Psychoneuroendocrinology 95 (2018) 128–137

Contents lists available at ScienceDirect

Psychoneuroendocrinology

journal homepage: www.elsevier.com/locate/psyneuen

Role of oxytocin in the ventral tegmental area in social reinforcement

Johnathan M. Borland, Kymberly N. Grantham, Lauren M. Aiani, Kyle J. Frantz, H. Elliott Albers*

Center for Behavioral Neuroscience, Neuroscience Institute, Georgia State University, Atlanta, GA, 30302, USA

ARTICLE INFO

Keywords:
Social behavior
Social interaction
Social motivation
Social salience
Social cognition
Social reward
Dopamine
Mesolimbic dopamine system
Neuropeptides
Vasopressin
Operant

ABSTRACT

The rewarding properties of social interactions play a critical role in the development and maintenance of social relationships, and deficits in social reward are associated with various psychiatric disorders. In the present study, we used a novel Operant Social Preference (OSP) task to investigate the reinforcing properties of social interactions under conditions of high or low reward value, and high or low behavioral effort in male Syrian hamsters. Further, we investigated the role of oxytocin (OT) in a key structure of the mesolimbic reward system, the ventral tegmental area (VTA), in mediating the reinforcing properties of social interaction. Adult male hamsters were placed in a three-chambered apparatus, and allowed access to either a social chamber containing an unrestrained conspecific or a non-social chamber, by pushing through a one-way entry, vertical-swing door. Increasing the duration of social interaction (reward value) decreased the frequency of entering the social interaction chambers, whereas decreasing the duration of social interaction conversely increased the frequency of entries. Moreover, increasing behavioral effort required to access social interaction decreased the frequency of entries, especially under conditions when the duration of social interaction was only 5 s. OT injected into the VTA decreased the frequency of entering social interaction chambers in a manner similar to that observed when duration was increased, whereas injection of an OT receptor antagonist in the VTA increased the frequency of seeking social interaction. Taken together, these data support the hypothesis that activation of OT receptors in the VTA are critical for the reinforcing properties of social interactions. Furthermore, social interactions may exhibit duration and cost dependent reinforcing effects on behavior similar to those observed with food and drugs of abuse.

1. Introduction

Social reward is a critical element in the development, expression, and maintenance of social behaviors and relationships (Suomi et al., 1971; Krach et al., 2010; Trezza et al., 2011). Despite the importance of social reward in adaptive and maladaptive behaviors, much remains to be learned about the reinforcing properties of social interaction and the neurobiological mechanisms underlying its rewarding properties. Various types of social interactions can serve as behavioral reinforcers (Everitt et al., 1987; Lee et al., 2000; Matthews et al., 2005; Trezza et al., 2011). To extend our ability to investigate social reward and reinforcement, we developed a new operant social preference (OSP) task for Syrian hamsters (Borland et al., 2017), a species in which social interactions are highly rewarding (Meisel and Joppa, 1994; Gil et al., 2013) and which serves as an important model for pre-clinical studies of psychiatric disease (Terranova et al., 2016). Hamsters are provided the choice to push through a vertical swing door into a chamber for brief social interaction, push into an empty chamber, or remain in a start chamber. As in other new operant social tasks (Cummings and Becker, 2012; Achterberg et al., 2016; Golden et al., 2017), animals demonstrated a preference for the social chamber within 2–3 test sessions, in a manner similar to preference for access to reward of a different modality, palatable food (sunflower seeds) (Borland et al., 2017). With this novel method, the parameters and neural underpinnings for behavioral reinforcement by social reward can be examined in great depth.

In the present study, we aimed to test the effects of both reward *value* and behavioral *cost* on the reinforcing effects of social interactions. Specifically, we investigated whether the duration of social interactions between adult males alters the motivating and reinforcing properties of those interactions. Because studies investigating the rewarding properties of other stimuli (e.g., drugs) have found that increasing reward value (e.g., dose) decreases the number of rewards obtained in a test session (Maldonado et al., 1993; Doherty et al., 2013), we predicted that increasing the duration of social interaction would decrease the frequency of seeking social interaction. Conversely, decreasing the duration of social interaction would increase the frequency of seeking social interaction. Moreover, based on behavioral economics

* Corresponding author.
E-mail address: biohea@gsu.edu (H.E. Albers).

https://doi.org/10.1016/j.psyneuen.2018.05.028
Received 3 February 2018; Received in revised form 20 May 2018; Accepted 20 May 2018
0306-4530/ © 2018 Elsevier Ltd. All rights reserved.

Fig. 1. Operant Social Preference Apparatus: schematic (left) and vertical view (right). The main chamber contains an experimental subject whereas, one of the side chambers is occupied by a stimulus hamster; the subject and stimulus hamster are separated by a vertical-swing door. Visual, auditory and olfactory cues are shared between the chambers through the open top and holes in the door. An acrylic bucket positioned on the stimulus hamster side of the doors serves to hold weights.

and progressive ratio schedules of reinforcement in drug and food reinforcement studies (e.g. (Rowlett, 2011; Beeler et al., 2012; Doherty and Frantz, 2012; Bentzley et al., 2014), we also predicted that increasing the behavioral cost (i.e., weight of an access door) to gain access to social interaction would decrease the frequency of seeking social interactions in a test session, especially when the duration of social interaction was relatively short. As such, the present study investigates whether the relationships between reward value (i.e. duration of interaction) and the effort required (i.e. weight on the vertical swing door) to obtain rewards are similar to those reported for other rewarding stimuli (e.g., drugs of abuse).

In a second set of experiments, we investigated the role of oxytocin (OT) in mediating the reinforcing properties of social interactions. OT is a neuropeptide that influences many different social processes and behaviors (Caldwell and Albers, 2016; Johnson and Young, 2017), including play behavior (Bredewold et al., 2014), social recognition (Albers, 2012; Wacker and Ludwig, 2012), and aggression (Harmon et al., 2002; Kelly and Goodson, 2014). Studies in humans also support a role for OT in regulating social behavior (Groppe et al., 2013; Rilling et al., 2014), and OT has been proposed as a potential treatment for a range of psychiatric disorders including autism spectrum disorder (Dichter et al., 2012; Stavropoulos and Carver, 2013; Young and Barrett, 2015). Because of the strong link between deficits in social reward and psychiatric disorders, understanding how OT contributes to the neural mechanisms controlling social reward is a critical gap in current knowledge.

OT administered peripherally or in the cerebroventricular system can increase reward in the context of conditioned place preference models (CPP) (Liberzon et al., 1997; Kent et al., 2013; Kosaki and Watanabe, 2016). These effects may be mediated by OT in the mesolimbic reward system. Activation of oxytocin receptors (OTRs) in the nucleus accumbens appears necessary for social reward in male mice (Dolen et al., 2013), and activation of OTRs in the ventral tegmental area (VTA) also appears necessary for social reward in male hamsters and mice (Song et al., 2016; Hung et al., 2017). Yet in these studies, the possibility that activation of OTRs influences the memory of the reward stimulus instead of the reward value itself cannot be excluded (Bardo and Bevins, 2000). Indeed, OT can influence memory processes in general and social memory in particular (de Wied and Versteeg, 1979; Albers, 2012; Gabor et al., 2012). Therefore, we used a direct test of social reinforcement, per se, with the operant social preference task, focusing on the role of OTRs in the VTA. We predicted that if activation of OTRs in the VTA mediates the reinforcing properties of social interactions, then injection of OT into the VTA will decrease the frequency of seeking social encounters, whereas injection of an OTR antagonist will increase the frequency of seeking social encounters.

2. Materials and methods

2.1. Subjects

Male Syrian hamsters (N = 73, 11 wks of age; 120–140 g) were purchased from Charles River Laboratory (Wilmington, MA) and housed singly, in solid-bottom, Plexiglas cages (43 × 22 x 20 cm), containing corncob bedding and cotton nesting material (Neslets; Ancare, Bellmore, NY) in a humidity and temperature controlled (22 °C) vivarium. Hamsters were provided food and water *ad libitum,* and housed on a reverse light-dark (LD) cycle (14L:10D; lights off at 13:00) for 4 weeks before experiments. All behavioral tests were performed under red light during the first 3 h of the dark phase. All procedures were carried out in accordance with the National Institutes of Health Guide for the Care and Use of Laboratory Animals, and approved by the Georgia State University Institutional Animal Care and Use Committee.

2.2. Operant social preference (OSP) apparatus

For a detailed description of the OSP apparatus, see (Borland et al., 2017). Briefly, the test apparatus consisted of three chambers: a main chamber, and two smaller chambers, each separated from the main chamber by one-way entry vertical-swing doors equipped with buckets that can hold weights (Fig. 1). Test and stimulus hamsters can be placed in any of the chambers. The entire apparatus is made of clear Plexiglas with an open top, allowing detection of visual, olfactory and auditory cues among the chambers, thereby reducing memory requirements in the choice of whether or not to enter through the swing doors, e.g. to interact with a conspecific.

2.3. Operant social preference (OSP) conditioning

For a detailed description of conditioning sessions, see (Borland et al., 2017). Briefly, male test hamsters (120–140 g) were allowed to move throughout the apparatus, while a smaller (100–120 g) male stimulus hamster was confined to one of the small chambers. Stimulus hamsters were group-housed five per cage, and subjects were paired with a different stimulus hamster every test session. If a subject chose to enter a small chamber, time allowed in that chamber was either 20 s (baseline), 5 s, or 60 s. After the designated time course expired, the subject hamster was removed from the small chamber by the experimenter and placed back into the main chamber, facing the back wall, equidistant from the two small chambers. All test sessions were 10 min in total length. To assess chamber entries under higher effort requirements after conditioning sessions, door weights were progressively increased over consecutive days, from baseline at 113 g (4oz), to 227 g (8oz), 340 g (12oz), 454 g (16oz) and 624 g (22oz). Only subjects that met acquisition criteria (at least 2 entries into chambers containing stimulus hamsters per session and more entries into social chambers vs.

Download English Version:

https://daneshyari.com/en/article/6817543

Download Persian Version:

https://daneshyari.com/article/6817543

Daneshyari.com