Impulsivity can in general terms be characterized as impetuosity, with short-sighted and ill-considered actions [27]. Impulsivity is a characteristic of normal behavior, though severe impulsivity can be pathological, and is apparent in humans as a variety of mental disorders, including aggression, drug addiction, attention deficit hyperactivity disorder, and others [19, 24]. Factor analysis of questionnaire data on impulsivity has shown that the concept of “impulsive behavior” includes a number of independent aspects and, although there are differences in definitions, they are overall related to the following processes: decreases in inhibitory control, impatience in relation to delays in reinforcement, and excessively rapid decision-taking, due to an absence of appropriate consideration of the task, as well as the more universal deficit of attention [8, 13]. In animals, a multitude of different aspects of impulsivity have been studied in models using operant reflexes. The most successful example of tasks associated with impatience for delayed reinforcement is the delay-discount paradigm, in which the impulsive selection is defined as a preference for a small but delayed reinforcement over a more valuable but delayed reinforcement [9, 15]. Choice of the more valuable but delayed reinforcement is associated with the signs of self-control, while preference for the immediate low-value reinforcement is an impulsive selection.

Understanding of the neurochemical nature (bases) of impulsive behavior may make a valuable contribution to the treatment of mental diseases. There is extensive evidence demonstrating a relationship between impulsivity and the functioning of the serotoninergic (5-HT, 5-hydroxytryptamine) system. One of the first studies on this problem identified a reduced cerebrospinal fluid level of the 5-HT metabolite 5-HIAA in patients with depression who have committed suicide [4]. This observation was also supported by studies of other cohorts of subjects, including alcoholics, offenders, violent criminals, and healthy volunteers with impulsivity as
a personality characteristic [22]. It has been hypothesized that decreases in 5-HT levels in the brain lead to increases in impulsivity [22, 25]. Thus, selective lesioning of the 5-HT system in rats induces increases in various aspects of impulsive behavior [17, 18]. However, current results on the effects of treatment with agents decreasing or increasing serotonin levels are not always unambiguous [2, 6, 21, 28–30]. In addition, there are very few studies in which the effects of changes in serotonin levels have been studied selectively in individuals with different levels of impulsivity [16].

The existence of at least 15 structurally different subtypes of 5-HT receptors is now known, with at least three different effector mechanisms – via adenylate cyclase, phospholipase C, and ion channels [11]. Unfortunately, specific agonists and antagonists for many 5-HT receptors remain unavailable. Studies of the role of serotonin receptors in the control of behavior are presently restricted to studies of the functions of a number of receptor subtypes in animal experiments. The best studied are subtype 1A receptors, for which a number of selective ligands have been approved by the Medical Ethics Committee in accordance with the position of the Institute of Higher Nervous Activity and Neurophysiology, Russian Academy of Sciences in relation to studies with experimental animals.

Rats were kept in cages in groups of five animals with free access to water. The quantity of food provided was regulated such as to maintain body weight at about 80% of the weight with free access to food. The experimental apparatus consisted of a rectangular chamber of size 30 × 60 × 30 cm. A feeder was mounted in the middle of the front wall of the chamber; access to the feeder was guarded by a mobile screen made of transparent plastic. Movable pedals were positioned on each side of the feeder. Signal lamps were located in the feeder and above each pedal. Lamp switching, pedal extension, food delivery, and formation of time intervals were controlled by a personal computer running a program written by D. A. Ivliev.

Rats previously trained in the experimental chamber to press a pedal to obtain food – 45-mg standard pellets (dust-precision pellets, Bio-Serv, USA) – were given the choice between receiving a scanty reinforcement immediately after pressing (one pellet) and a more valuable (four pellets) but delayed reward. On the basis of their choice between reinforcement value in relation to delivery time, 18 rats were assigned to the “impulsive” group, choosing a strategy of responding rapidly to obtain the low-value reinforcement, and 22 rats were assigned to the “self-controlled” group, able to wait for the more valuable reinforcement. The learning time required by the rats to achieve stability in selecting the pedal to receive reinforcement in accordance with the preferred strategy was 4–6 months.

Rats performed 25 trials in each daily experimental session. The scheme for each trial was analogous to that described in [1, 9]. After triggering of the experimental program, the general illumination light was switched on in the chamber, along with the lamp in the feeder. Over a period of 10 sec, the rat was presented with the opportunity to move the screen with its nose to gain access to the feeder. If no such reaction was made, the program was terminated, the light was extinguished, and the next launch of the program was started 5 sec later. Movement of the screen served as the signal for extension of the two pedals, which remained extended for 10 sec. If no reaction was made, the pedals were retracted, the light was extinguished, and the program was restarted after 5 sec. Pressing of one of the pedals led to immediate delivery of one pellet of food; pressing of the other pedal led to delivery of four pellets with a delay. The pedal delivering the delayed reinforcement and duration of the delay were specified at the beginning of the experiment. The experimental scheme is shown in Fig. 1.

The numbers of pedal presses performed to obtain one or the other type of reinforcement and the numbers of missed reactions were counted (k1 – the number of pedal presses delivering the low-value immediate reward, k2 – the number of pedal presses delivering the more valuable but