



## Review

# “Sexy stimulants”: The interaction between psychomotor stimulants and sexual behavior in the female brain

Fay A. Guarraci<sup>a,\*</sup>, Jessica L. Bolton<sup>b</sup><sup>a</sup> Southwestern University, USA<sup>b</sup> Duke University, USA

## ARTICLE INFO

Available online 20 November 2013

## Keywords:

Paced mating  
Partner preference  
Mate choice  
Cocaine  
Caffeine  
Amphetamines

## ABSTRACT

Research indicates gender differences in sensitivity to psychomotor stimulants. Preclinical work investigating the interaction between drugs of abuse and sex-specific behaviors, such as sexual behavior, is critical to our understanding of such gender differences in humans. A number of behavioral paradigms can be used to model aspects of human sexual behavior in animal subjects. Although traditional assessment of the reflexive, lordosis posture of the female rat has been used to map the neuroanatomical and neurochemical systems that contribute to uniquely female copulatory behavior, the additional behavioral paradigms discussed in the current review have helped us expand our description of the appetitive and consummatory patterns of sexual behavior in the female rat. Measuring appetitive behavior is particularly important for assessing sexual motivation, the equivalent of “desire” in humans. By investigating the effects of commonly abused drugs on female sexual motivation, we are beginning to elucidate the role of dopaminergic neurotransmission, a neural system also known to be critical to the neurobiology of drug addiction, in female sexual motivation. A better understanding of the nexus of sex and drugs in the female brain will help advance our understanding of motivation in general and explain how psychomotor stimulants affect males and females differently.

© 2013 Elsevier Inc. All rights reserved.

## Contents

1. Introduction . . . . .	53
2. The female rat as a model of sexual behavior . . . . .	54
2.1. Measures of mating behavior . . . . .	54
2.2. Beyond the lordosis reflex . . . . .	54
3. Psychomotor stimulants interact with female sexual behavior . . . . .	55
3.1. Amphetamine . . . . .	55
3.2. Methamphetamine . . . . .	56
3.3. Caffeine . . . . .	58
3.4. Cocaine . . . . .	58
4. Implications . . . . .	59
References . . . . .	60

## 1. Introduction

A growing body of research suggests that there are critical differences between how men and women are affected by drugs of abuse, including psychomotor stimulants (e.g., cocaine, methamphetamine,

caffeine, methylphenidate, amphetamine). For example, women begin using drugs younger, enter into drug rehabilitation sooner, and experience shorter periods of drug abstinence after abuse than men (for review: Brady and Randall, 1999; Lynch et al., 2002; Walker et al., 2006). Furthermore, female injection drug users (IDU) are more likely to engage in risky behaviors (such as borrowing needles, sharing drug preparations, maintaining sexual relationships with other IDU, and failing to use a condom during vaginal/anal sex) than male IDU (Evans et al., 2003). Such gender differences may be a function of hormonal and neural differences between men and women in their response to

\* Corresponding author at: Department of Psychology, Southwestern University, 1001 East University Ave., Georgetown, TX 78626, USA. Tel.: +1 512 863 1747; fax: +1 512 863 1846.

E-mail address: [guarracf@southwestern.edu](mailto:guarracf@southwestern.edu) (F.A. Guarraci).

drugs of abuse (reviewed in Becker, 2009). For example, women experience greater positive effects from drugs during the follicular phase of their menstrual cycle, when circulating gonadal hormones are highest (Evans et al., 2002; Justice and de Wit, 1999; Sofuoglu et al., 1999). Males have higher basal dopaminergic tone than females (Xiao and Becker, 1994, 1997), but conversely, they are less responsive to stimulation by drugs of abuse and natural reinforcers (Walker et al., 2012; Walker et al., 2006). Furthermore, the amount of dopamine released in response to drugs of abuse is modulated by estrogen in females (Becker, 1990), whereas gonadal hormones have no effect on dopamine release or drug reward in males (Castner et al., 1993; Jackson et al., 2006), suggesting a biological mechanism underlying potential differences in abuse liability between men and women, as well as differences for women across the menstrual cycle.

Not only do stimulants affect females differently than males, different stimulants also affect sex-specific behaviors, such as reproductive behavior, differently, which is consistent with the gender disparity in hormonal interactions with drug reward. It has been suggested that addictive drugs activate or “hijack” the neural circuits that are responsible for finding basic necessities of survival (i.e., food, water and sex) reinforcing Kelley and Berridge (2002). However, much of the research investigating the relationship between drugs of abuse and natural reinforcers has focused on males and specifically, male sexual behavior. Considering the pronounced gender differences in behavior and in the underlying neural circuitry described above, it is clear that a thorough investigation of how females are affected by psychomotor stimulants is necessary. In fact, considering the hormonal interactions with drugs of abuse in females that do not occur in males, we argue that the potential for interactions between drugs of abuse and sexual motivation is even greater in females than males.

We are beginning to see advances in our understanding of how drugs of abuse interact with natural rewards, such as sexual behavior, in females using a variety of different animal models. In general, research in animals is consistent with observations in women: some drugs of abuse enhance motivation for natural rewards like sex, whereas others are disruptive (Pfaus and Gorzalka, 1987). By specifically studying female models of motivated behavior, we hope that basic research can better guide our study of addiction in women and advance our understanding of potential gender differences in the neurobiology of motivation. The goal of this review is to describe paradigms that are useful in assessing sexual motivation in female rats and to summarize recent research that explores the interactions between psychomotor stimulants and female sexual behavior.

## 2. The female rat as a model of sexual behavior

### 2.1. Measures of mating behavior

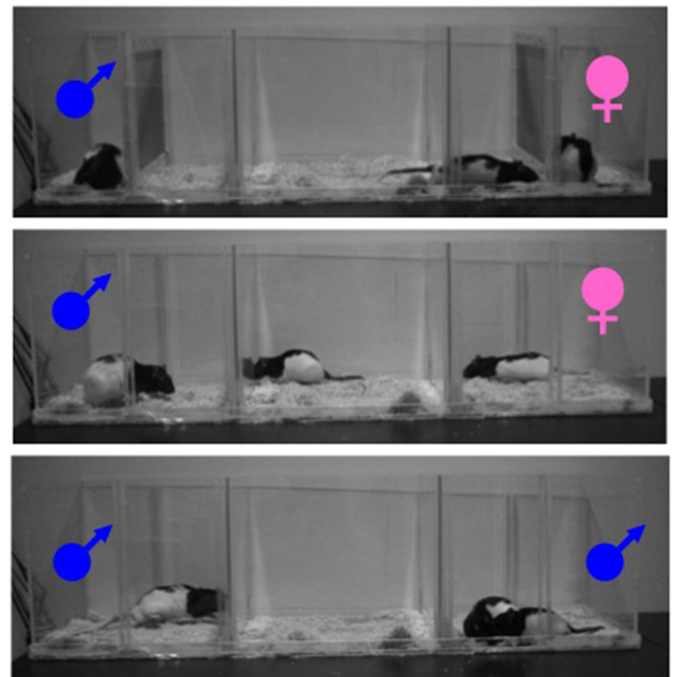
Sexual behavior in the female rat is characterized by both receptive and proceptive behaviors. Receptive behavior is defined by the lordosis posture, which is the dorsal flexion of the female rat's back in response to being mounted by a male rat (Beach, 1976). The lordosis posture facilitates male penetration and reflects a female's willingness to engage in sexual behavior. Female rats also display proceptive behaviors, including hopping, darting, ear wiggling, and pacing of sexual stimulation (Erskine, 1989). These behaviors function to “solicit” the attention of potential mates. If a sexually receptive female has the opportunity, she will approach and withdraw from a sexually vigorous male, thereby controlling the timing of the receipt of sexual stimulation (i.e., mounts, intromissions, and ejaculations). This pattern is known as paced mating behavior. The pacing of sexual stimulation by the female can be observed under semi-naturalistic conditions and has been studied extensively in laboratory settings (for review see, (Blaustein and Erskine, 2002; Erskine, 1989)). Furthermore, by giving the female the opportunity to pace the receipt of sexual stimulation from more than one male simultaneously, we have been able to assess how measures of paced

mating behavior reflect sexual motivation. When contrasted with conditions where the female *cannot* control the receipt of sexual stimulation from one male, paced mating behavior with multiple males is more similar to the mating conditions of rats in their natural habitat (Calhoun, 1962) and is associated with increases in the reproductive success of the female (Coopersmith and Erskine, 1994).

### 2.2. Beyond the lordosis reflex

In addition to measuring a full range of female sexual behaviors (as described above), a number of paradigms can specifically assess sexual motivation. For example, the partner preference paradigm is used commonly to evaluate the appetitive aspects of sexual behavior (Avitsur and Yirmiya, 1999; Bakker, 2003; Paredes and Alonso, 1997; Paredes and Vazquez, 1999). Partner preference tests typically allow an experimental animal to make a choice between two stimulus animals; one that is a sexual partner (e.g., sexually vigorous male) and one that is not (e.g., female). In female rats, preference for a male rat is most robust when the male is placed behind a wire mesh such that sexual contact is limited (NO CONTACT; Fig. 1, TOP), when compared to conditions where physical contact is not limited and mating is possible (CONTACT; Fig. 1, MIDDLE). These results suggest that the distal cues (i.e., auditory, visual and olfactory) of a sexual partner are sufficient for the display of partner preference in females (Clark et al., 2004). Because female rats spend less time with a male partner when mating is possible than when mating is prohibited, it is possible that some aspects of physical contact during a sexual encounter are aversive for female rats. It is also possible that pacing the receipt of sexual stimulation by the female, when there is an opportunity to mate, can interfere with the expression of a preference for a male partner. Specifically, withdrawing from the male and remaining away after sexual stimulation artificially reduce the time a female rat will spend with a male rat during a partner preference test.

The conditioned place preference (CPP) paradigm has also been used to assess the reinforcing aspects of a sexual encounter for female rats. Long used to assess the reinforcing properties of drugs of abuse



**Fig. 1.** Photographs of a female rat during a test of partner preference, where stimulus rats (male in LEFT compartment and female in RIGHT compartment) were placed behind wire mesh (TOP; NO CONTACT) or where a female rat could interact freely with stimulus rats (MIDDLE; CONTACT). Photograph of a female rat during a test of mate choice, where experimental female rat could interact freely with two male stimulus rats (BOTTOM).

Download English Version:

<https://daneshyari.com/en/article/2012840>

Download Persian Version:

<https://daneshyari.com/article/2012840>

[Daneshyari.com](https://daneshyari.com)