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The mind body problem, part three: ascension of sexual function to cerebral level

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Abstract

Physiologically, the somatic nervous system intervenes in external interaction between the body and environment, while autonomic nervous system ensures the functioning of internal organs. We present in this paper a psycho-physiological perspective suggesting that mental function (somatic in nature, because coordinates environmental interaction) is closer to and more aligned with the physiologic functioning of autonomic nervous system (due to autonomy, duality, etc.). At opposite end, sexual function (autonomic in nature, erection for example being a parasympathetic vasodilatory reflex) seems to be compatible and even dependent by a somatic participation (erectile response is rather induced by environmental stimuli than internal visceral stimuli).

The perspective presented here is that the mind and sexuality are two distinct relational processes which, being related to the same environmental stimuli/ peripheral afferents, should be supported by a common (somatic-autonomic) neurobiological substrate.

Keywords: mind, sexuality, psycho-physiological approach, mind body problem



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Introduction

The primary role of sexual function is to ensure species continuity, including in humans. Although erectile and ejaculatory mechanisms in men may appear to be simplistic and well described, researchers and practitioners actually rely on rather sophisticated instruments to assess these two processes in clinical practice. As an example, the International Index of Erectile Function (IIEF) incorporates multiple investigative subdomains which assess not only erectile function but also orgasmic function, sexual desire (as it is mentally constructed), intercourse satisfaction, and overall satisfaction (1). This example underscores the psycho-physiological interdependencies existing within the brain between the mind and sexuality. Although at first glance it might seem that links between mental and sexual processes are remote or far-fetched; in fact, it is not so. Traditionally, sexual desire has been viewed as a construct related to the mind (as a spontaneous/voluntary mental event), while sexual arousal more as a response or reaction to sexual stimuli. However, recent studies show that sexual desire also responds/ increases due to action of sexual stimuli, and further that the mind is able to favor/initiate voluntarily the specific responses of sexual arousal (erection, for example) (2). These interdependencies between the mind and various subdomains of sexuality (libido, arousal) are consequences of the fact that human conscious

existence and its link to the environment (enabling an awareness of reality) are ensured by the mind which, serving as an environmental operator (receiving external stimuli), supports both cognitive and sexual activation. Thus, both cognitive and sexual functions require focused mental attention, forcing a selection between cognitive and sexual predominance. Yet, sexual predominance cannot be achieved without some level of cognitive processing—an individual prefers certain sexual partners, resorts to internal information (memory, imagination, dreams) or to environmental information for sexual activation and response (modulating voluntarily the specific autonomic-sexual responses of erection or lubrication), is conscious about the cerebral deployment of sexuality (in the form of libido, sexual arousal, orgasm), has curiosities initiating new explorations, and so on (2).

To explain putative connections between the mind and sexuality, several aspects must be presented and further clarified. First, sexual function/ control has evolutionarily ascended from the spinal cord to the cerebral level, a requisite premise for understanding the autonomic component of the brain and mind (required by sexual activation and response). Second, within the brain, the mind should be distinct from, but overlap with, sexual processes, so as to be compatible with each other (the voluntary focus of our mind activating either cognitive or sexual

events). As a consequence, we might suppose the corresponding neuro-physiological processes both of the mind and of sexuality to be organized along similar lines, at least with respect to sexual processes that are consciously/ voluntarily modulated (libido, sexual arousal).

Discussion

To understand the existing connections within the brain between the mind and sexuality, it is necessary to first discuss the level (spinal and/ or cerebral) of the neurobiological support for sexual function in humans.

1. Spinal versus cerebral control of sexual function

1.1 The classical perspective regarding spinal sexual reflexes

From a biological perspective, sexuality is essential for reproduction and perpetuation of mammalian species, including humans. Classically, erection is a neurovascular event controlled by spinal parasympathetic centers, while ejaculation is under the control of sympathetic (for emission) and parasympathetic (for expulsion) centers of the spinal cord (3). These spinal reflexes are effective/ functional in humans, evident from the capacity to trigger ejaculation in humans with spinal cord injury involving interruption of descending cerebro-spinal fibers (4). Some researchers consider these spinal sexual centers

responsible for the control of sexual function and response, presumably integrating inputs from peripheral genital afferents with descending cerebral influences (from paraventricular nucleus, medial preoptic area, medial amygdala, paraventricular nucleus, etc.) to produce a unified coherent sexual response (5, 6, 7).

In fact, even today the mechanisms of erection and ejaculation are not fully understood at either the spinal or cerebral levels (8, 9). While on the one hand much progress has been made (e.g., according to fMRI studies, many cerebral regions are directly implied in sexual activation and response, having specific functions) (5, 9), much yet remains unknown (e.g., how these distinct regions of the brain and the abstract mind are interrelated with each other as well as with more primitive spinal processes). The gap between the known and unknown might be due, in part, to an inadequate conceptual approach to the problem (10, 11). For example, as a counterargument to the spinal perspective presented above, it may be that neurologically simpler spinal structures (capable of mediating only simple reflexive responses) are inadequate for the more complex task of integrating external genital inputs with complex descending mental messages (excitatory/ inhibitory cerebral outputs) in order to generate a single and coherent sexual response (10, 11).

1.2 Neurophysiology of spinal sexual reflexes

The autonomic spinal centers of erection (parasympathetic) and of emission (sympathetic) do not have dedicated afferents, as their afferents do not originate from internal smooth muscle organs. These autonomic spinal centers must rely on peripheral inputs from somatosensory structures, such as occurs with touch receptors of the genital skin. The impulses generated by external genitalia are channeled by the somatic peripheral afferents toward somatic centers of the spinal cord. From here, nervous impulses cross towards either the somatic motor neurons/efferents (closing the somatic spinal reflex) or the autonomic sexual centers/efferents (generating an autonomic spinal response). As a consequence, both direct (somatic) and derived (in this case, autonomic/sexual) spinal reflexes depend solely on somatic peripheral inputs channeled through somatic spinal afferents and centers (12).

During the evolving of the human species, the control of somatic (environmental) interaction ascended from the spinal cord to the cerebral level (to become the basis for mental/cognitive function) as a consequence of the ascension of somatic peripheral inputs/information through spino-cerebral fibers towards superior centers of the brain (13). In order to avoid elaboration of two distinct and possibly competing (spinal reflexive and cerebral

analytical) response systems to the same external stimulus/ information, cerebral structures have come to exert inhibitory descending influences on somatic spinal centers (5, 6). However, such descending influences would inhibit not only the direct-somatic responses, but also the *derived* autonomic-sexual circuits/responses, which as noted earlier depend on functioning of the somatic spinal centers. Given this scenario, it might also be presumed that the autonomic sexual functioning and control centers also ascended in humans from spinal level to cerebral level (10, 11), eventually leading to cerebral control of sexual responses such as erection and ejaculation. Indeed, numerous studies describe both sympathetic and parasympathetic neurological areas *at the brain level* that are directly involved in sexual control and response (erection, ejaculation) (7, 9).

1.3 The contemporary approach: a “dual-control” of sexual function

Over the past decade, a “dual-control” approach to psychosexual functioning has been developed, which reconciles the old (spinal) and new (cerebral) perspectives related to sexual control and response (10, 11); this dual control approach might be understood initially by invoking examples from other physiological systems. Specifically, the human heart has two distinct pacemakers, the superior-sinoatrial node and the inferior-atrioventricular node. The

atrioventricular node is anatomically interposed between the sinoatrial node and heart muscle, and functionally dominated/controlled by sinoatrial node that emits a higher impulse frequency. Under normal conditions only the sinoatrial node works as a pacemaker (generating electric impulses), while the atrioventricular node works only as a conductor (transmitting electrical impulses from the sinoatrial node to the heart muscle). However, when the sinoatrial node becomes nonfunctional (e.g., local infarction), the inferior atrioventricular node 'takes over' functioning from the superior sinoatrial node, working thus both as a pacemaker (generating electrical impulses, even if with a lower frequency) and as a conductor (channeling the generated impulses towards heart muscle) (14).

The ascension of sexual function to the cerebral level in humans might in some respects parallel the dual working model of the heart. In other words, the neurological control of sexuality could be located at the superior-cerebral level, without necessarily excluding the potential for inferior-spinal control. Under normal conditions the superior-cerebral neurological structures exert control over the sexual organs, while the inferior-spinal neurological pathways are functioning only as a conductor (transmitting the inputs and outputs between the brain and

genitalia), being interposed between them (10, 15). But under special circumstances (accidental or experimental injury of the cerebro-spinal tracts), the brain may lose neurological control/connection to genitalia. In such a pathological situation, the spinal cord may assume neurological control of the sexual organs from the brain (the descending inhibitory influences cease), enabling, for example, the ejaculation response even if functioning only as a primitive reflex (e.g., in the form of premature emission) (4, 16).

1.4 Spinal sexual reflexes vs. cerebral control of sexual mechanisms

Why is the assumption that the neurological control of sexuality occurs normally at the brain level and not the spinal level so critical? Because such a model offers a perspective for understanding the role/ action of sexual neuromodulators. Thus, when somatic peripheral inputs (environmental information) are channeled to the brain, they must serve for both cognitive (informational) and sexual (erogenous) purposes. For this reason cognitive (norepinephrine, histamine, etc.) or sexual (hormones, pheromones) neuromodulators must intervene, giving information received in the brain either a somatic-cognitive (informational) or a sexual-autonomic (arousal/ libido)

interpretation (15, 17). Moreover, such a model can provide a physiologic explanation regarding how the mind (in essence a cognitive-somatic function) is able to intervene, at least in part, with regard to sexual functioning (an autonomic cerebral function) (10, 11). Thus, the attentional focus of the mind is able to initiate either cognitive or sexual commitments, depending on the environmental context. Yet, the mind is able to exercise semi-voluntary influences on autonomous processes like vasodilatation-erection and, furthermore, is conscious about many sexual events, like the ‘mentally-derived’ components of libido and orgasm (18).

2 Psychological and neuro-informational approaches of the mind

To understand the existing interrelation between the mind and sexuality, it is necessary not only to understand the ascension of the control of sexuality to the brain and thus towards the conscious domain of the mind (as was just discussed), but also to understand the mind functioning in a neuro-informational/ physiopsychological mode (19), closer to and more aligned with the physiologic mechanisms of sexuality.

Beginning from a psychological perspective, individuals are aware within their conscious mental existence and experiences of the following four distinct but interrelated mental events:

2.1 A person’s mental existence/ identity has abstract (artistic, cultural, etc.) preoccupations and pleasures, acting sometimes counter to the primary biological needs of the body (such as dressing, eating or sleeping) in favour of mental/psychological needs and goals (such as elaboration of a new theory/ idea, solving a math problem, playing chess, enjoying music/ internet gaming, etc.) (19).

2.2 Mental existence is embedded within its own internal/ mental reality. Just as the physical body exists within an environment of material stimuli, the mental identity exists within a mental reality (composed of both concrete and abstract information, or “data”). For example, people’s jobs and their tasks, their immediate and long term strategies, their position and public image, social conventions and rules, etc. often define (or are part of) the surrounding reality yet, at the same time, are abstract/ mental data composing a veritable mental reality (20).

2.3 Beyond the external-physical interaction between the body and environment (similar elements in nature, composed by matter), there is within the brain an analogous internal interaction- also between similar elements in nature, that is, between the person’s mental existence and the corresponding mental information/ reality surrounding him/her. This mental interaction implies on the one hand the data action as a trigger (exposure to information,

through attentional processes, that intervenes in data selection/ reception), and on the other hand, the person's reaction to information, through a decision making process which intervenes in selecting and elaborating the responses (20, 21).

2.4 The mind presents a true (actual) autonomy with respect to external stimuli/ environmental reality, having the capacity to maintain itself. Thus, we can contemplate a certain problem from an undefined period of time, or we might resort to imagination creating and/ or studying an inexistent reality. Finally the mind is able to elaborate internal-mental realities during dreams, which are obviously disconnected from external reality, but that are nevertheless identical with the reality surrounding us (when we are awake), because the reality surrounding us (not only during dreams but also when we are awake) is actually an internal mental reality (19).

The four elements described above might be conceptualized from a neuro-informational (psycho-physiological) perspective as distinct yet interrelated postulates.

`Postulate` no 1

The mind works with/operates on internal mental stimuli instead of external stimuli. Just as environmental reality consists of external (physical/ chemical) stimuli, internal mental reality is composed by internal (mental) stimuli.

In other words, while our body interacts with the electromagnetic field (as visual stimuli, acting on cone cells), acids/ bases (as gustatory stimuli, acting on tongue papillae), air vibration (as auditory stimuli, acting on tympanum), agitation/ movement of molecules (as thermal stimuli, acting on free nerve endings of the skin) etc., the mind interacts with internal representations of those stimuli, namely colors, sounds, tastes, temperature etc.

Thus, physiologically, the body is not capable of being aware about the external stimuli on its own (our body is interacting just physically/ chemically with electromagnetic waves, acids, etc.). At other end, that is, in conscious/mind terms, there is no direct mental access to the real-external stimuli (physical/ chemical stimuli, like electromagnetic waves, etc.). Yet, the mind is aware of a surrounding reality and its incorporated stimuli. This means that the surrounding external reality/ stimuli with which the mind interacts are actually re-represented as internal events—mental in nature—that are able to interact with similar mental events represented by our mental existence/ identity. More specifically, from a physio-psychological perspective, external stimuli (electromagnetic waves, air vibration, acids/ bases, etc.) interact with physical receptors of the body and that information is projected in

primary somatosensory (visual, auditory, gustatory, etc.) cortical areas. From here information can pass towards motor cortical areas generating reflex responses (in animals), or towards secondary somatosensory cortical areas generating information in a mental/ conscious format (colors, sounds, tastes, etc.). From this origin begins the phenomenon of human mental existence and experiences.

`Postulate` no 2

The mind elaborates internal mental responses instead of external responses, without a mandatory external transmission. Psychologically, internal mental information arrives at or enters our mental existence/ identity through the conscious domain of the mind and, more specifically, through attentional focus of our mind that has the capacity to select from the information received. The information received/ selected undergoes an analytical process and the conclusion/ response is projected back into conscious (internal mental) reality, for various purposes. Thus, depending on the context, the conclusion can be retained in the mind as a backup plan/ solution when a critical situation arises in the future; it might be used as an advantage over the competition; or it might be communicated immediately or at some future time to other persons, etc. Whatever the situation, the mind is able to evaluate conscious/

mental data and elaborate a number of possible responses in a similar/ conscious format, which may or may not be further exteriorized as information or as motor responses/behavior.

`Postulate` no 3

A person's mental existence/ identity is supported by a distinct/ dedicated neurobiological structure/ support.

Psychologically, internal mental information (colours, sounds, etc.) are transmitted from our conscious reality towards our mental existence/ identity through attentional focus of our mind. From a psycho-physiological perspective, this transfer of information implies the action of nervous impulses from somatosensory cortex (which generates colours, sounds, etc., depending the area of somatosensory cortex that is activated) towards another neurobiological structure. This other neurobiological structure (receiving physiologically nervous impulses) corresponds to our mental existence/ identity (which receives and acts upon psychologically-based information). In other words, our mental existence/ identity is supported by a distinct/ dedicated neurobiological structure/ support.

3. Sexuality composing the mind

From a physiological perspective sexuality is a cerebral autonomic process that implies

participation of two distinct and opposite networks, namely sympathetic and parasympathetic nervous systems. Contrary to the general functioning of autonomic system which is designed for connection among internal organs (and thus works with internal stimuli), activation of sympathetic and parasympathetic *sexual* mechanisms must function with or on the external environmental systems, namely through somatic-cognitive receptors (genital skin/erogenous areas, eyes). Visual stimuli for example (that are somatic-cognitive in nature) are able to activate not only sexual desire but also sexual arousal, which in conscious terms is expressed in the form of libido and sexual arousal.

From a psychological perspective, the mind is a relational function. Contrary to the general functioning of the somatic nervous system (designed for relational function, which usually implies external stimuli and responses), the mind works with internal stimuli, elaborates internal responses and presents a veritable autonomy with respect to environment (having the capacity to maintain itself). Moreover, neural imaging studies show that the mind implies participation of two distinct and opposing neural network systems (TPN and DMN). Again, the mind presents psychological autonomy from the

environment, and physiologically is supported by a neural substrate that is organised according to the functioning of the autonomic nervous system in that operates two distinct and opposite neural networks (11, 19).

In conclusion, the mind incorporates characteristics from sexuality (from the corresponding autonomic system), while sexuality incorporates characteristics from relational function (from the corresponding somatic nervous system). Why? At the spinal level, autonomic sexual reflexes depend by somatic afferents, as discussed earlier. At cerebral level, the attentional focus of the mind channels information not only for cognition, but also for sexual purposes. From an evolutionary perspective, the ascension of the autonomic sexual system to the cerebral level supposes cohabitation between the autonomic sexual system and the somatic relational system, somatic pathways serving as peripheral afferents for autonomic sexual centers (10). To avoid a blockade of somatic activity–relational response, autonomic sexual centers serve (in turn) somatic peripheral afferents, processing environmental nonsexual information autonomously (cognition).

From a psychological perspective, internal mental information is transmitted from internal reality (cortex) towards internal mental existence,

through the attentional focus of the mind. From a psycho-physiological perspective, internal mental existence is supported by a dedicated neural substrate. From a sexual perspective, the same information must be transmitted from cortex towards hypothalamus. For these reasons, it was postulated that the neural substrate that supports internal mental existence should be represented by an autonomous/ hypothalamic cerebral structure (11, 19).

Conclusions

Cognition and sexuality are two distinct relational-environmental functions, strongly interrelated at cerebral level. In this paper we addressed (at least in part) these interrelation, in an attempting to better understand cognition and sexuality and thus as a new step in the understanding of the mind functioning and in the solving of the mind body problem.

The psychological and psycho-physiological approaches presented here should be further addressed in our opinion from the perspective of the lateralization process of the brain. Just an example, lateralization of cognition favors deployment of several psychological tasks enhancing usually cognitive abilities (22), while decreased or aberrant hemispheric lateralization often predisposes to poor cognitive functioning or even mental disorders like schizophrenia, bipolar disorder, ADHD, etc. (23, 24). Not

surprising, sexuality is also a lateralized process of the brain, in respect to both sexual hormones (15, 17, 25) and pheromones (26, 27, 28). In addition, lateralization of sexuality seems to be strongly linked to hand preference (a somatic-mental function, in nature), according to the previous mentioned studies.

New studies are necessary in our opinion to further clarify the existing interrelations between the mind and sexuality.

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