Bupropion (Wellbutrin) increases dopamine in the CNS and—to a lesser degree—norepinephrine. To the extent that the process of spatial learning and memory is mediated by dopamine, one would expect the sustained administration of bupropion to facilitate performance on spatial tasks such as the radial arm maze. Pharmaceutical drugs such as bupropion may also influence self-control via cortical or subcortical neurochemical processes. Dopamine modulates positive affective states such as reward and pleasure (Arias-Carrón et al., 2007), as well as negative affective behaviors such as compulsion and perseveration (Ulloa et al., 2004). Therefore, any factor that influences levels of dopamine in the brain could conceivably enhance a variety of psychological processes; among them, learning, memory, perhaps even self-control.

The current experiment focused on the behavioral effects of a commonly prescribed antidepressant drug. It was hypothesized that sustained administration of bupropion would enhance spatial learning and memory, improve self-control and promote emotional stability. The effects of environmental enrichment (EE) were assessed as well. Given the benefits of EE (Rosenzweig, 1984, Leggio et al., 2005), it was hypothesized that enriched conditions of rearing would also enhance performance. In addition, bupropion was expected to mitigate any adverse effects engendered by austere conditions of rearing.

Method

Subsequent to weaning, half of the subjects (n=8) were reared in an enriched environment, the remaining half (n=8) were reared in an austere environment. Half of the subjects assigned to the enriched condition were administered 30mg/kg of bupropion daily, the other half were not. An analogous drug regimen was used with rats assigned to the austere condition. Beginning at 100 days of age, the activity level of individual subjects was assessed in an open field. Subjects were also tested on a spatial learning and a self-control task. In the former, rats were placed on an elevated central platform with several arms radiating outward. The rats’ task was to retrieve food by visiting the end of each arm only once. In the self-control task, rats trained in an operant chamber received a choice between one pellet of food and three pellets of food. The choice-reinforcer delay was longer for the large amount of food, and choosing this reinforcer increased the delay on subsequent trials.

Results and Discussion

Figure 1 depicts the mean number of errors on the spatial learning task for rats assigned to the bupropion and control treatments. In the enriched condition, the performance of rats receiving bupropion was superior to that of control rats—though only in the first block of sessions (p < .05). In the austere condition, the performance of rats receiving bupropion was indistinguishable from that of control rats. Thus, the effect of this antidepressant drug on spatial learning was modest. In contrast, the effect of conditions of rearing was substantial. Subjects reared under enriched conditions made significantly fewer errors on the radial arm maze than subjects reared under austere conditions (p < .01).

The mean wait for the large magnitude reinforcer by rats assigned to the bupropion and control treatments is shown in Figure 2. In the enriched condition, the waiting times of rats administered bupropion were shorter than those of control rats (p < .05 for square-root transformed data). That is, subjects receiving bupropion were more impulsive. It is noteworthy that in an experiment involving cocaine, another drug that increases dopamine, Logue et al. (1992) reported an increase in impulsiveness on a task requiring rats to wait for a large magnitude reinforcer [cf. Pitts and McKinney (2005) for an extended discussion of the effects of stimulants on self-control]. Figures 3 and 4 summarize the open field data. Whereas the bupropion treatment engendered higher levels of emotionality than the control treatment in the enriched condition, the opposite pattern was observed in the austere condition (p < .01 and .05, respectively). In addition, subjects reared in the enriched environment were more active in the open field and groomed more frequently than subjects reared in the austere environment (p < .05 and .01, respectively). Contrary to the experimental hypothesis, the effects of bupropion were not uniformly beneficial. This finding may be attributable to the modulation of spatial learning and self-control by different areas of the prefrontal cortex, specifically, the medial prefrontal cortex and the orbitofrontal cortex (Winstanley et al., 2006).

Figure 1. Mean number of errors on the radial arm maze for subjects assigned to the bupropion and control conditions. Longer durations of waiting indicate higher levels of self-control. Plus and minus standard errors of the mean are indicated with standard error bars.

Figure 2. Mean wait for the large magnitude reinforcer by bupropion and control subjects assigned to the enriched and austere rearing conditions. Longer durations of waiting indicate higher levels of self-control. Plus and minus standard errors of the mean are indicated with standard error bars.

Figure 3 (above). Mean wait for the large magnitude reinforcer by bupropion and control subjects assigned to the enriched and austere rearing conditions. Longer durations of waiting indicate higher levels of self-control. Plus and minus standard errors of the mean are indicated with standard error bars.

Figure 3 (below). Mean frequency of defecation in open field by bupropion and control subjects assigned to different conditions of rearing. Higher frequencies correspond to higher levels of emotional behavior. Plus and minus standard errors of the mean are indicated with standard error bars.

Figure 4. Mean number of squares crossed and mean frequency of grooming in the open field. The activity levels of subjects assigned to the enriched and austere conditions are shown separately. Plus and minus standard errors of the mean are indicated with standard error bars.