

Sexual Motivation and Desire

Introduction

In this chapter we will describe motivation as it is conceived in psychological or, much broader, in cognitive neuroscience studies. We agree with philosophy of science remarks of Kupferman (1991) who wrote: ‘As more is learned about the actual physiology of hypothetical drive states, the need for invoking these states to explain behavior may ultimately disappear, to be replaced by more precise concepts derived from physiology and systems theory’ (p. 751). We are also guided by Money’s radical behaviorist position: ‘Motivation theory lays claim to be scientific. Because it deals with motives, it creates the illusion that it has power to provide a scientific explanation of why a person does what he/she does, whether consciously or unconsciously, voluntarily or involuntarily. A motivational, that is, a teleological explanation, is not a scientific one, however. It is an explanation of causal purpose, whereas a scientific explanation is one of causal mechanism. Only the latter leads to prediction, prevention, and, ultimately, to control or regulation.’ (Money, 1994: p. 135).

We begin with a short review of historical notions about sexual motivation and desire. It is striking that Freud’s writings are still influential in much current work in this domain. Next, we will review theories which focus on the interaction between organism and environment. We will emphasize work about motor effects, specifically action tendencies and motor preparation. We introduce a preliminary model of the generation of sexual desire and action. An important topic is the relationship between subjective desire and variations in intensity of sexual arousal and subjective sexual excitement. In the end we will summarize study methods and paradigms we currently employ in the study of sexual motivation. The focus of studies in our lab is the specification of behavioral mechanisms that may explain how sexual action comes about.

Notes on the History of Concepts

Sexual Motivation is ‘a Constant Force’

Sexual motivation is a construct, used to explain the generation of sexual action. Sexual desire is the subjective experience of being attracted to or pushed towards objects

or behaviors with potential rewarding effects. Desire seems to be about the promises of satisfaction, maybe through sexual action, but it is as much about hope, expectation, longing and craving. Without these there would be no desire.

Freud (1953) preferred the use of the word libido. 'Everyday language possesses no counterpart to the word 'hunger', but science makes use of the word 'libido' for that purpose.' (p. 135). In a footnote, added by Freud, it is explained that the German language word 'Lust' is ambiguous, because it can either mean the experience of need and of a gratification. In a note on page 212 the explanation has been elaborated upon. 'The word 'Lust' takes into account the part played by preparatory sexual excitations which simultaneously produce an element of satisfaction and a contribution to sexual tension'. 'Lust' has two meanings, and is used to describe the sensation of sexual tension ('Ich habe Lust' = 'I should like to', 'I feel impulse to') as well as the feeling of satisfaction.

Libido, according to Freud (1964), is fueled by the sexual instincts. An instinct arises from a source within the body. 'Its source is a state of excitation in the body, its aim is the removal of that excitation; on its path from its source to its aim the instinct becomes operative psychically. We picture it as a certain quota of energy which presses in a particular direction. It is from this pressing that it derives its name of 'Trieb' (literally 'drive') (p. 96). Freud made clear that libido does not arise from an external stimulus. 'An instinct, then, is distinguished from a stimulus by the fact that it arises from sources of stimulation within the body, that it operates as a constant force and that the subject can not avoid it by flight, as is possible with an external stimulus' (p. 96). How the drive builds up remains unclear and there is only a faint reference to homeostasis as it is currently used in theories of motivation.

Freud's distinction between drives generated in older parts of the brain and regulation by the neo-cortex was a building block for his psychoanalytic theory of Id and Ego. It was an attempt at parsimony: looking for a comprehensive motivational mechanism.

Some of his contemporaries showed less sophistication. Until Moll's publication in 1897, the sexual impulse was seen as the expression of a 'need of evacuation' of male semen. Moll proposed to distinguish between two component drives. First, there is an impulse of detumescence, which aims at the relief of tension in the sexual organs. And then there is the impulse of contraction, which is the instinct to approach, touch, and kiss another person, usually of the opposite sex (Ellis, 1933).

The adequacy of the instinct/drive views has been challenged by evidence from several lines of investigation, including phyletic comparisons, effects of castration, and research on the periodicity of sexual desire (Hardy, 1964; Singer & Toates, 1987). As Beach concluded: 'No genuine tissue or biological needs are generated by sexual abstinence.... What is commonly confused with a primary drive associated with sexual deprivation is in actuality sexual appetite, and this has little or no relation to biological or physiological needs' (Beach, 1956: p. 4).

Sexual Motivation as an Appetite

While there may not be an innate sexual impulse, conditions most likely exist that are innately pleasurable (e.g., local stimulation of the genitals and the experience of

orgasm; Hardy, 1964). According to Hardy, these conditions 'form the constitutional base for the elaboration of sexual appetite' (p. 7). In his appetitional theory of sexual motivation, Hardy postulates that sexual motives are learned expectations about the generation of affective states; the learning is a result of actual experiences or imaginal processes. The pleasure that accompanies genital stimulation continues throughout life as an affective base for motivational development; many stimuli may become associated with it and may serve as cues leading to the elicitation of sexual desire (Hardy, 1964). On the other hand, habituation processes can occur in many sexual areas wherein the repetition of a given activity produces a diminished affective response (Beach, 1956). Sexual motives are not restricted to the learning of positive expectations (the 'approach' type), motives may also be avoidant (because of negative expectations). However, most of the motivated behavior is ambivalent and based upon a mixture of positive and negative expectations. Sources of negative affective expectations, for example, social sanctions and feelings of guilt, provoke inhibition or concealment of sexual expression.

Hardy's distinction between sexual motives is similar to Byrne's conception of erotophilia-erotophobia (Byrne, 1986). Byrne also presumes the existence of an innate mechanism of sexual arousal (that is responsive to tactile stimulation) and claims that all human beings are probably born with erotophilic or positive emotional responses to sex. According to Byrne, the acquisition of positive (erotophilic) and negative (erotophobic) emotional responses to sex involves the pairing of sexual cues with emotion-producing reward or punishment (Byrne, 1986).

From Hardy's text, it is not clear how motives differ from conscious intentions. This, however, is highly relevant when we consider control of sexual motivation. 'For... expectations to motivate behavior, the person must believe that some action (symbolic or overt) on his part helps or is required to bring about the desired affective change. A motive, then, is an expectation that the pursuit of a given course of action will contribute to, or result in, a change in affective state' (p. 5). Hardy's challenge of the Freudian and biological drive view is most clear in his discussion of control of sexual appetite. 'A device sometimes suggested to control sexuality is to reduce tension by displacement or sublimation, i.e., to relieve sexual drive by reading, dancing, painting, attending the theater, etc. According to appetitional theory, if the substitute activity is sexually stimulating, then the appetite will tend to increase and the problem of control is worsened. If the activity is nonsexual in character, sexual impulses will not be relieved nor aroused... In contrast to Freud's view that much human activity gratifies a sublimated libido, it seems probable that sex is often indulged in as a substitute for a reasonable satisfying life in other areas' (p. 14-15).

Notwithstanding Hardy's sharp opposition to the biological drive theory, like Freud, he seems to imply that there is a constant preparedness to react to cues that signal positive sexual affective consequence. Hardy sees two ways to control sexual appetite. Authoritarian social control may be required for 'blatant obscenity' and sexual abuse. The other and preferred way is self-control, which requires awareness of the mechanics of sexual appetite. Seeking non-sexual situations with ample non-sexual gratification may help constrain sexual expectations and prevent motivation from

growing. He mentions a well-known variation on non-sexual distraction: sexual continence 'and the idealization of the ability to delay immediate gratification of impulse' (p. 15).

Motivation as Arousal and Arousability

The domain of sexual motivation also includes the study of sexual arousability, defined as the individual's propensity for arousal given an adequate source of sexual stimulation. In Whalen's energetic view, sexual arousal (the current state of sexual excitement) and sexual arousability (the rate at which an individual approaches maximal arousal) together define sexual motivation (Whalen, 1966). He distinguishes motivation from sexual activity (e.g., reported fantasy and desire) because sexual behavior can demonstrate motivation but it is not part of motivation. According to Bancroft, sexual arousability ('central arousability') is, together with cognition (e.g., internal imagery) and affect (mood states), one of the three dimensions of sexual appetite. In his view, sexual arousability points to a neurophysiological mechanism that determines the sensitivity of the sexual response system (its central and genital components) to internal and external stimuli. High arousability might imply a high sensitivity for external cues, revealing itself through an increased likelihood of central and genital responses. These responses could, in turn, lead to an increase in sexual thoughts and the experience of sexual appetite or desire (Bancroft, 1989).

Both Whalen and Bancroft view hormonal (i.e., androgen) factors as important determinants of sexual arousability. After reviewing the data available in 1966, Whalen concluded that androgens determine the responsiveness to erotic stimuli; they alter the threshold for erotic stimulation. At present, however, the relationship between androgens and the sexual response appears to be much more complex. Empirical studies point to the possibility of two distinct sexual response systems: one that is androgen-dependent, and one that is not (Bancroft, 1989). Erections during sleep and erections in response to erotic fantasy appear to be affected by androgen withdrawal and replacement. Erection in response to external erotic stimuli (e.g., erotic films) may remain intact despite androgen deficiency. However, recent evidence suggests a more variable dependence on androgen. The original data resulted from (video-taped or filmed) visual erotic stimulation (VES), which provoked full erectile responses in hypogonadal men. Comparisons of erectile response of eugonadal and hypogonadal men to internal stimuli (imagery, fantasy) showed less consistent results than VES (Bancroft & Janssen, 2000). Furthermore, the androgen-dependent system is believed to be linked with sexual desire, that is, levels of androgen seem to have an effect on sexual interest and sexual activity (Bancroft, 1989).

What are the implications of these findings for our understanding of the determinants of sexual arousability? According to Bancroft (1989), sleep erections give us 'a window' into the central arousability system' (p. 77). This window allows for the assessment of sexual arousability when it is 'relatively independent of the effects of the environment or cognitive processes' (p. 72). Thus, the information obtained through this window relates primarily to the androgen-dependent response system

itself, that is, to the responsivity of the sexual response system to internal stimuli (e.g., sexual imagery). The responsivity of the sexual response system to external stimuli depends, as is implied by Bancroft, on many other (i.e., cognitive and environmental) factors, the exact nature of this mechanism being less clear. In a discussion of changes in hormonal status in female to male transsexuality it has been observed that two subjects with almost no androgen activity (due to androgen insensitivity) had the highest 'libido' in the total study population (Gooren & Giltay, 1996). We may safely conclude at this point that sexual arousability is dependent on hormonal influences in a more complicated way than was once believed.

Prolegomena for a Theory of Sexual Motivation

Sexual motivation, to be a functional mechanism, has to respond both to the concerns of the organism (the energetic aspect) as well as to relevant environmental cues (the situational aspect). Models of incentive-motivation (Singer & Toates, 1987) highlight this interaction. The energetic aspect *pushes* the individual towards the situation; the situation *pulls* the individual in its direction. The push of motivation may increase through past experience possibly in combination with various hormonal or other somatic factors. Pull factors depend on attractivity of the situation. Motivation will come about when an actual stimulus matches the conditions of the sexual system. There is no motivation to be found in the organism; it is an emerging property that will come about when all conditions are met.

Motivation is a (Potential) Action Mechanism

Bindra (1968; 1974), in his landmark papers, proposed an approach to motivation with specific attention to the interaction of organism and environment. According to Bindra motivational processes should not be exclusively linked to variables connected with the state of the organism (homeostatic drives), nor only to environmental incentive stimuli, but equally to both. Incentive stimuli, also called 'hedonic', 'emotional', or 'affective' stimuli, are reinforcing stimuli, which 'include such biologically important objects, events, and situations as food, water, an odor, a taste, a sexual partner, a nest or home area, the call of a distressed offspring, a loud noise, a predator, and injurious levels of heat or cold' (Bindra, 1974: p. 199). Bindra introduced the concept of a central motive state, which is 'a hypothetical set of neural processes that promote goal directed actions in relation to particular classes of incentive stimuli – for example, it promotes food seeking and eating in relation to food, or defensive fighting and escape in relation to a predator' (p. 201). The incentive, it is supposed, guides response selection through the excitatory or priming influence of the central motive state on somatovisceral reactions, consummatory or rejectional acts, and locomotor and skilled actions.

Bindra drew attention to the similarity of motivation and emotion when he wrote that 'motivational state' and 'emotional state' are 'interchangeable terms' (Bindra, 1974: p. 201). Both concepts may help explain actions and feelings, eventually they

explain the same things. Emotions may serve the satisfaction of some concerns (fight-flight or approach) and will generate relevant action. Interaction with an incentive may change the affective state of the organism. Bindra's and similar views on emotion and motivation have induced several emotion researchers to consider preparation for action to be a central function of emotion mechanisms.

One of these researchers is Frijda who wrote: 'Motivation, to a large extent, is the elicitation of behavior systems by appropriate external stimuli (or thoughts of them). A behavior system is a potential action (a program), or a sequence of potential actions' (Frijda, 1986: p. 361). Such a system has provisions for the recognition of occasions for activating or stopping an action.

According to Frijda, emotions are ways to satisfy concerns. That is why emotions result in motivational states: the action tendencies. When applied to sexual behavior this means that sexual motivation arises when an individual interacts with appropriate external stimuli or thoughts of them. Sexual motivation can be demonstrated only during the sexual response process. It is an emerging property of that process. Singer and Toates (1987), in their version of an incentive motivation model, have specified three elements for sexual motivation to come about: 1. The internal state or disposition. This state is similar to Bindra's central motive state, and to arousability, as proposed by Whalen (1906) and Bancroft (1989). We suppose that the specific provisions for sexual response are incorporated in this state, we prefer to call these provisions the sexual (response) system. 2. Stimuli in the environment that match the conditions of the sexual system. 3. Rules for access to sexual partners which govern the acting-out of sexual action tendencies. The addition of the third element allows for an important source of regulatory processes in human sexual behavior.

'Lust' (German) = Desire and Pleasure

In the discussion of Freud's (1953) libido concept we already mentioned the important distinction between need and gratification, or tension and satisfaction. In modern usage sexual response is divided in a motivational component and a consummatory component. In the motivational component (sexual) action of the organism is prepared, and virtual or real steps are taken at initiation of sexual interaction. The motivational component may be related to need and tension and the consummatory component to gratification and satisfaction.

Incentive sensitization theory (Berridge & Robinson, 1995), the appetitional system of Panksepp (1998), which is called the SEEKING system, and the work of Robbins and Everitt (1999), among many others, propose explanations for the distinction of wanting and liking, which are similar to the distinctions made by Freud. Wanting is the, via classical conditioning established, expectation of reward, which activates instrumental behavior to obtain the reward. Liking is the unconditional hedonic experience derived from consummation of the reward. Berridge and Robinson (1995, 1998), on the basis of neurobiological and affective behavioral evidence, have suggested that 'mesotelencephalic dopamine-related systems mediate reward by a psychological process that is separable from sensory pleasure' (1995: p. 73). These authors imply that two separate neural mechanisms are involved. One dopamine dependent mecha-

nism, evolved through associative learning, mediates incentive salience (wanting). 'It causes the perception of an event to become attractive, sought after, and capable of riveting attention' (1995; p. 72). Panksepp (1998) describes this energizing for his SEEKING system '...the SEEKING system has a characteristic feeling tone – a psychic energization that is difficult to describe but is akin to that invigorating feeling of anticipation we experience when we actively seek thrills and other rewards' (p. 145). The other mechanism is responsible for the sensory pleasures of reward (liking). Evidence from many studies shows that the dopamine system contributes to wanting and not to liking.

Berridge and Robinson (1995) remind us in a note that the processes of wanting and liking are different from the conscious awareness of desire and pleasure. The words are used because the psychological processes of wanting and liking can cause subjective feelings of desire and pleasure, but they are not identical.

A Preliminary Model of the Generation of Sexual Desire and Sexual Action

In the foregoing paragraphs important elements for a model of sexual motivation have been reviewed. Before we embark on our exercise in reductionism we would like to point to the complexities of our endeavor. Our aim is to specify the routes of 'sexual' information in the neural, behavioral, and cognitive system to arrive at a description of the generation of sexual action. It is as yet uncertain how much of this process consists of the recruitment of general mechanisms and to what extent we may rely on specific mechanisms which we hypothetically call the sexual system. We speculate that parsimony requires that specific processes are derived or result from general mechanisms. The implication is that sexual motivation is a specific outcome of general motivational mechanisms. Another complication arises from the awareness that the CNS processes information in parallel, which means that 'sexual' information may be processed in very different ways. The outcome of such parallel processing may allow for complicated variations in response. The dissociation between subjective sexual experience and autonomic physiological processes is only one example of these complexities.

Two Modules, to Begin with

We propose a model of sexual motivation with at least two modules; a 'sexual arousal module' to account for variation in response intensity and action tendencies, and a 'regulation module' to account for regulation by inhibition and facilitation.

The sexual arousal module typically is a feedforward module. The goal of action in this module is to perform until targets of sexual response are reached; lubrication, erection, action readiness, orgasmic release. Stimulus information guides this process of energizing the sexual system, eventually leading to the rewards of sexual interaction (Bindra, 1974; Panksepp, 1998; Robbins & Everitt (1999)).

Intensity of sexual arousal depends directly on stimulus attractivity. According to Singer and Toates (1987), attractivity of a stimulus depends on abstinence and acces-

sibility of the stimulus. When intensity of sexual arousal increases, so does the action tendency. This in turn, will produce felt action tendencies, desire and appetite, and subjective sexual excitement. Awareness of sexual desire comes about when the information from activity in the sexual arousal module increases beyond the perceptual threshold. Contrary to common belief and romantic explanation desire is not spontaneous, although it may be experienced as spontaneous. Feelings are driven by stimuli. Only the desire to feel desire or appetite is not necessarily driven by a sexual stimulus.

The regulation module typically is a feedback module. Regulation is relevant at every step in the arousal module. Regulation keeps the sexual response on track. This aspect of processing is largely unavailable to consciousness. To produce a specific sexual response the CNS has to suppress other response tendencies, at least those incompatible with the sexual response. This means that inhibition is prerequisite for sexual response from its very onset. Thus, both inhibition and facilitation determine the sexual outcome.

Optimal sexual response requires numerous non-sexual behaviors, for example approach to sexual stimuli, making contact, initiating sexual interactions. Once sexual action is considered, it is important to discern the many concerns that may be satisfied by expression of sexual response. Priorities for action determine to a large extent which concerns will be satisfied (Frijda, 1986), these may be sexual but most often there is a complicated mix of several concerns (e.g., safety, sensation, satisfaction, intimacy, power).

The sexual arousal module is a 'go' provision. Sexual action tendencies feed into motor programs which may be sex-specific, e.g., relaxation of genital smooth muscle, increase in tension of muscles connected with coital movements. The regulation module has provisions to 'enhance', 'decrease', and 'stop' sexual response. Here again we have sex-specific and non-sex-specific regulatory events. Depending on the processing phase, provisions may act at an unconscious, automatic level or at a conscious and voluntary level.

We suppose that when confronted with a relevant stimulus the first reaction of the sexual system is similar to the way of processing labeled by LeDoux (1997) as 'quick and dirty'. These are possibly prepared or conditioned pathways, of which the subject is unaware, and processing occurs with immense speed. In a second stage the subject becomes aware of the sexual stimulus and his/her own sensations. Regulation processes will eventually result in 'decrease or stop sexual action', or in 'go, all the way'.

The 'go' decision depends on two important conditions. The first is derived from a general function of emotion intensity, which is disinhibition of action (when anxious: run away; when angry: attack; when horny: have sex). The second condition is derived from what we know about taking sexual initiatives. The decision to act depends on rational evaluation of the current sexual opportunity put into context of social norms, consequences etc...

Let's summarize some important points of our proposal:

Sexual motivation is an emerging property of sexual processing. Sexual stimulus information is transformed into motor commands. Processing is largely involuntary

and unconscious. Processing becomes conscious and voluntary beyond a threshold of sexual motor effects. The subjective experience of desire is a reflection of sexual motor effects. Desire is a consequence of processing.

The Relationship of Sexual Arousal and Sexual Desire

The intensity of sexual excitement and the associated sexual emotions (e.g., desire, lust, horniness) are dependent on the strength of the underlying sexual concerns and the attractiveness of sexual stimuli. When intensity of sexual excitement increases the action tendency and felt sexual desire are enhanced. Increasing emotion intensity has as one of its main functions the facilitation of behavior that serves the satisfaction of the underlying concern.

Sexual arousal may be produced by a multitude of external (e.g., visual and tactile) and internal (sexual imagery) stimuli. Furthermore, sexual arousal can be indexed with measures from three different response systems: verbal reports, physiological responses and overt behavior (Lang, 1970). An adequate model or theory of sexual arousal should help explain how stimuli acquire sexual meaning, and how they lead to physiological (e.g., genital) responses, affective responses (e.g., conscious subjective experience of sexual arousal), and sexual behavior. Particular instances of discordance between response systems highlight the potential complexity of the mechanisms involved in the activation of sexual arousal.

We hypothesize that the experience of desire is a consequence of an incentive energizing the sexual system. The felt tension and anticipation may be centrally produced but is also dependent on peripheral muscular reactions and genital vasocongestion.

The division between appetitive and consummatory components of sexual behavior has led some researchers on animal behavior to make a strict distinction between motivation and sexual arousal. Sachs (2000) argues that 'in ethological jargon motivation precedes the appetitive behavior () and the consummatory acts' (p. 556). To clarify the problem of 'the conflation of sexual arousal and sexual motivation' Sachs refers to fear and the perception of danger. 'Just as the perception of potential danger may motivate one to avoid the situation without evoking the emotion of fear, so too the perception of a potential sexual stimulus may motivate sexual behavior without necessarily leading to sexual arousal as an emotion' (p. 556).

Sach's argument may originate from his reliance on the paradigm in animal studies, which separates instrumental behavior to get access to a potential partner and the eventual interaction with that partner. Our hypothesis is that sexual arousal is part of the more general action readiness caused by the presence of an incentive. When action is needed to gain access to a partner, attention will go to that action and less to the experience of desire, although it will be difficult to distinguish between these two processes. In a very dangerous situation, most people will tend to first try to escape or avoid the situation before they subjectively experience fear. This is a very functional reaction and a nice demonstration of how parallel processing may proceed.

Panksepp seems to follow a reasoning similar to ours. Activation of the SEEKING system modifies subjective experience. 'This is especially important since many

investigators who discuss human emotions have had difficulty agreeing what emotional state this system is supposed to mediate. I would suggest that 'intense interest', 'engaged curiosity', and 'eager anticipation' are the types of feelings that reflect arousal of this system in humans' (p. 149).

Another recent model concerning interactive mechanisms in sexual arousal has been put forward by Barlow (1986). This model has guided us in some of our ideas about sexual arousal and sexual desire. Barlow's working model of sexual dysfunction integrates much of what is known about the role of cognitive processes in sexuality and their consequences for emotional responses. Empirical evidence (reviewed by Barlow) has produced five factors, which differentiate sexually functional from dysfunctional men.

'First, sexually dysfunctional subjects consistently evidence negative affect in the sexual context, whereas sexually functional subjects display more positive affect. Second, dysfunctional subjects consistently underreport their levels of sexual arousal and generally, evidence diminished perceptions of control over their arousal. Third, dysfunctional men are not distracted by non-sexual-performance-related stimuli in that they evidence no decrease in erectile response, whereas sexually functional subjects are distracted and show decreases in sexual response. Fourth, dysfunctional men are distracted by performance-related sexual stimuli, whereas sexual arousal of sexually functional men is enhanced. Finally, anxiety inhibits sexual arousal in dysfunctional subjects but facilitates arousal in sexually functional subjects' (p. 146).

Together, these findings provided the basis for Barlow's model. The model is characterized by its emphasis on the interaction between autonomic activation and cognitive processes in the determination of functional and dysfunctional responding. The response patterns are conceptualized as forming either a positive or a negative feedback system. Both loops start with the perception of explicit or implicit demands for sexual performance. This perception results in either positive or negative affective evaluations, both triggering autonomic arousal. This increase in autonomic arousal enhances attention for those (i.e., positive/erotic or negative/threatening) features of the sexual situation that are most salient. Continued processing of erotic cues produces genital response, and ultimately leads to sexual approach behavior. Continued processing of non-erotic issues (e.g., social consequences of not responding) produces a dysfunctional arousal pattern and ultimately leads to avoidance behavior.

Through the Looking Glass: Paradigms

For a number of years we have successfully studied the motor output of the sexual system by monitoring variations in blood flow in the genitals and, in addition, by asking subjects to report their emotional and sexual experience. Recently we started to incorporate into our research a number of paradigms that may yield some insight into the generation of sexual action, and at the same time these paradigms connect our work with cognitive neuroscience.

Priming paradigms allow for the observation of unconscious processing by presenting subjects with stimuli below the awareness threshold. Effect of the prime is observed in the processing of a subsequent stimulus which is presented beyond the awareness level, the so-called target stimulus. In current studies we use reaction time as dependent variable, to investigate the automatic activation of the sexual system. In the near future we will add EMG measures of the genital smooth muscle. But before discussing these studies in detail let us consider the usefulness of studying unconscious activation.

Cognitive elaboration is often considered to be a necessary step in initiating sexual responses (Barlow, 1986). In the application of Barlow's model in a Waking Erectile Procedure by Janssen, Everaerd, Van Lunsen, and Oerlemans (1994), a few men with psychogenic erectile disorders did not react to our attempts to interfere with their negative elaboration. At that point we started searching for other tasks to further interfere with negative elaboration. We speculated that inhibition in these men may have taken place in a processing phase before sexual meaning or sexual response become conscious. Research into the mechanisms of anxiety has focussed on answering a similar question. This question is: is conscious elaboration a prerequisite for anxiety, or do anxiety stimuli operate without elaboration. Many researchers think that some anxiety stimuli do not need conscious elaboration, they may be unlearned or conditioned (LeDoux, 1997). A similar reasoning may apply to sexual stimuli.

In Janssen and Everaerd's priming study this non-conscious activation has been demonstrated (Janssen & Everaerd, 1993). In a study by Spiering, Everaerd, and Janssen (submitted) we added proof for the crucial supposition that unconscious processing of pre-attentional sexual primes does not result in conscious sexual excitement. In these studies subjects are presented with pre-attentional visual primes or visual neutral primes, which were followed by a sexual or neutral target. The results for subjective sexual arousal were striking: No effect of unconsciously presented sexual primes was found; there were no differences between the sex target preceded by a sex prime and the sex target preceded by a plant prime. In contrast, conscious sex primes did lead to increases in subjective sexual arousal measured on sexual targets compared to sex targets preceded by a conscious plant prime. In another experimental session subjects were asked to categorize the targets as quickly as possible by pressing one of two buttons, one labeled with the word 'sex', one labeled with the word 'plant'. We expected subjects to react with shorter reaction times to decisions about sexual targets when unconsciously primed with a sexual stimulus. The sex target primed by a sex prime clearly and significantly yielded the fastest decisions on the target. All decisions were slowed down when the same targets were preceded by supraliminal, conscious primes. But this time the decision on the sex target, preceded by a sex prime were the slowest of all decisions. It is important to note that conscious primes, in contrast to unconscious primes, inhibited decisions about the target. This phenomenon was also found in studies of Geer in a number of lexical decision tasks. He coined this phenomenon SCID, Sexual Content Induced Delay (Geer & Manguno-

Mire, 1996). In processing conscious primes an extra computational step is involved. Normally, this takes extra processing time, but, apparently, even more processing time is required for a sexual stimulus.

So a tentative answer to our initial question is: yes, sexual stimuli may be processed in an unconscious way and they can activate the sexual system. Inhibition in this early processing of sexual response may be of strict neurophysiological origin. There are indications that habituation is almost lost in severely traumatized patients (Shalev, Orr, Peri, Schreiber, & Pitman, 1992). In line with these findings in traumatized patients, we may find disturbances in basic neural routines in patients with sexual dysfunctions which originate from sexual or other traumas.

Stimulus Attractivity Studies

There are several interesting reasons for exploring variations in stimulus attractivity. Increasing stimulus attractivity results in more arousal, and eventually in greater subjective excitement and desire. Various stimuli may induce different content of sexual imagery and as a consequence impact sexual response differently. Highly attractive stimuli result in more arousal, and eventually in greater subjective excitement and desire than stimuli that are less attractive.

Incentive motivation theory suggests that the attractive value of a stimulus may increase, when the subject is abstinent for the stimulus after some initial exposure. In contrast, habituation seems to reduce attractivity. Common knowledge therefore forbids 'to live with your love', love's paradox doesn't want you to stay too long with your object of desire.

Of course, there are other options for varying stimulus attractivity; for instance, one may apply stimuli from the Guttman scale of sexual interactions (Bentler, 1968 a,b) with increasing attractivity, stimulus characteristics may be changed as for example by changing partners.

An abstinence paradigm is an interesting variety of manipulating stimulus attractivity because it may enable a test of two theoretical points of view. One is the drive theory of motivation. Abstinence will result in some bodily deprived state which eventually can be measured. On the other hand incentive motivation theory puts the weight on changes in stimulus attractivity and not on changes in bodily state.

There are many technical difficulties that hinder the construction of an abstinence paradigm in humans. Compared to the use of such a paradigm in animal studies the most important barrier in humans is the control over cognitive events that take place after initial exposure. In animal studies, the animal, often rats, are separated after a short exposure, and it is supposed that rats do not remain in imagery with their partner. This is what people typically do. Our current approach is to prevent sexual imagery after initial exposure. In one of the next studies we will explore the possibility that some mode of cognitive processing will enhance attractivity, while another mode will detract attractivity (cf. ironic processing (Wegner, 1989): the intention not to think about, for example, white bears induces thoughts about white bears).

Motor Imagery in Sexual Fantasies

Voluntary action and also some automatic action is guided by plans. The question we did not address yet is, how in our model do we go from activity in the sexual arousal module to actual behavior. At a certain point activation of the sexual arousal module will lead to a decision or plan to engage in sexual behavior or not. One such plan could involve engaging in fantasies about sexual behavior.

The literature on motor imagery has shown that there is overlap in the activation of sensory and motor areas in the brain when imagery about action and action itself are compared (Jeannerod, 1997). Because this seems to be the case, looking at imagery about behavior is as valid as looking at behavior itself.

Lang (1979) used schema-theory and proposed a propositional network in the brain to explain efferent processes in anxiety. Dekker and Everaerd (1988) used Lang's ideas to look at voluntarily induced variations in the strength of sexual responses by having subjects fantasize about motor expression. According to Lang, attending only to stimulus information ('what is it?') will not result in emotional response, or only in very weak responses, because the propositional network is not fully activated. This mode of processing resembles what people do when they try to control their emotions by not letting themselves become too involved in, for instance, events in a movie. They may tell themselves: 'oh, it's just a movie'. Emotions come about when people not only attend to stimulus information, but also to so-called response information ('what is it?' plus 'what would I feel if I were in that situation?'). Following this line of reasoning, imagery that contains motor expression should result in stronger emotions. In two studies of Dekker and Everaerd in the 80s, imagery containing motor expression indeed resulted in stronger sexual arousal than imagery not containing motor expression (Dekker, Everaerd, & Verhelst, 1984; Dekker & Everaerd, 1988).

In their timely review Leitenberg and Henning (1995) summarized the most popular and common fantasies. It turns out that most people, men and women, fantasize about intercourse, oral-genital activity, and emotional experience. Our best guess at this point is that the most preferred and most arousing fantasies are indeed about motor output.

T-reflex Modulation

From a functional perspective, sexual arousal is the first step in the unwinding energetics of sexual response. ANS efferent activity has been the most widely used parameter for monitoring the presence and the intensity of sexual response (Janssen & Everaerd, 1993; Laan & Everaerd, 1995). As energetics develop it is to be expected that early motor preparation can be observed. To monitor early motor preparation there is a possibility of using modulation of reflexes by emotional arousal (Bonnet, Bradley, Lang, & Requin, 1995; Brunia & Boelhouwer, 1988). Bonnet et al. (1995) studied the modulation of T-reflexes during the presentation of pictures from 'The International Affective Picture System' designed by Lang, Öhman, and Vaitl (1988). Pictures were designed to induce emotions varying in valence (positive to negative) and in intensity (low to high). Similar to what has been said about sexual response, Bonnet et al. reasoned that emotional responses are preparations for actions. Thus

motor preparation and facilitation of motor responses can be monitored as an aspect of emotional processing. This motor facilitation is non-specific relative to valence; no differences in the modulation of T-reflexes were found between negative and positive emotional states. As was expected, increasing emotional intensity resulted in increased reflex amplitudes.

To study early motor preparation by sexual arousal we were able to bring together the work on T-reflex modulation of the Tilburg psychophysiology group and the experience with studies into sexual response of our group in Amsterdam. In a first study we explored the modulation of T-reflexes by sexual arousal and anxiety.

To induce different emotional states we used stimuli that had been explored in our earlier studies about sexual response (Laan, Everaerd, & Evers, 1995). The stimuli consisted of sexual, anxiety-inducing, sexually threatening, and neutral film excerpts. We expected the neutral film to have no modulating effects on T-reflex. The other film excerpts were expected to facilitate T-reflexes, and we had no reason to expect a differential response.

In a study with a small sample of female students we found that induced emotions indeed modulate the amplitude of T-reflexes, while the neutral induction does not show these effects. There was, as expected, no difference between anxiety and sexual film excerpts.

In a second study we induced sexual arousal with increasingly intense sexual stimuli, again in women. Increasing intensity induced larger reflexes.

We are now preparing studies in men and women. T-reflex modulation as well as genital measures of sexual arousal will be used. We are also preparing studies that look into changes in tension in m. gluteus medius, which is involved in coital movements. In contrast to the T-reflex paradigm this may produce a specific window on sexual behavior.

Dopamine and Sexual Response

We are preparing studies to look at the effect of dopamine agonists on sexual response, in men and women. In a double-blind placebo controlled study T-reflex modulation, genital response, and sexual activity in response to sexual stimuli will be measured. We expect that dopamine will especially influence reflex modulation, wanting and sexual activity and that there will be no or a lesser effect on pleasure and satisfaction.

Concluding Remarks

In this chapter we have described our preliminary ideas about a mechanism of sexual motivation. We have focussed on how action may be generated in what we have called the sexual system. We proposed that sexual desire is the subjective experience of an attractive sexual stimulus combined with perceived physiological changes associated with the motivational process. Felt desire is a direct reflection of motor preparation and motor output. These processes come about through processing at an

unconscious level. Subjective experience will occur when phenomena in the process transcend perceptual thresholds. Because of the complicated parallel processing in the CNS, attentional processes will play an important role in determining subjective experience.

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