, connection with hand preference is different for hormones and pheromones. Thus, estrogens would activate the right hemibrain in right handed persons, while female pheromones would activate the same right hemibrain in left handed persons. In an opposing manner, androgens would activate the left hemibrain in left handed persons, while male pheromones would activate the same left hemibrain in right handed persons (4, 22, 23). These divergences between hormones and pheromones is the consequence of the informational dichotomy of the mind, sexual hormones being related to the hypothalamic-abstract-extrapyramidal system (descending extrapyramidal fibers doesn't cross), while sexual pheromones are related to the thalamic-concrete-pyramidal system (descending pyramidal fibers crossing at decussation).

- *Informational dichotomy of the mind*

Traditionally external information enters through the classical thalamic input route, which peripherally is represented by receptors, at the intermediate level by the thalamus, and at the superior level by primary sensory cortex (the cortical gateway for environmental information). At any level, this input may be blocked, meaning the cortex is unable to receive the corresponding input/ information (5, 6). However, recent studies with positron emission tomography and functional magnetic resonance imaging show that erotic visual stimuli may circumvent the primary visual cortex, yet enter the cortex and consciousness, with the primary visual cortex being in fact strongly de-activated. This observation suggests that erotic visual stimuli may actually disengage the classical thalamic input route (24), ascending and activating cortical areas/ mind through a parallel (hypothalamo-cortical) input route (5, 25). In support of the idea of two distinct (thalamic and hypothalamic) input routes for visual stimuli, distinct (dorsal and ventral) input streams have already been identified for several sensory modalities, including temperature (26), audition (27), touch (28), skilled grasp (29), language (30), and so on.

The two distinct input routes are connected as afferents to two distinct and antagonistic cortical networks, represented by the task-positive network (TPN) and the default mode network (DMN). These two cortical networks are related to distinct and incompatible cognitive models, with imaging studies showing that the two cortical networks usually exert reciprocal inhibition. In fact, the classical/ dorsal thalamic input route of information corresponds to the dorsal system of attention, while the newly described ventral hypothalamic input route would correspond to the ventral system of attention (5).

To summarize, there are two distinct cerebral units that are reciprocally inhibiting: a) the first is represented centrally by the task-positive network that is linked peripherally via the thalamic input route and b) the second that is centrally represented by the default mode network that is linked peripherally via the hypothalamic input route. Being incompatible, these two distinct cerebral units are connected to distinct output routes, which are represented by the two distinct and incompatible motor efferents: the pyramidal route (cortico-bulbar and cortico- spinal tracts) and the extrapyramidal route (from cortex, basal ganglia, cerebellum, to reticular formation of pons and medulla) (22, 23).

The two output routes are incompatible with one another because on the one hand they originate from distinct cerebral centers, and because on the other hand, they correspond to opposite descending tracts. Centrally, the pyramidal system of the right hemibrain coordinates the left hand (due to decussation), while the extrapyramidal system of the right hemibrain coordinates the right hand (no decussation). Peripherally, a right hand preference should imply a dual innervation: through the pyramidal system from the left cerebral hemisphere and through extrapyramidal system from the right hemisphere. Thus, right hand usage/ preference is not associated with only one cerebral hemisphere, rather both hemispheres must be activated. In other words, the anatomical organization of the pyramidal and extrapyramidal systems would be incompatible with the physiologic concept of laterality/ dominant hemisphere, where one hemisphere takes precedent over the other in controlling output. As a

consequence, it is probable that the two (pyramidal and extrapyramidal) output routes are activated separately, similar to the two input routes (22, 23).

In conclusion, the two cerebral units might function as follows: the first is for the "concrete" mind and involves the thalamic input route/ task-positive network/ pyramidal output route; the second is for "abstract" mind and involves the hypothalamic input route/ default mode network/ extrapyramidal route. Sexual hormones activate the abstract mind while sexual pheromones activate the concrete mind. This dual system explains why estrogens activate the right hemibrain in right handed persons, while female pheromones activate the same right hemibrain in left handed persons. This difference is due to the fact that estrogens are related to the extrapyramidal system of right hemibrain (that has no decussation), while female pheromones are related to pyramidal system of right hemibrain (that crosses at decussation).

Conclusions

Many basic aspects of sexuality (erection, emission and expulsion reflexes, for example) were initially studied on animal subjects, and extrapolated and later documented in humans (31). These ancestral reflexes ascended in humans to the cerebral level due to expanded cognitive capacity, which (serving as an environmental operator) enables/ mediates both sexual and mental processes. As a consequence, the study of sexuality implies in humans specific aspects/ studies that are not possible on animals, namely studies related to the involvement of cognitive processing in sexual behavior and response.

In psycho-physiological terms, even if mental function is somatic in nature, it presents characteristics that are specific to the autonomic nervous system (operating on internal stimuli/ ideas, elaboration of internal responses, and presenting autonomic functioning/ disruption from environment). At opposite pole, even though sexual function is autonomic in nature (erection supposes vasodilatation and ejaculation contraction of seminal vesicles, etc.), it in fact requires strong somatic participation (sexual activation requires an environmental partner/ interaction that generates important erogenous stimuli, which physiologically are somatic/ cutaneous in nature) (5, 6).

Future research should further clarify these interdependencies between the mind and sexuality in general, and in particular the relational dichotomy of the mind, which remains still unexplored.

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