THE DUAL CONTROL MODEL: THE ROLE OF SEXUAL INHIBITION & EXCITATION IN SEXUAL AROUSAL AND BEHAVIOR

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Introduction

Psychophysiological studies of sexuality have largely, if not completely, ignored issues of individual variability in responsiveness. Most of the research published in this area involves the comparison of subject groups, experimental conditions, or treatments. The few attempts to evaluate individual variability have been largely restricted to the measurement of sexual attitudes and behavioral tendencies. Erotophobia-erotophilia is a well-known example (Fisher, Byrne, White, & Kelley, 1988). This construct is measured with the Sexual Opinion Survey (SOS), a questionnaire that assesses affective and evaluative responses to different types of sexual activity or stimuli. Until recently, no models or measures existed that focus specifically on individual differences in sexual response.

The dual control model of sexual response postulates that sexual arousal and associated behaviors depend on the balance between sexual excitation and inhibition. It is an example of a state-trait model, although most research so far has focused on the trait dimension of the model. The model proposes that the weighing of excitatory and inhibitory processes determines whether or not a sexual response occurs within an individual in a given situation, and at the same time it assumes individual variability in the propensity for these processes. The model was developed in an attempt to synthesize existing research findings in the area of male sexual dysfunction, to contribute to this research by underscoring the relevance of exploring individual differences, and to stimulate new research, in this and other areas of sexual response and behavior. In this paper, we will present the model's background, discuss findings from several lines of research, reflect on the model's strengths and weaknesses, and consider directions for future research.

Background

From the late 1970s on, psychophysiological research on the mechanisms of sexual arousal--and the models in which this research culminated--has had a strong focus on the exploration of cognitive processes, in particular the role of attention. For example, Barlow's model, published in 1986 and integrating most of the then available research, proposes that the activation of sexual response is dependent upon "task-relevant" cognitive processing of a sexual stimulus (Barlow, 1986). Problems with sexual functioning would result from "task-irrelevant" processing, or distraction. Barlow's model was based on findings from a series of studies exploring differences between men with and without erectile problems in how they process and respond to sexual stimuli. In men with psychogenic[1] erectile dysfunction, fear of failure or sexual worries were believed to interfere with the sexual response because they distract from attending to sexual cues (Barlow, 1986). Janssen and Everaerd (1993) proposed, consistent with Barlow's model, that men with psychogenic erectile problems fail to respond due to a predominantly nonsexual processing of relevant stimuli, a process indeed dependent on attentional processes (i.e., distraction), but initiated at an unconscious or "automatic" cognitive level in response to psychological threats or performance-related worries (see also Janssen, Everaerd, Spiering, & Janssen, 2000). Through a cognitive window, the interface between psychological processes and genital response thus seems to depend heavily on two factors: the presence of a sexual stimulus and the absence of processes interfering with the activation of a response to a sexual stimulus.

Bancroft (1995) questioned the strong reliance on the role of attention in these theoretical approaches and suggested that a third component, involving direct neurophysiological inhibition of erectile response, was missing. Bancroft (1995, 1999) reviewed findings from, among others, pharmacological studies and research on erections during sleep (NPT) and made a convincing case for the idea that more direct forms of inhibition should be considered. To give just one example, erections induced by the intracavernosal injection of smooth muscle relaxants are considered a peripheral, target organ effect, or an effect not mediated by

psychological mechanisms. However, a substantial proportion of men with psychogenic erectile dysfunction have been found to respond poorly to such injections (e.g., Bancroft & Malone, 1995), indicating that inhibition can occur to stimuli (in this case pharmacological) that rule out explanations in terms of "task-irrelevant" processing.

It could be argued that most research on the role of cognitive processes in sexual dysfunction has not dealt with inhibitory but excitatory mechanisms (Janssen & Bancroft, 1996). That is, "distraction models" are perhaps more accurately described as models that treat inhibition as a "lack of excitation." They thus conceptualize sexual arousal one-dimensionally, as something that is activated or not. The dual control model emphasizes the role of inhibition, where responses are suppressed or not, as well as excitation, implying that in studying sexual arousal, we have to discern both excitatory and inhibitory influences.

Broader Context and Assumptions

When contemplating the many ways the control of sexual response can be conceptualized, the notion of "level of analysis" comes to mind. At a lower, or "molecular," level, sexual responses are most likely controlled by multiple inhibitory and excitatory neurophysiological processes (e.g., Stoléru & Mouras, this volume). Even at some intermediate level, the evidence points to highly complex interactions, involving, for example, the norepinephric activation of arousal, the disinhibition of dopaminergic systems, the involvement of testosterone-dependent systems, neuropeptidergic as well as serotonergic processes, and peripheral mechanisms (Bancroft, 1999). The dual control model represents a higher, or "molar," level of analysis. The model postulates the involvement of two neurophysiological systems, one relevant to activation and the other to suppression of sexual response, much like the "conceptual nervous system" proposed by Gray (1982). Gray's theory, and related work by researchers like Eysenck (1967) and Depue (e.g., Depue & Collins, 1999), concerns more general mechanisms of activation and inhibition and can be described as a theory of approach and avoidance and the associated concepts of reward and punishment.

The idea of regulation by forces and counterforces, or by the interaction between activation and suppression, is not uncommon in other areas of psychological inquiry, such as psychophysiology, memory and cognition, and emotions and affect. As is true for the dual control model of sexual response, this typically includes assumptions (or questions) about independence or orthogonality. For example, the sympathetic and parasympathetic branches of the autonomic nervous system have traditionally been viewed to have reciprocal or counteractive effects. Therefore, their functional outcomes were reducible to a single dimension. More recent research, however, shows that the two autonomic systems can be activated at the same time and act independently from each other (e.g., Berntson, Cacioppo, & Quigley, 1991). Similarly, in research on "affect," there is an increased recognition of the possibility that positivity and negativity are outcomes of independent processes and can co-occur (e.g., Cacioppo, Gardner, & Berntson, 1999). In other words, more traditional views of affect, involving one-dimensional, bipolar constructs (where positive and negative activation are reciprocal), are being challenged and proposed to be replaced with (at least) two-dimensional, or bivariate, approaches. As a final example, in cognitive psychology, in particular in memory research, interference and inhibition are considered independent processes. Inhibition involves active suppression (for example of memory intrusions), whereas interference is usually defined as the result of competition among multiple stimuli, processes, or responses (Harnishfeger, 1995). This is not unlike the distinction between the effects of distraction (sexual worries competing with sexual cues, interfering with excitation) and those of active neurophysiological inhibition on sexual response.

Clearly, the above examples in themselves do not directly support the notion that the regulation of sexual response would involve two independent mechanisms. From a conceptual point of view, the more parsimonious approach would be to focus not on two but on one mechanism of control. Considering that a review of the literature leads us to conclude that excitation, or the lack of excitation, fails to explain response outcomes in all relevant situations, perhaps the study of inhibition would suffice. However, research on the behavioral tendencies of approach and avoidance (e.g., Gray, 1982), the workings of the autonomic nervous system, and on affect, although just examples, underscore the importance of considering the existence of multiple control systems. In the case of sexual response, we believe that there indeed is a role for excitation, both at a state and a trait level, as it may help in explaining the responsivity or sensitivity of the sexual response system in the absence of inhibition.

The dual control model is first of all a conceptual device, a way to structure and formulate research questions. Reality is without question more complex. For example, even distraction, or the activation of interference, might be the result of inhibitory processes (cf. Gray, 1982). And, inhibition will need to be activated or require some type of excitatory activity

(Bancroft, 1999). Also, although we assume that inhibitory and excitatory processes, at a trait level, are orthogonal or independent, at a state level they may not be as disconnected and could possibly modify each other's output levels or "set points." Perhaps we should think of it in similar ways as research shows the autonomic nervous system works, where there can be coactivation, uncoupled activation, and reciprocal activation (Berntson et al., 1991). Again, many levels of analysis are possible, and we approach the dual control model as a starting point for new research as much as we believe it integrates existing findings. Many if not most questions concerning the value or appropriateness of the model are empirical in nature and thus open to examination.

A number of other assumptions are associated with the dual control model. First, it is assumed that our putative sexual inhibition and excitation systems reflect specifically sexual rather than general mechanisms of activation and inhibition (cf. Gray, 1982). Secondly, we assume that sexual inhibition and excitation are both adaptive, and that they serve, across species, a number of biological functions. Whereas the relevance of sexual excitation is relatively straightforward, functions of sexual inhibition could include the refractory period, the suppressing effects of chronic stress on reproductive behavior, and the detection of threat, either sexual or nonsexual, when inhibition of sexual response facilitates avoidance of that threat (see Bancroft, 1999, for a more extensive discussion). Thirdly, although learning may play a role in determining individual variabilities in response tendencies, it is assumed that individual variation in sexual inhibition and excitation is a stable trait and may be, at least in part, genetically determined. Finally, we embarked on our research program with the idea that a high propensity for sexual inhibition (and a low one for sexual excitation) would be associated with a vulnerability to sexual dysfunction (see Bancroft & Janssen, 2000, 2001, for fuller discussion) and a low propensity for sexual inhibition (and a high one for excitation) with an increased likelihood of sexual risk taking (see also Bancroft, 2000; Bancroft et al., 2003b; Bancroft et al., 2004).

The SIS/SES Questionnaire

We started our research on the dual control model with the development of a paper-and-pencil measure of propensities for sexual inhibition and excitation, the Sexual Inhibition Scales/Sexual Excitation Scales, or the SIS/SES questionnaire (Janssen, Vorst, Finn, & Bancroft, 2002a, 2002b). Although the concepts of excitation and inhibition are probably just as relevant (if not more; cf. Bjorkland & Kipp, 1996) to women's sexual responses, and although the SIS/SES questionnaire has demonstrated its value in research in women (Carpenter, Graham, Janssen, Vorst, & Wicherts, 2006), the measure was originally developed for use in men because the available research underlying the dual control model was largely restricted to the neurophysiology and psychophysiology of male sexual response. In designing the questionnaire, we followed a "facet design" approach, although not in its most comprehensive form. Facet design is a conceptual method that integrates aspects of instrument construction, construct development, and data analysis (e.g., Shye & Elizur, 1994). The majority of questions for the SIS/SES questionnaire were written in an "if-then" form. For items relevant to excitation, the "if" statement described a potential sexual stimulus and the "then" statement, the occurrence of a sexual response. We attempted to include a variety of "facets," including the type of stimulus (e.g., fantasy, visual, auditory, and olfactory stimuli, and social interactions) and type of response (sexual arousal and/or genital response). For inhibition, we started from the premise that it would play a specific role in modifying sexual responses in the avoidance or reduction of "threat." Threats were conceptualized as being either intrapersonal or interpersonal in nature, and items were constructed to cover inhibition due to negative consequences of sex, performance anxiety, norms and values, and physical or psychological harm.

Factor analysis on the data of a sample of 408 sexually functional, heterosexual men (with a mean age of 23 years) identified 10 factors, involving 45 items. A further factor analysis, carried out on the subscale scores, identified a single excitation factor (SES), but differentiated sexual inhibition into two factors, which we have called "Inhibition due to threat of performance failure" (SIS1) and "Inhibition due to the threat of performance consequences" (SIS2). Confirmatory factor analysis on the data from two additional samples of 459 (mean age of 21 years) and 313 (mean age of 46 years) heterosexual men showed the 10-factor model to be best, but only marginally better that the nested 3-in-10 model, and supported our continued use of the higher-level factor structure. The three scales showed close to normal distributions in all three samples and respectable levels of internal consistency and test-retest reliability. SES and SIS1, but not SIS2, were related to age (negatively and positively, respectively). In addition, correlations between the excitation and the two inhibition factors were low, showing excitation and inhibition to be relatively independent, and a significant but low correlation revealed little overlap between the two inhibition scales.

In evaluating the scales' discriminant and convergent validity, we found a small degree of overlap with measures of global traits of behavioral inhibition, neuroticism, harm avoidance, and reward responsivity, suggesting that the SES scale taps aspects of reward responsivity and the SIS scales (especially SIS2) aspects of global behavioral inhibition. However, the modest degree of overlap supports the idea that the SIS/SES questionnaire predominantly measures propensities that are specific to sexual responsivity.

Two Types of Sexual Inhibition?

We had not anticipated the identification of two inhibition scales. The questions making up the two scales were conceptually different, however, and it became apparent that the items of the SIS1 scale mainly assess situations where the most obvious threat is the anticipated failure of sexual response, whereas in the items of the SIS2 scale, the threat is in the anticipated consequence of sexual response. Hence our descriptive title "Inhibition due to threat of performance *failure*" for SIS1 and "Inhibition due to threat of performance *consequences*" for SIS2.

It is possible that the two scales reflect two distinct inhibitory systems. Our lack of understanding of the nature and specificity of central inhibition of sexual response should leave us open to this possibility (Bancroft, 1999). However, in more detailed discussions of this issue (Bancroft & Janssen, 2000, 2001), we postulated that as SIS1 appears relevant to the anticipation of failure of response, the threat is more intrinsic. While this could be a consequence of learning, it nevertheless implies some inbuilt tendency for response failure. We proposed that this could be a consequence of a basically high inhibitory tone. By contrast, SIS2 seemed to involve inhibition that is activated or triggered by external threats. We will return to this distinction later.

Application of the Model in Nonlaboratory Research

Sexual Dysfunction

As the dual control model evolved from research on sexual dysfunction, a logical first application of the model involved the exploration of its relevance to sexual function. Starting with a somewhat older, nonclinical male heterosexual sample (N = 313, mean age = 46 years; Janssen et al., 2002a), we asked men whether they had (i) *ever* had difficulties in obtaining or keeping an erection, and (ii) whether they had such difficulties in the past 3 months. We explored the relationships between our scales and these two questions using multiple regression, with the three SIS/SES scales and age as the independent variables. In predicting answers to the "ever had difficulties" question, SIS1, SIS2, and age were significant. SES did not figure in the equation. For erectile difficulties in "the past 3 months," SIS1 and age were both strong predictors, SES predicted weakly and negatively, but SIS2 did not enter the equation. We thus found SIS1 strongly predictive of erectile problems in this nonclinical sample, for both time periods, whereas SIS2 was only relevant on the "ever had difficulties" basis. The findings are consistent with the SIS1 measure reflecting some trait vulnerability that would persist and, as the previously found correlation with age suggests, may be amplified by the effects of aging. In contrast, SIS2 indeed appears to measure a tendency to respond with inhibited erection when a threat is present, a situation that is likely to occur with lower probability over a 3-month period than for "ever." We found a similar association between SIS1 (and age) and erectile problems in a study comparing a convenience sample of homosexual men (N = 1,379) with an age-matched sample of heterosexual men (N = 1,558; Bancroft, Carnes, Janssen, Goodrich, & Long, 2005). In this study we also asked about problems with rapid ejaculation. Erectile problems were reported more frequently by homosexual men and rapid ejaculation more frequently by heterosexual men. Homosexual men scored higher on SIS1 whether or not they reported erectile problems. Interestingly, in a related study in which we compared HIV+ and HIV– homosexual men (Bancroft, Carnes, & Janssen, 2005), we found that HIV+ men were both more likely to report erectile problems and to have higher SIS1 scores. These combined findings, considering that they involve convenience samples, suggest that there may be differences in the propensity for sexual inhibition as measured by SIS1 between homosexual and heterosexual men, differences that seem consistent with Sandfort and de Keizer's (2001) speculation that homosexual men are more prone to performance anxiety, which may, possibly, be associated with higher risk taking (e.g., related to a reluctance to use condoms). Trait anxiety--but not sexual excitation and inhibition scores--was predictive of rapid ejaculation, but only in the heterosexual men. If replicated, the differences we found between homosexual and heterosexual men may reflect a greater importance of erectile function in the sexual lives of homosexual men and greater importance of ejaculatory control in heterosexual relationships.

We have started collecting relevant data from clinical subjects. In

comparing a small sample of men seeking help for erectile problems with a nonclinical male sample, we found that the men with erectile problems had the lowest SES as well as highest SIS1 and SIS2 scores (Bancroft & Janssen, 2000). In another study (Bancroft, Herbenick, et al., 2005), we compared 171 men attending sexual problem clinics for a variety of problems (e.g., erectile problems, rapid ejaculation) with an age-matched nonclinical sample of 446 men. We found similarly low SES and high SIS1 scores for men in the two samples who reported having erectile problems. Again, our SIS/SES scales were not related to rapid ejaculation. In the clinical group, SIS/SES scores were related to some features of the sexual history of potential etiological relevance. For example, SES was higher in men with normal waking erections and with erections better during masturbation than during sexual intercourse. However, SIS1 was not as clearly associated with clinical features and sexual history variables in this sample. Although this research is at an early stage, we have made an attempt to formulate a number of predictions relevant to prognosis and treatment (Bancroft & Janssen, 2000, 2001). For example, we predicted that men presenting with erectile dysfunction who have normal or low SIS1 scores, but normal or raised SIS2 scores, may benefit from psychological treatment that focuses on the presence of psychological or interpersonal threat (e.g., certain types of partner response patterns). Men with erectile dysfunction who have a high SIS1 score may, we suggested, be more resistant to psychological treatment, at least if it is used on its own. In such cases, the use of pharmacological treatment in combination may be successful. We also predicted that when the problem exists with a low SES and a normal or low SIS1 and SIS2, an excitation facilitator (e.g., Viagra) or focus on more effective methods of stimulation might prove to be effective. In a small pilot study in men with mild to moderate erectile problems (Rosen et al., 2006), we found that performance anxiety and negative expectations regarding treatment at baseline were negatively related to effects of Viagra. In contrast, SIS/SES scores were not a significant predictor of treatment efficacy. However, because effects of SIS/SES may have been obscured by the small number of subjects who completed the study (N = 34) and by the predominant effects of pharmacotherapy in this sample, further research on the relevance of propensity of sexual inhibition and excitation to prognosis and treatment is clearly warranted.

Mood and Sexuality

Although negative mood is generally believed to be associated with a loss of sexual interest and impairment of sexual arousability, recent research shows that the relationship is more variable, with *increased* sexual interest occurring in association with negative mood in a proportion of individuals. We have explored the extent to which individual variability in the relation between mood and sexuality can be explained using our dual control model in two studies, one involving straight men (N = 919, mean age = 28 years; Bancroft et al., 2003a), the other involving gay men (N = 662, mean age = 36 years; Bancroft, Janssen, Strong, & Vukadinovic, 2003). We proposed that, for the majority of individuals, negative mood would be associated with a reduction in sexual responsiveness. However, in an individual who has a low propensity for sexual inhibition, and/or a high propensity for sexual excitation, the coexistence of negative mood and sexual arousal would be a possibility.

Using a simple, newly developed measure, the Mood and Sexuality Questionnaire (MSQ), we found that while a majority of the heterosexual subjects experienced a decrease in sexual interest when depressed, 9% reported an increase. For anxiety, 21% reported an increase. In a regression analysis on the MSQ's total score, age, SIS2, SIS1, ZDPR (a measure of depression proneness; Zemore, Fischer, Garratt, & Miller, 1990), and SES entered the model, in that order. Using ordinal logistic regression we examined the same variables for the individual MSQ scales, which resulted, overall, in a similar pattern. Qualitative data from in-depth interviews demonstrated that the picture is more complex with depression than with anxiety and revealed that sexual behavior may be more likely with depression because of a need for intimacy, for self-validation, or simply for sexual pleasure. The motivation to engage in sexual activity when anxious seemed more simply related to the postorgasmic calming effect.

Quantitative and qualitative results from the study in gay men showed that they, like the heterosexual sample, vary in how their sexual interest and response is affected by negative mood. Of those who had been depressed or anxious enough to recognize a predictable pattern, a substantial minority reported increased sexual interest when depressed (16%) or anxious (24%). The qualitative data from interviews revealed, as with the heterosexual men, that the relationship with anxiety/stress was relatively straightforward; either the individual found that anxiety or stress increased attention to sexual cues, with sexual activity, particularly masturbation, providing some temporary reduction in anxiety, or the individual's attention was focused on the cause of the anxiety and not on sex. However, with depression, the relationship was more complex, even more so than we found with heterosexual men; a number of gay men

described how negative mood made them more likely to take sexual risks, because in such a mood they "didn't care" about consequences.

Of the similarities between gay and straight men, SIS2 played a similar role in the regression analyses for both groups; the higher the SIS2 score the less likelihood of experiencing a positive mood-sexuality relationship. SES played a role in both the gay and straight sample, although in the analysis for the gay men it showed an increased likelihood of a positive relationship between mood-sexuality with anxiety, but not depression.

We are in the process of testing a new, more sophisticated version of the MSQ. The original version does not take differences in the effects of depression on masturbation and on interactions with a partner into account, nor does it assess the intensity of experienced mood states, the co-occurrence of mood states (e.g., anxiety and depression), the effects of sexual activity on mood, or the relationship between mood and behavior. With the new version, which assesses a wider range of emotional states (including happiness), we try to evaluate the complexities in the relationships between mood and sexual desire, response, and behavior in more depth.

We believe this is a new and promising area of research, where sexual excitation and inhibition may not only help explain paradoxical patterns in the relationship between mood and sexuality, but where interactions between all these elements may prove of relevance to our understanding of a variety of topics, including "risky" and "compulsive" sex. For example, Bancroft and Vukadinovic (2004) found, in a small sample of self-designated "sex addicts," increased sexual interest in states of both depression and anxiety to be typical for these subjects. Overall, "sex addicts" scored higher on SES than a control group, but they did not differ in SIS2. There was an interesting exception to this finding: the "sex addicts" who did not use masturbation as their principal form of "acting out" had lower SIS2 than both "compulsive masturbators" and controls, as well as relatively high SES. These preliminary findings suggest that in striving to understand "compulsive" sexual behavior, we should be expecting a range of etiological mechanisms associated with different behavioral patterns. Our dual control model may be relevant to only some of those patterns.

Sexual Risk Taking

Although the past few years have demonstrated an increased awareness of the relevance of studying the role of sexual arousal and other emotional states in sexual risk taking, this has not yet been translated in much systematic research. In one of our research projects, we examined the relevance of the dual control model, and the role of mood and its effects on sexual interest and response, to sexual risk taking in samples of gay (N = 589, mean age = 36 years; Bancroft et al., 2003b) and straight men (N = 879, mean age = 25 years; Bancroft et al., 2004). Although we looked at the relevance of a number of other variables (e.g., sensation seeking, trait anxiety, and depression), we will focus here only on findings related to the SIS/SES and MSQ.

In the gay sample, we found low SIS2 scores to be predictive of sexual risk taking in terms of unprotected anal intercourse (cf. Bancroft, Carnes, & Janssen, 2005) and oral sex, but not of number of casual partners or cruising behavior. Similarly, in the straight sample, SIS2 scores were strongly and negatively predictive of number of partners with whom no condoms were used in the past 3 years. SES scores, although strongly predictive of number of sexual partners in gay men, were not related to any of the other "risk behavior" variables and not related to any of the measures in the straight sample. The fact that SIS2 but not SES was involved in risk taking suggests that the relevant mediation of the effects of sexual arousal on risk taking is not simply a matter of arousability but of the likelihood of inhibiting arousal, and hence behavior, in certain situations.

Interestingly, although SIS1 was not predictive of any of our risk measures in the (younger) straight sample, we found that *high* SIS1 was predictive of unprotected anal intercourse and the number of casual partners in the gay sample. This suggests that high inhibitory "tone," or a lowered ability to reliably achieve an erection, may reduce an individual's likelihood of using a condom and at the same time increases the likelihood of having more "one-time" partners.

In both samples, we found evidence that men who report an increased interest in sex when depressed, as measured by our MSQ, also reported a greater number of sexual partners and, in the gay sample, a higher frequency of cruising behavior. Thus, the tendency to experience more interest in sex when in a negative mood appears to increase the likelihood of looking for sexual partners, as reflected in casual sex and cruising, but was not predictive of how risk is managed once the partner is found (i.e., whether condoms are used). As predicted, SIS2 proved more relevant to the latter.

Studies in Women

We now also have a substantial amount of data from women on the role of sexual excitation and inhibition and of the relationship between mood and sexuality. In a study involving a sample of heterosexual women (N = 1,067), and a comparison group of heterosexual men (N = 978), we examined the factor structure, reliability, and validity of SIS/SES scores in women (Carpenter, Graham, et al., 2006). Confirmatory factor analyses of women's SIS/SES scores provided moderate support for the higher-level model found in men. As we had previously found in men, correlations in women between the sexual excitation (SES) factor and the two sexual inhibition factors (SIS1 and SIS2) were low, while the SIS1 and SIS2 factors exhibited a modest positive correlation. Gender differences were found, with women scoring higher on the two original inhibition factors and lower on the sexual excitation factor in comparison with men. The test-retest reliability and convergent and discriminant validity of women's SIS/SES scores, using the original factor structure, were similar to those we found for men. In this study we also developed and tested a short version of the SIS/SES questionnaire (SIS/SES--Short Form), which features items with similar psychometric properties in women and men. The 14-item version of the SIS/SES showed to be associated with test-retest reliability and convergent/discriminant validity that closely resemble the longer, 45-item measure.

While these preliminary findings suggest that the SIS/SES questionnaire may also be of value in research on sexual response, functioning, and behavior in women, substantial progress has been made in work on the development of a new measure, designed specifically for use in women (Graham, Sanders, Milhausen, & McBride, 2004). One of the starting points of this project is that the SIS/SES questionnaire may not tap all relevant sources of sexual excitation and inhibition in women, including effects of body self-consciousness, concerns related to reputation, and relationship variables. Comparison of women's (and men's) responses on the old and new questionnaires should increase our understanding of the processes involved in sexual response.

In another recent study, we examined the relationship between mood and sexuality in heterosexual women (N = 663; Lykins, Janssen, & Graham, 2006; Graham, Sanders, & Milhausen, in press). The female sample was compared with a sample of heterosexual men (N = 399). Men and women differed in their responses to the questions about the effects of anxiety and depression on sexual interest and response. Women reported more of the negative effects of these mood states on their sexual interest and response than did men. The distributions within the male and female groups, however, were comparable. Although scores on SIS2, as we had found before, were the best predictor of the relationship between mood and sexuality in men, the picture was more complex for women, where SES turned out to be the best predictor of this relationship.

Psychophysiological Studies on Sexual Inhibition and Excitation

Psychophysiological Validation of the SIS/SES Questionnaire

In a first laboratory study, we explored the SIS/SES questionnaire's value in predicting actual psychophysiological responses in a group of male heterosexual college students and compared and contrasted participants by grouping them in three ways, by high and low SES, SIS1, and SIS2 scores (Janssen et al., 2002b). We expected high SES individuals to show greater genital response than low SES individuals to erotic stimuli in general. Regarding SIS1, we predicted that a distracting task during the presentation of sexual film clips would reduce genital response in low SIS1 scorers, while having no effect or a positive effect on the high SIS1 group. In addition, we expected high SIS1 subjects to show a reduced genital response under high performance demand (operationalized by emphasizing in some conditions that we were particularly interested in their erectile response).

To explore the predictive value of SIS2, we decided to use erotic stimuli that vary in their potential to invoke inhibition. Two types of erotic film were used, one nonthreatening (involving consensual sex) and the other threatening (involving coercive sex; cf. Laan, Everaerd, & Evers, 1995; van der Velde, Laan, & Everaerd, 2001). We predicted that low and high scorers on the SIS2 factor would differ in their sexual responses to the coercive films, with genital responses in the low inhibition group being less influenced by the content of these films. We did not expect to find differences in their emotional responses, with both groups responding negatively to the coercive films, which would support the assumption that both groups processed the threatening content of these films. Emotional responses were measured by means of self-ratings and startle responses (e.g., Graham, Janssen, & Sanders, 2000). Startle response is typically enhanced during negative emotions and diminished during positive emotions.

The findings of our study provided clear validation of the SES

scale. The high SES group showed generally higher genital and subjective sexual arousal responses regardless of erotic stimulus type. We did not succeed in providing validation of our SIS1 scale, which may partly be attributable to the fact that the subjects were young, sexually functional men. Analyses of variance revealed no interactions between the high and low SIS groups and either "performance demand" or "distraction" conditions. There was, however, good validation of the SIS2 scale. High and low SIS2 groups did not differ in their genital response to the consensual sexual stimuli, but the low SIS2 group showed significantly greater genital response to the sexually threatening stimuli. This pattern was not apparent with the subjective reports of sexual arousal, and of particular interest, both groups showed evidence of negative affect during the threatening stimuli, both in subjective reporting and objectively with the startle response. Thus, in spite of a negative affective response, the low inhibition participants showed more genital response.

Shock-Threat: A Laboratory Analogue of Risky Sex?

In a second experiment, a pilot study (Janssen, 1998), we made an attempt to evaluate the relevance of the dual control model to both sexual response *and* behavior. In this study, we presented a group of sexually functional men with three erotic films. As a measure of sexual risk taking, the men were given control over the duration of the erotic film--they could press a button to terminate its presentation--under variable (incremental) levels of shock-threat. To explore the interaction between sexual arousal and risk taking, the men were exposed to two shock-threat conditions: one where they were at risk of receiving a shock from the beginning of the film and one where the threat of shock was started after a delay of 1.5 minutes. For both conditions, the risk of receiving a shock increased the longer the subject watched the film. Feedback about the level of risk (i.e., the probability of receiving an electric shock) was provided by a bar that appeared on the left side of the screen and that increased in height over time. In contrast to earlier studies using shock-threat (e.g., Barlow, Sakheim, & Beck, 1983; Beck, Barlow, Sakheim, & Abrahamson, 1987), participants were at risk of receiving actual shocks, which were applied, beginning when risk levels reached 80%, to the inside of the elbow of their nondominant arm. The two film conditions were presented in counterbalanced order and were followed by an erotic film excerpt that was not combined with shock-threat (after shock electrodes had been removed).

Initially, we established shock levels for each individual participant at the beginning of the session. Subjects were given shocks of variable intensity and asked to rate them on how painful (1 = not painful to 10 = extremely painful) and unbearable (1 = doesn't bother me to 10 = completely unbearable) they found them to be. The final shock level was selected as the one where the sum of the subjects' scores on the two scales was 15 or 16. Of the first 20 subjects, only 3 ended at least one film presentation. Although all participants indicated that the electric shocks were unpleasant (the experimenter, located in an adjacent room, could at times hear subjects verbally express their anguish), the majority watched all three erotic film clips for the full duration. Only after several modifications were made to the procedure (e.g., using preset instead of individually determined shock levels, shifting the emphasis in the study description from our interest in *whether* to *when* participants would end film presentations), 7 of an additional 10 participants pressed the button at least once. Some preliminary analyses showed that the termination of shock threat was negatively correlated with sexual sensation seeking and erotophilia and positively with harm avoidance and one lower level SIS2 factor (i.e., sexual inhibition related to “getting caught,” or being observed by others during sexual activity). This latter finding, combined with an absence of correlation with other sexual inhibition factors, suggests that risk taking in the laboratory, at least in terms of terminating the sexual films, may have been influenced more by the laboratory situation than by the experience of pain (Scepkowski & Janssen, 2006).

Regarding viewing time and sexual arousal, we had predicted that both would be inversely related to SIS2 scores. However, the low number of subjects that actually ended a film presentation prohibited the statistical evaluation of the first prediction. Genital response data were missing in 5 subjects. Multiple regression analyses, with genital response during shock-threat conditions as dependent, and the three SIS/SES scales and state anxiety (STAI; Spielberger, Gorsuch, & Lushene, 1970) as independent variables, showed only SIS1 to be of relevance (correlations for penile rigidity during the two shock-threat films and SIS1 were +.44 and +.41). SES, like SIS2, did not figure as a predictor of genital response, although it proved relevant to the degree of sexual desire subjects experienced during the various conditions. None of the four independent variables predicted the level of subjective sexual arousal for any of the film presentations.

Thus, SIS1, and not SIS2, proved to be predictive of genital responses in this study. Did we, using shock-threat, unintentionally implement a more effective manipulation of SIS1-relevant processes than we had tried to create in our earlier study (in which we tested the effects of

distraction and performance demand)? In our discussion of the findings of that study, we suggested that either clinical subjects or stronger manipulations were needed to reveal the impact of SIS1. So perhaps we managed to do the latter, unintentionally, in the current study. For example, it is possible that the shock-threat (in combination with a bar on the screen, changing in size and representing the level of threat), functioned as a distractor. But why did we fail to demonstrate a role for SIS2? Did the fact that subjects could end the film presentation at any time reduce the amount of ("external" or SIS2-relevant) threat? We expected low SIS2 to be important as it would allow for "excitation transfer," or at least for the co-occurrence of sexual arousal and anxiety (induced by shock-threat). However, it seems that this mechanism was not of relevance in this study, as state anxiety levels (measured by STAI) were not related to genital response levels. It should be noted that while the participants in this study had nonexceptional SES scores (mean = 58.3), in comparison to our earlier questionnaire studies (e.g., Janssen et al., 2002a), they exhibited relatively low SIS1 (mean = 24.5) and SIS2 (mean = 25.2) scores. It thus appears that there was a volunteer bias, with high sexual inhibition individuals (both SIS1 and SIS2) avoiding participation.

Response Patterns in High and Low Sexual Risk Takers

As part of our research on sexual risk taking, presented earlier in this paper, we invited our questionnaire and interview subjects to also participate in a psychophysiological study (Janssen, Goodrich, Petrocelli, & Bancroft, 2006). In view of the complexity of the preliminary findings of the shock-threat study, we instead decided to use the design of our first laboratory study on the dual control model (Janssen et al., 2002b). When we applied this design (with the two types of sexual film, distraction and performance demand) to this new sample, however, we encountered another unanticipated, yet intriguing, phenomenon. Twelve men, or almost 50% of the first 25 subjects (mean age = 29 years), did not respond to the sexual stimuli (i.e., penile rigidity of less than 5% to the noncoercive film clips; 8 men had 0% rigidity). This is, to our knowledge, one of the few psychophysiological studies in which men participated who were recruited from the community--in our case, from bath houses, STD clinics, bars, and so on. In some of these venues, sexual stimuli (including video screens) are omnipresent, and this, in combination with comments from participants about the lack of more interesting, specialized ("niche"), or more extreme or "kinky" stimuli, made us consider the possibility that the unusually high rate of nonresponders could be related to high levels of exposure to and experience with sexually explicit materials. Conversations with the subjects reinforced our idea that in some of them a high exposure to erotica seemed to have resulted in a lower responsivity to "vanilla sex" erotica and an increased need for novelty and variation, in some cases combined with a need for very specific types of stimuli in order to get aroused.

We redesigned the study and decided to eliminate the distraction and performance demand manipulations and to include newer, more varied clips, as well as some longer film clips. Also, instead of presenting subjects with a set of preselected ("researcher-selected") videos only, we let them choose two clips themselves from a set of 10, of which 10-second previews were shown and that included a wider range of sexual behaviors (e.g., group sex, interracial sex, S & M, etc.). We recruited an additional 51 subjects and found that with the improved design still 20 men, or approximately 25%, did not respond well to the sexual video clips (penile rigidity of less than 10% in response to the long self-selected film).

We employed a Ward's (Ward, 1963) hierarchical cluster analysis using the means of the four nonthreatening sexual films and found evidence for two distinct clusters, a low and a high response cluster. The clusters differed in genital responses to all four of the film clips, as well as to the second threatening film (see Table 1). Interestingly, the clusters did not differ with respect to genital responses to the first of the two threatening sexual films nor to subjective sexual arousal to *any* of the six films.

<INSERT TABLE 1 ABOUT HERE>

We conducted a logistic regression analysis to determine if high responders could be differentiated from low responders using age, sexual orientation, SES, SIS1, SIS2, experience with erotic videos, self-reported erectile difficulties, and sexual risk taking as predictor variables. The regression model significantly discriminated between the two groups ($\chi^2(8) = 22.26$, $p < .01$; see Table 2), explaining 39% of the variance. In total 78% of the participants were correctly classified ($z = 4.61$, $p < .001$), with hit rates of 82% for high and 59% for low responders ($ps < .01$). The results indicate that a participant was more likely to be classified as a high responder as his age decreased and his SES and sexual risk taking scores increased. Homosexual participants were more likely to be classified as low responders than heterosexual participants. Finally, the analyses suggested that as the number of erotic films seen within the past year increased a participant was more likely to be classified as a low responder.

<INSERT TABLE 2 ABOUT HERE>

In addition to genital and subjective sexual arousal, we measured electrodermal, startle eye-blink, and cardiovascular responses in this study. Following from our questionnaire studies (Bancroft et al., 2003, 2004; which revealed a negative relationship between sexual risk taking and SIS2) and our study in college students (Janssen et al., 2002b; showing SIS2 to be associated with genital responses to threatening, but not nonthreatening, sexual stimuli), we predicted that sexual risk taking would be associated with stronger sexual arousal to threatening sexual stimuli. With regard to the other response measures, we included those to allow us to explore whether sexual risk taking would be associated with stronger responses (or decreased inhibition) of specifically *sexual* responses to threatening sexual stimuli or (also) with other, nonsexual psychophysiological response patterns, and in particular ones that could reflect a hyporeactive autonomic or (e.g., when it comes to startle responses) defensive response to such stimuli and that, thus, could imply a role for more general inhibitory mechanisms (cf. Iacono, Carlson, & Malone, 2000).

We found differences between our low and high risk groups in genital response to the second threatening sexual film (T2) only. In addition, the groups also differed in their responses to the two researcher-selected films (RS1 and RS2). Subjective sexual arousal was highest in the high risk group as well, but in contrast to our findings on genital response, this effect was not restricted to some subset of films. With respect to the other psychophysiological variables, we did not find any clear effects related to sexual risk taking for the electrodermal and cardiovascular responses. We did, however find an effect for startle responses: Regardless of film type, eye-blink responses were smaller for the high than for the low sexual risk taking groups.

We also examined, in an exploratory fashion, the relationship between sexual risk taking, personality-related variables, and psychophysiological responses to the threatening sexual films in a multiple regression analysis. We decided on the basis of our findings from the cluster analysis to focus on the second threat film (T2). Thus, we explored the possibility that sexual risk taking (using the number of sexual partners in past 3 years without using condoms as our primary dependent measure) could be predicted by relevant personality and behavioral variables and that responses to the threatening sexual film would contribute to the prediction of sexual risk taking above and beyond the other variables. We performed the regression analysis with age, sexual orientation, number of sexual partners in the past year, sensation seeking, SIS2, and eye-blink and genital responses to the second threatening sexual film (T2) as independent variables. Although our findings on the cardiovascular and electrodermal response measures were less clear and consistent (Janssen et al., 2006), we included change in systolic blood pressure and total skin conductance during the second threatening sexual film (T2) as additional independent variables. Of the electrodermal measures, we selected change in total amplitude as it was the variable with the highest, and in fact significant, correlation with our measure of sexual risk taking (r = -.23, $p < .05$). The model explained 38% of the variance in risky sexual behavior (see Table 3). The number of partners the participants reported having had sex with in the past year was a significant predictor, as was sexual orientation, with higher risk levels being associated with a heterosexual sexual orientation. Age played a role as well but was not significant ($p < .07$). Our personality measures of sensation seeking and sexual inhibition (SIS2) did not predict sexual risk taking. Neither did systolic blood pressure and skin conductance. However, sexual risk taking was associated with smaller eye-blink responses and stronger genital responses to the sexually threatening film.

<INSERT TABLE 3 ABOUT HERE>

A second regression analysis was run to explore to what degree the findings of the first analysis were specific to responses to the sexually threatening film (T2). For this purpose, we replaced the last four predictors (systolic blood pressure, skin conductance, eye-blink, and genital responses to the second threatening sexual film) with the average systolic blood pressure, skin conductance, eye-blink, and genital responses to the four nonthreatening sexual films. This analysis showed that eye-blink responses to the nonthreatening sexual films were not a significant predictor ($p > .8$) of sexual risk taking, and although average genital response to the four nonthreatening films significantly contributed to the model ($p < .03$), its effect was slightly less strong than that of genital responses to specifically the second threatening sexual film ($p < .02$). Also, this model explained a somewhat smaller proportion of the variance (30%). A final exploratory regression analysis, combining the two genital response variables, revealed that they largely nullified each other's influence. However, while the effect of genital responses to nonthreatening sexual stimuli was now nonsignificant ($p > .2$), genital responses to the threatening film still

contributed, although only marginally ($p < .10$), to the model.

Overall, these results suggest, consistent with the findings from our questionnaire studies (Bancroft et al., 2003; 2004), that sexual risk behavior, at least to some degree, is associated with differences in (the regulation of) sexual response. Whereas we had predicted that such differences would be relatively specific to stimuli relevant to sexual inhibition (cf. Janssen et al., 2002b), and although the findings on the second threatening sexual film do suggest that differences in inhibitory control of sexual response may be involved, on the whole the findings also imply a role for other, more general sexual response mechanisms. In addition, our findings suggest that a role for psychophysiological mechanisms that reflect not sexual but more general approach/avoidance response mechanisms (or, in the case of startle eye-blink, defensive motivation; Benning, Patrick, & Iacono, 2005).

Our measure of sexual inhibition did not predict sexual risk taking. In our study with college students (Janssen et al., 2002b), SIS2 predicted genital responses to threatening sexual films. That study, however, did not focus on or incorporate any measures of sexual risk taking. In our questionnaire studies on sexual risk taking (Bancroft et al., 2003, 2004), we found evidence for a relationship between sexual inhibition/excitation proneness (and also sensation seeking) and sexual risk taking. Those two studies, however, did not involve any psychophysiological measures. The findings of these studies combined with those of the one discussed here clearly suggest that the relationships among (self-report) measures of risky sexual behavior and sexual excitation/inhibition proneness on the one hand, and psychophysiological responses, as measured in the laboratory, on the other, are more complex than we assumed. Obviously, differences in samples, designs, and procedures all contribute to variability in research findings. However, other possible explanations need to be considered as well, including ones that involve limitations of or problems with the use of self-report measures to assess individual differences in the not readily observable activity and reactivity of putative neurophysiological systems or mechanisms (cf. Brenner, Beauchaine, & Sylvers, 2005). Thus, this involves questions about the validity and reliability, and their interaction, of such measures. More specifically, the use of SIS/SES in a relatively small experimental study may be more problematic than its use in survey studies, which typically involve larger samples. Our earlier psychophysiological study may not have been affected by this as much, as participants in that study were recruited on the basis of their SIS/SES scores, allowing for a comparison of more extreme groups.

Conclusions and Future Directions

The Kinsey Institute's dual control model and its spin-off, the SIS/SES questionnaire, were developed in the hope that they would contribute to our understanding of individual differences in sexual response, function, and behavior. Although with this review we hope to have demonstrated their potential for research on various aspects of male (and to some degree, female) sexual response and behavior, we acknowledge that we still have a long way to go in improving our grasp on the complex roles of inhibitory and excitatory processes in human sexual response and behavior. For one, our model emphasizes the importance of interactions between, or the weighing of, sexual inhibition and excitation, and more advanced statistical analyses, allowing for a more rigorous assessment of their relative contribution (e.g., through the inclusion of interaction factors), would be required to explore this further. But other issues, concerns with, and limitations to the use of the SIS/SES questionnaire warrant discussion. Our model postulates a conceptual nervous system involving central mechanisms that are relevant to sexual inhibition and excitation; yet our research strongly relies on the use of a self-report measure, the SIS/SES questionnaire, to establish the sensitivity of these putative neurophysiological systems. Although we believe this instrument has shown to be of value, a number of factors could limit its applicability. People vary not only in their sexual responsiveness but also in their sexual experiences, and the two are related in intricate ways, potentially confounding the inferences we make on the basis of people's SIS/SES scores. That is, we don't know if a person's lack of experience with certain sexual stimuli or situations is a result of external circumstances (e.g., related to demographic factors, "opportunity") or of exactly those traits that we are trying to measure--their proneness for sexual inhibition and excitation. In our questionnaire, we ask people, in case they have no experience with certain stimuli or situations (and this may be of particular relevance to SIS2), to *imagine* how they would respond. This means that in some cases, we will use a person's own predictions as a basis for our own predictions regarding his or her responses or behavior in our research studies. In addition to other factors that threaten the validity of self-report measures (e.g., social desirability, response biases), this may be an inherent problem of factor-analytically derived measures, where multiple questions are needed to reliably assess a trait.

A related issue involves the failure to capture a person's full range of experiences, and the associated levels, or intensity, of their inhibitory and

excitatory responses, using a questionnaire of this kind. For example, although it is not unlikely that a person with a highly sensitive inhibitory "system" will respond with inhibition to a wide variety of relevant cues, it is also possible that in some people inhibition is triggered only by very specific stimuli (just like for some, only certain stimuli may lead to sexual excitation). This information is not conveyed by our SIS/SES questionnaire, as the person indicating high responsiveness to one or two specific inhibitory cues could end up receiving a low overall SIS2 score (because the scales are based on sum scores involving larger numbers of questions).

Then, of course, there is the issue of how well the questionnaire captures the multi-dimensional nature of sexual response (e.g., distinguishes between genital response and subjective sexual arousal) and the stability of individual propensities of sexual inhibition and excitation over the life span. To start with the latter, we assume that people vary in the sensitivity of our putative neurophysiological response systems and that this variability could be established in individuals from an early age on. At the same time, however, it would be naive to assume that such traits, while stable to some degree, could not be shaped and modified through experience. Longitudinal studies, behavioral genetics studies, and studies measuring SIS/SES before and after treatments of various kinds could shed more light on this.

As for the various components of sexual response, it is true that although the SIS/SES questionnaire strongly focuses on genital response, it does not consistently do so. Considering that we combined questions about "sexual arousal" with questions about erectile responses, it could be argued that our questionnaire implicitly treats sexual arousal as some uniform construct. The SIS/SES factors indeed make no distinction between subjective sexual arousal (and its motivational aspects) and genital response. This is a limitation that has been considered more carefully in the development of the new questionnaire measure for women (Graham, Sanders, & Milhausen, in press).

The introduction of the notion of "conceptual nervous systems" in personality research has been attributed to Pavlov (Pickering, 1997; Strelau, 1997). In his research on conditioning in dogs, Pavlov observed individual differences in the speed of conditioning and the stability of conditioned reflexes. On the basis of his observations, he proposed a typology of central nervous system properties, which included a role for excitation and inhibition, as well as for the balance between the two. Both Eysenck's (1967) and Gray's (1982) theories on personality were influenced by Pavlov's ideas (Strelau, 1997). Pavlov used his conditioning paradigm as an experimental and psychophysiological method to study "temperament." That is, he used experimental manipulations and related individual differences in their effects to aspects of personality. We believe that, in our research on the role of sexual excitation and inhibition, we should also consider alternative ways of studying their relevance to sexual response and behavior. While the SIS/SES questionnaire has already proven to be of value, future research on the dual control model should probably give greater emphasis to the fact that it, in essence, is a state-trait model, and we thus should attempt to incorporate ways of manipulating sexual excitation and inhibition at a state level as well.

Note

1. The term *psychogenic* is considered to be of diminishing clinical value. Here, as in the research by Barlow and others, it refers to erectile problems that are not attributable to peripheral (vascular, hormonal, or neurological) factors.

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