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**Central activation of the sexual system**

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# Chapter 1

## General Introduction



What happens when a person is confronted with a sexually competent stimulus? How is stimulus information transformed into particular sorts of actions? In this thesis central activation of the sexual system is investigated from a cognitive perspective. When writing about the "sexual system", I mean sexually specific as well as nonspecific circuits within the brain, which interact to produce a sexual response. Using a priming paradigm, I investigated differential contributions from unconscious versus conscious information processing.

For a full blown sexual emotion, specific reactions have to be activated (e.g., genital arousal, a subjective experience of sexual arousal) as well as nonspecific reactions (e.g., heart rate changes, a subjective experience of tension). The activation of these reactions is mediated by physiological sensitivity (e.g., androgenic hormones) and environmental variables, such as stimulus context, rules, and opportunities. Also cognitive processes figure prominently. Sex can be construed as an emotion (Everaerd, 1988; Geer, Lapour, & Jackson, 1993), and emotional reactions depend on appraisal of the stimulus, which includes memory, regulatory, and attentional processes interacting with one another. The focus of this thesis is on these cognitive processes.

Activation of sexual response may be largely determined by unconscious cognitive processing. The subjective experience of sexual arousal certainly depends on conscious processing, the individual's awareness of bodily sensations together with the appraisal of the response as sexual. Yet subjective experience can be seen as contingent on information processing outside of awareness. Sexually competent stimuli may have the capacity of being recognized unconsciously; autonomic responses as well as motor programs may be activated by efferent messages from implicit sexual memory.

### Origin of the research objectives

Research reported of in this thesis begins where Erick Janssen (1995) finished his "Provoking penile responses." His primary goal was to strengthen the position of psychological assessment in the diagnosis of male erectile dysfunction. In sexually dysfunctional participants it was attempted to provoke responses by reducing the effects of negative controlled processing, and in sexually functional subjects the role of automatic

processing in the activation of genital responses was studied. At the end of the thesis, a cognitive model of sexual arousal was presented in which the main results were integrated. In the next paragraphs the most relevant findings are summarized.

The principal question in the diagnosis of male erectile disorder is whether the physiological mechanism is intact (Everaerd, 1993). When the initial interview fails to provide sufficient information about the erectile capacity of the patient, tests may be employed that allow direct observation of penile responses. If a sustained response results from these tests, the conclusion follows that the physiological mechanism is most likely intact. It is then appropriate to proceed with psychological explorations, and further (invasive) diagnostic assessments can thus be avoided (Janssen, 1995). A psychophysiological protocol, Waking Erectile Assessment (WEA), was evaluated (Janssen, Everaerd, Lunsen, & Oerlemans, 1994) that proved to be a viable initial screening procedure. WEA was designed to elicit penile responses by employing visual and tactile stimuli both separate and in combination. To reduce inhibiting effects of performance-related cognitions a distraction task (simple additions) was implemented in the WEA. Experimental studies revealed that neutral distractors decreased sexual responses in functional men, but had no effect or even facilitated sexual responses in sexually functional men (Barlow, 1986).

Differences between functional and dysfunctional participants were further explored from the perspective of automatic versus controlled cognitive processing. The ease with which functional subjects can become sexually aroused suggests a highly automatized response mechanism. In dysfunctional participants, however, it seems that this automatic response mechanism is disrupted by negative cognitive elaboration. This inhibition of sexual responding might occur on a more conscious, controlled cognitive level (e.g., involving sexual worries), or it might also involve an automatized mechanism (Janssen & Everaerd, 1993). The preattentive activation paradigm (Holender, 1986) allows studying automatic processes. In this paradigm affective responses are provoked while conscious processing of the presented stimuli is minimized.

A first pilot study (Janssen, Everaerd, Spiering, & Janssen, 2000, Experiment 1) was designed to provide a direct test of the assumption that genital responses may be activated as a result of automatic processing of a sexual stimulus. A group of sexually functional heterosexual men was

presented with a series of sexual (target) slides. A neutral (e.g., a picture of a plant) or a sexual (e.g., a nude female model) priming stimulus preceded each target slide. Exposure duration of half the neutral and sexual primes was set at the participant's perceptual threshold level and the other half of the primes were set at 20 ms below this threshold. It was expected that, in comparison with the neutral primes, the presentation of a sexual prime would facilitate responses to the sexual target slides. Sexual priming stimuli will activate early components of the genital response, and this activation should be reflected in higher initial response levels to the sexual target stimuli. A recognition test, to check the manipulation of subliminal presentation, revealed that some participants were found to be discriminating priming stimuli above chance. Therefore, an explorative grouping factor Recognition group (high recognizers vs. low recognizers) was created.

As expected, maximum genital responses during the first 5 seconds of the sexual target presentations were different for sexually and neutrally primed target presentations. Surprisingly, the direction of this effect was opposite to the one predicted, that is, genital responses to sexually primed targets were lower than responses to neutrally primed targets. Although main and interaction effects were only marginally significant, this reversed priming effect was found to be significant for the short exposure duration and a "low recognizers" participant group. While these latter findings are consistent with the results of other priming studies (e.g., Murphy & Zajonc, 1993; Smith, Spence, & Klein, 1959; see also Bornstein, 1989) demonstrating that affective priming effects are stronger with lower levels of prime exposure, the reversal in the direction of the priming effect was unexpected.

There is an explanation for the lower initial responses to the sexually primed targets. Several investigators (e.g., Earls & Marshall, 1982; McConaghy, 1974) have observed that during initial stages of erection the penis undergoes an increase in length, which is associated with a simultaneous *decrease* in circumference. Recently, Kuban (1997), in a comparison between volumetric and circumferential measures, found a negative correlation between the two measures for approximately 25% of his participants, and indicated that in many of these cases an initial increase of penile volume coincided with a decrease in penile circumference. Unfortunately, the software used in the Janssen et al. (2000) study set all negative "responses" to zero circumference change, thus eliminating the

opportunity for checking this phenomenon in the data. However, the findings of these other studies suggest that the present experiment did yield evidence for early activation of the genital response. If sexual prime presentations indeed activated early components of the genital response, and if this activation was reflected, at least in some subjects, in an initial decrease in penile circumference (resulting in a 'zero' response in the present study) a relatively low mean response for the total group of subjects is to be expected. In conclusion, while the interpretation of the direction of the priming effects found in this study is problematic, the finding that penile circumference was affected by the presentation of sexual primes does indicate that stimuli presented under conditions limiting access to consciousness are nevertheless capable of activating processes relevant to sexual response.

In view of the uncertainties surrounding the interpretation of these findings, a second experiment (Janssen et al, 2000; Experiment 2) was designed in an attempt to tap the effects of automatic processing at an earlier stage, that is, at a central level, using a behavioral measure (decision time). Although this type of measure is clearly inappropriate to probe genital activation effects, it allows for a test of the underlying and necessary assumption that sexual meaning is processed in a fast, automatic manner. Participants in this experiment were presented with a number of neutral and sexual target stimuli. Their task was to indicate as fast as possible whether the target was neutral or sexual. As in the first experiment, two different relationships between primes and targets were created. For congruent trials the target was preceded by a related prime (e.g., sexual-sexual), whereas on incongruent trials the target was preceded by an unrelated prime (e.g., neutral-sexual). Based on our assumption that sexual meaning of stimuli can be activated without the need for a high (i.e., conscious) level of processing, it was predicted that response times to sexual targets would be shorter for congruent than for incongruent trials.

The results of this experiment provide evidence for the idea that the meaning of sexual stimuli can be perceived in a fast, automatic manner. For a low-recognition group a significant effect of prime-target relationship was found, indicating that decision times during congruent trials were shorter than decision times during incongruent trials. This effect was significant for trials with sexual targets only. Interestingly, a negative correlation was found for the sexual trials between the effect of priming and recognition

accuracy, indicating that priming of sexual targets was more successful at lower levels of stimulus accessibility. In fact, the results for the "high" recognition group show that at high levels of recognition the priming effect significantly reversed. Sexual primes, as compared to neutral primes, occasioned *longer* decision times to sexual targets in the high recognizers group. No significant correlation was found for trials with neutral targets.

As was noted in interpretations of the results of the first experiment, the finding that priming of sexual stimuli is more successful at lower levels of prime exposure is consistent with the results of some earlier affective priming studies (e.g., Murphy & Zajonc, 1993; Smith et al., 1959). For example, Murphy and Zajonc found that very brief presentations of affective primes produced significant shifts in participants' judgments of novel stimuli, but had no effects at exposures allowing conscious identification of the primes. In explaining their results, the authors referred to the model of Öhman, Dimberg, and Esteves (1989) that proposes that affect is processed early in the information processing chain, that is, before more complex perceptual stimulus features are encoded. According to Murphy and Zajonc, it follows from this model that at degraded exposure levels stimuli elicit affective decisions that are unencumbered by other, more complex information. They further propose that affective stimuli are likely to activate more complex networks of associations with longer exposures. If the outcome of this more elaborate appraisal contradicts or dilutes the primary affective decision, the two sources of information may nullify each other, thus canceling priming effects. Clearly, the findings of the second experiment of Janssen et al. (2000) support the notion that different processes are involved at different levels of stimulus accessibility.

If we apply Murphy and Zajonc's (1993) interpretation to these results, we still need to explain why the supposedly more elaborate appraisal processes nullified, and even reversed, the priming effect. It may be speculated that the early sexual appraisal of stimuli mainly activates sexual associations, while later appraisal processes may lead to an additional activation of other, apparently more negative (cf. Geer, 1991) and response inhibiting associations. It should be emphasized, however, that in the present study these "later" appraisal processes took place at some intermediate level of stimulus accessibility. Stimulus exposures (about 50 milliseconds) were extremely small, and similar for the low and high recognition groups.



At the end of his thesis, Janssen (1995) presents a conceptual model of sexual arousal, which recently has been published in a slightly adapted version (Janssen et al, 2000). In this model sexual arousal is considered to be the outcome of a process involving several cognitive actions. Two main information processing stages are distinguished: an appraisal stage and a response generation stage (cf. Frijda, 1986; see Figure 1.1). Appraisal, as noted above, refers to the mechanisms that give a stimulus event emotional meaning, and involves processes of encoding and matching of stimuli in memory. Response generation can be conceptualized as an “integrative” stage, integrating meaning with response or motor plans, which may lead to subjective experience of sexual arousal and genital response. The two stages, which form the central pathway in this model, mediate between stimuli and responses and are proposed to operate primarily on an automatic or preattentive level. As a third ingredient of the model, controlled or attentional processes, involving higher level regulation processes, both affect, and are affected by, central pathway operations.

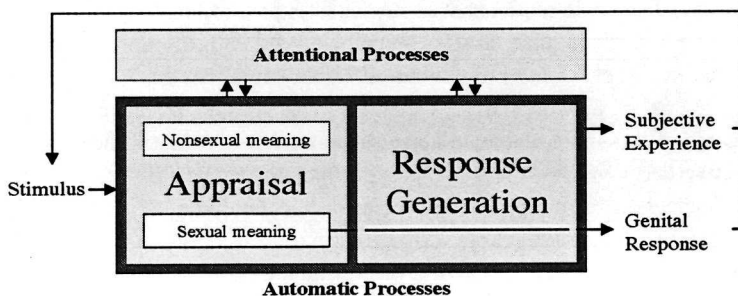


Figure 1.1. An information processing model of sexual arousal (Janssen et al., 2000).

In what way can we conceptualize the activation of sexual responses in terms of this rudimentary information processing model of sexual arousal? Clearly, the process starts with a relevant stimulus or stimulus event. The stimulus is encoded and matched with memory elements. A match with sexual elements in memory primes genital responses and this (primary) appraisal triggers attentional processing (cf. Öhman, 1986). When

a stimulus event predominantly provokes sexual meaning in the memory system, attentional processes and the central pathway will operate in harmony. In this situation, attention enhances the processing of sexual meaning. In other words, attention is directed towards task-relevant, sexual cues (cf. Barlow, 1986). Central to our theoretical perspective is the notion that the central pathway is an automatic one and that, when sexual meaning prevails, this automatic process triggers the attentional system and directs it towards the sexual content of the stimulus event. Thus, a sexual stimulus may be viewed to attract attention to its sexual content in an automatic way (cf. Shiffrin, 1988). As a next step, both the activation of genital responses and the awareness of becoming sexually aroused become part of the stimulus event and feed-back into the central pathway. This means that responses become an object of appraisal themselves. This interactive process may eventually lead to the occurrence of full-blown genital and subjective sexual responses.

#### Research objectives, definitions, and outline of the thesis

My aim in this thesis was to clarify central activation of the sexual system. A first objective was to improve the preattentive priming paradigm that was introduced by Janssen (1995). Results that were obtained (Janssen et al., 2000) are promising but allow alternative interpretations. A second objective was to extrapolate the findings to a female population and investigate gender differences with respect to activational mechanisms. A third objective was to investigate the clinical applications of this approach. A last objective was to further test, and when necessary modify, our model of sexual arousal (Figure 1.1; Janssen et al, 2000).

The chapters of this thesis (2-6) contain reports of experiments conducted in a period of approximately 5 years. In this period the literature and our knowledge have developed and consequently different overlapping terms are used, that is, *automatic*, *implicit*, *preattentive*, and *unconscious*. These concepts stem from different fields of research and are defined as follows.

The term *automatic* was introduced for information processing mechanisms that require none of the limited attentional capacity (LaBerge & Samuels, 1974; Posner & Snyder, 1975; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). Automatic processes were described as fast, effortless,

unintentional, and operating in parallel, that is, without interfering with ongoing mental activity. In contrast, *controlled* processes demand attentional capacity, operate sequentially, and are under intentional control.

The concept *implicit* stems from the field of memory. Long-term memory is not a unitary entity, but can be subdivided into *explicit* (or declarative) and *implicit* (or procedural) memory (Squire, 1992; Tulving & Schacter, 1990). Explicit memory is consciously accessible; implicit memory is not.

*Preattentive*, taken literally, means before attention operates. So-called preattentive search is really a search in which attention is distributed widely over the whole display rather than narrowly focused and is directed serially to one subgroup at a time (Treisman & Gormican, 1988; Treisman & Souther, 1985). Preattentive search can be construed as a filtering of information so that some features or aspects of an array are "passed through" and others are "filtered out". Preattentive visual search was defined as fast, automatic, and parallel and works on low-level stimulus features with the primary objective of delineating objects in the spatial surroundings. *Focal attention* is slow, deliberate, and serial and is concerned with more complex inferential and interpretative processes in identifying the located objects in perceptual awareness (Posner & Snyder, 1975; Shiffrin & Schneider, 1977; Schneider & Shiffrin, 1977).

*Unconscious processes* have two essential features: they are inaccessible for phenomenal awareness and independent of voluntary control (Kihlstrom, Mulvaney, Tobias, & Tobis, 2000). The essential feature of *consciousness* is awareness; to be conscious is to be aware of things. Attention is a prerequisite of consciousness. Consciousness refers to those thoughts, memories, sensations, and actions of which one is aware, whereas attention refers to those processes that modulate neuronal activity (Tassi & Muzet, 2001).

The following paragraphs outline the contents of this thesis in greater detail. In Chapter 2 to 5 six experiments are reported, three using subliminal prime presentations and three using supraliminal prime presentations. In Chapter 2, unconscious versus conscious activation of the sexual system was investigated. Only men were tested. Sexual slides, *targets*, were preceded by either sexual or neutral *primes*. In a *cognitive task*, participants had to group randomly presented targets as quickly as possible into sexual and nonsexual

categories. In a subsequent *affective task*, participants provided an assessment of sexual arousal, followed by an evaluation of the target. In the first experiment (i.e., unconscious activation), primes were made inaccessible to conscious cognitive elaboration. In the second experiment (i.e., conscious activation) primes were presented at a conscious level.

In Chapter 3, the first experiment (unconscious activation) as reported in Chapter 2 have been replicated, with some modifications, with women as participants. The first experiment of Chapter 3 is a direct replication. In the second experiment, besides the male-oriented sexual picture set, pictures of two other sets were presented: female-oriented sexual pictures and baby pictures. Also influence of the menstrual cycle on unconscious activation was examined.

The next two chapters are built on the second experiment of Chapter 2 (conscious activation). In Chapter 4 the effects of conscious appraisal of sexually romantic versus sexually explicit stimuli were investigated. Male and female participants were presented with the cognitive and affective task. The affective task was hypothesized to result in differential access to memory, where assessments of sexual arousal are influenced mainly by implicit memory, and where evaluations are influenced mainly by explicit memory. In Chapter 5 two manipulations were added to the cognitive task to investigate underlying information processing mechanisms. Firstly, varying the instructions influenced the appraisal process. Secondly, primes with nonsexual emotional content were added to test specificity.

Chapter 6 is the last empirical chapter. The two topics are: (1) patient study and other clinical research, and (2) directions for future research.

Chapter 7 is a theoretical integration of unconscious cognitive processes that set up sexual responding. Three hypotheses were discussed. (1) Sexual features are subject of a preattentive search. (2) Sexually competent stimuli activate motor output by a match with implicit memory. (3) Hot and cold cognitions are postulated as unconscious products of bodily feedback and explicit memories. Attentional amplification of these cognitions results in conscious experience of sexual feelings and sexual thoughts.

Chapter 8 presents the general discussion of this thesis. Alternative explanations and the outcome of the research objectives are considered.

This thesis comprises several articles (Chapter 2 to 6). Since these articles are self-containing, the text of some of the chapters shows some overlap.