Bisphenol A (BPA) is a particularly important environmental estrogen. It is not only widespread but also potentially ingested by humans, being released by polycarbonate plastics, the lining of food cans, and dental sealants (Brotons et al. 1995; Olea et al. 1996). Prenatal exposure to BPA can affect the development and function of reproductive organs as well as adult sexual behavior, especially in male rodents and in their offspring (Atanassova et al. 2000; Desai-Fulgheri et al. 2002; Farabollini et al. 2002; Fisher et al. 1999; Howdeshell et al. 1999; Rubin et al. 2001; Vom Saal et al. 1995, 1998; Williams et al. 2001a, 2001b). Perinatal exposure to BPA has also been implicated in altered profiles of nonsocial behaviors, resulting in a reduced motivation to explore and a reduced anxiety in the male offspring (Farabollini et al. 1999). In the present work, we wanted to extend the analysis of the consequences of early BPA exposure on nonsocial behaviors, investigating behaviors that rely upon central serotonergic and dopaminergic brain systems. Specifically, the serotonergic system is thought to be important for impulse control across a wide range of behaviors (Soubrié 1986), whereas the dopaminergic system is strongly involved in mediating motivation and reward (Robbins and Everitt 1996; Wise 1996).

The dopaminergic system is particularly important for the expression of novelty-seeking behavior (Bardo et al. 1996; Pierce et al. 1990). Both humans and animals have a natural need to search for novel and rewarding stimuli (Renner 1990; Zuckerman 1994), and the experience of novelty is rewarding via the activation of the mesolimbic dopaminergic system (Rebec et al. 1997a, 1997b). This behavioral trait is particularly expressed during adolescence in both humans (Arnett 1992; Zuckerman 1994) and animal models (Adriani et al. 1998; Bardo et al. 1996; Macri et al. 2002). In rodents, adolescence is classically defined as the ontogenetic period including the week preceding the onset of puberty and the first few days thereafter (Speal and Brake 1983). We tested the hypothesis that possible alterations in coping with novelty, deriving from perinatal exposure to an estrogen pollutant, could be easily detectable around puberty. The latter is indeed characterized by the onset of prominent hormonal regulation. For this reason, BPA-exposed rats of both sexes were assessed in a novelty preference test (Bardo et al. 1988; Misslin and Ropartz 1981) during adolescence (Speal and Brake 1983).

The role of the serotonergic system in modulating premature and impulsive responding is widely recognized on both clinical (Limonio et al. 1983) and preclinical literature (Soubrié 1986). Impulsivity can be defined in several ways, including a) the "failure to resist..."
an impulse, drive, or temptation" (Evenden 1999); b) responding without consideration of alternatives and/or consequences; or c) behaving in a way that is adequate to the environmental contingency. Many different aspects of impulsivity have been studied with operant paradigms in laboratory settings (Bradshaw and Szabadi 1992; Evenden 1999; Richards et al. 1997, 1999). One of the most widely adopted paradigms assumes that impulsive subjects are intolerant to situations when reward is delayed. Smaller immediate reinforcers are preferred to larger rewards, which come only after a delay (Bizot et al. 1999; Evenden and Ryan 1996, 1999; Logue 1988; Thiebot et al. 1985). In the present study, we evaluated the possibility that perinatal exposure to BPA may influence the development of the serotoninergic system in adult animals through the impulsivity test.

The specificity of the developmental changes affecting a central neurochemical system can be evaluated by assessing the effects of a psychoactive agent targeting that system upon the behavioral responses known to be modulated by that system. For this reason, it seemed appropriate to evaluate the increase of locomotion and rearing behavior that follow amphetamine administration (Kelly et al. 1975), because it is well known that release of dopamine within the dorsal and ventral striatum is involved in such a behavioral change (Staton and Solomon 1984). For this study, we considered a potential alteration in the behavioral effects of amphetamine administration an index of BPA-induced long-term effects on the function of the brain dopaminergic system.

We studied the effects of precocious exposure to BPA at concentrations within the range of human exposure and not teratogenic (Brotons et al. 1995; Olea et al. 1996). To this purpose, we administered BPA orally to pregnant females from mating day to weaning day. The substance was dissolved in arachis oil at a concentration of 0.04 mg/kg, which was administered orally by micropipette, the volume administered depending on body weight. Control females (n = 9) received arachis oil without BPA. Because animals were trained to receive the oil before mating, this procedure was not stressful.

**Experiment 1: novelty preference test.** Animals of both sexes were tested for levels of novelty seeking during adolescence. The experimental apparatus consisted of an opaque Plexiglas box with smooth walls (70 × 30 × 35 cm), subdivided into two compartments. The connecting door between the two compartments could be closed by means of a temporary partition. One compartment had a wide-mesh floor, whereas the other had narrow mesh. Animals were video recorded and later scored for measures of time spent in each compartment and activity rate in each compartment. To evaluate the activity rate, the floor of each compartment was subdivided into three sections by lines placed on the video screen at the time of video-recording analysis, and the number of line crossings (with both forepaws) was scored.

The whole experimental schedule took 5 days, each subject from both age groups being tested between 1000 and 1800 hr. Testing of different experimental groups was counterbalanced across time. The test was carried out under dim illumination. The floor of the apparatus was cleaned after each animal was tested. During the familiarization phase (days 1–3), animals were gently placed for 20 min in one compartment of the apparatus. During the novelty preference test (on day 4), animals were placed in the familiar compartment for a 5-min session. The partition separating the two compartments of the apparatus was then removed, and rats were thus allowed to freely explore the whole apparatus (both the familiar and the novel sides) for 24 min.

**Experiment 2: impulsive test.** When adult, the same animals were tested for levels of impulsivity. Before the schedule started, animals were food deprived (80% of free-feeding weight; see Table 1) to increase their motivation to work for food delivery. Each animal was then placed daily in a computer-controlled operant chamber (Gouldborn Instruments, Allentown, PA, USA), provided with two nose-poking holes, a chamber light, a feeder device, a magazine where pellets (45 mg; BioServ, Frenchtown, NJ, USA) were dropped, and a magazine light. The nose poking in either hole was detected by a photocell and was recorded by a computer, which also controlled food delivery. After a 30-min session, animals were returned to their home cages, where they were given standard chow (~8 g each), to keep animals at 80–85% of their free-feeding weight.

During the training phase (1 week), nose poking in one of the two holes [called the "immediate and small" (IAS) hole] resulted in the delivery of one pellet of food, whereas nose poking in the other hole ["large and delayed" (LAD) hole] resulted in the delivery of five pellets of food. After nose poking and before food delivery, the chamber light was turned on for 1 sec. After the food delivery, the magazine light was turned on for 25 sec, during which additional nose poking was recorded but was without any scheduled consequence (time out).

During the testing phase (1 week), a delay was inserted between nose poking in the LAD hole and the delivery of the five pellets. The chamber light was turned on during the length of this delay. Any additional nose poking taking place during this time interval was recorded but was without any consequence ["inadequate responding" (Sagvolden and Sergeant 1998; Sagvolden 2000)]. The delay was kept fixed for each daily session and was increased progressively over subsequent days (0, 10, 20, 40, 60, 80, 100 sec). The dependent variables were the percentage of choice between the LAD and IAS holes and the frequency of inadequate nose poking.

**Experiment 3: open field with amphetamine.** One week after the impulsivity test, all animals were tested for response to amphetamine in an open-field apparatus. This consisted of an opaque Plexiglas rectangular box with smooth gray walls and floor (70 × 30 × 35 cm). D-Amphetamine (AMPH; 1 mg/kg) was dissolved in saline (SAL; NaCl 0.9%) and injected subcutaneously in a volume of 1 mL/kg body weight. Approximately 15 min after the injection with either SAL or AMPH,
animals were placed in the open field for a single 30-min session. The behavioral profile expressed by each animal was video recorded and later scored by a treatment-blinded individual, using a computer and specific software (The Observer, version 2.0 for DOS; Noldus Information Technology, Wageningen, The Netherlands). This allowed a detailed analysis of several parameters, including latency, frequency, and duration of each behavior. Three behaviors were scored: rearing (body in vertical position), grooming (mouth or paws on body), and crossing (the floor of each compartment was subdivided into three sections by lines placed on the video screen at the time of video-recording analysis, and the number of line crossings with both forepaws was scored).

**Design and data analysis.** Data were analyzed by multifactorial analysis of variance (ANOVA). The general design of all experiments was two sex (male vs. female) × two treatment (BPA vs. oil) × subject. For the novelty-seeking paradigm (experiment 1), a side (familiar vs. novel) and a time factor were added. For the impulsivity paradigm (experiment 2), a delay factor (0, 10, 20, 40, 60, 80, 100 sec) was added. In the openfield test (experiment 3), a drug factor (SAL vs. AMPH) was added. Multiple comparisons within significant interactions were performed with the Tukey HSD test.

**Results**

**Experiment 1: novelty preference test. Activity rate.** The four-way ANOVA yielded significance for the time effect \( F(5,160) = 4.96, p < 0.001 \) and for the sex by time interaction \( F(5,160) = 2.49, p < 0.05 \), indicating that the time-course profile of activity during the test was markedly different in the two sexes. On this basis, and to analyze more specifically the effects of BPA exposure, the two sexes were analyzed separately by a three-way ANOVA.

For males (Figure 1C), the ANOVA yielded significance for the side by treatment interaction \( F(1,16) = 3.99, p < 0.05 \). Specifically, when animals were in the novel compartment, the activity rate was particularly elevated in the first part of the session, decreasing thereafter. Conversely, in the familiar compartment, the activity profile was flat during the whole session (data not shown). Moreover, a treatment × side × time interaction \( F(2,32) = 9.28, p < 0.05 \) emerged. The prenatal exposure to BPA resulted in higher activity levels than for controls in the novel environment. Conversely, levels of activity in the familiar compartment were not affected (data not shown).

For females (Figure 1D) the ANOVA yielded significance for the side by treatment interaction \( F(1,16) = 10.53, p < 0.01 \). As in males, the perinatal exposure to BPA resulted in higher levels of activity than for controls in the novel environment. Conversely, levels of activity in the familiar compartment were not affected (data not shown).

**Novelty preference.** In the three-way ANOVA, the main effect of time was significant \( F(5,160) = 12.26, p < 0.01 \). The novelty preference increased as session progressed. The ANOVA yielded significance for the sex by treatment interaction \( F(1,32) = 4.40, p < 0.05 \). As a whole, early exposure to BPA produced a marked reduction of time spent in the novel environment in females (Figure 1B), whereas the group of males was not affected (Figure 1A).

Separate analyses confirmed this picture. For females, but not males, the two-way ANOVA yielded significance for the main effect of treatment \( F(1,16) = 10.44, p < 0.01 \). Multiple comparisons performed within the female group revealed that, as a consequence of perinatal BPA exposure, a reduction of time spent in the novel environment was found at the beginning and at the end of the session.

![Figure 1](image-url)

**Figure 1.** (A,B) Mean (± SE) percentage of time spent in the novel compartment by subjects of both sexes on testing day (experiment 1). (C,D) Mean (± SE) activity rate, measured as number of line crossings per minute, shown by subjects of both sexes in the novel compartment on testing day. During the pretreatment period (days 1–3), subjects were familiarized to one compartment. On testing day, animals were placed in the familiar compartment. After 5 min, a partition was removed and subjects were allowed free access to a novel compartment of the apparatus for a 24-min session.

*\( p < 0.05 \) in comparisons between BPA and control perinatal treatments (n = 9).
[delay, $F(6,192) = 14.9$, $p < 0.01$; delay x hole, $F(6,192) = 49.1$, $p < 0.01$]. Such a finding suggests that, during the length of the delay, when they had to wait for the large reinforcer, rats were demanding more and more the small and immediate one. Interestingly, a significant main effect of sex [$F(1,32) = 4.44$, $p < 0.05$] and significant sex by treatment interaction [$F(1,32) = 4.25$, $p < 0.05$] were found. To better depict the profile, data from the two sexes were analyzed separately.

For males, a main effect of treatment [$F(1,16) = 8.29$, $p < 0.05$] as well as a delay by treatment interaction [$F(6,96) = 2.12$, $p < 0.05$] emerged. Multiple comparisons revealed that, as the delay increased, adult rats were associated with elevated nose poking. Interestingly, a significant delay by hole by treatment interaction [$F(6,96) = 3.24$, $p < 0.01$] appeared. Multiple comparisons revealed that, when the length of the delay was set to 1 min or more, BPA-exposed rats were associated with significantly lower frequency of nose poking in the IAS hole (Figure 3A). It is interesting to note that all these interactions were not significant within the female group; that is, female subjects were apparently not affected by BPA exposure (Figure 3B). Furthermore, early BPA exposure results in males whose profile is comparable with that expressed by females.

**Experiment 3: Open field with amphetamine. Crossing.** The ANOVA yielded a main effect of drug [$F(1,28) = 51.3$, $p < 0.01$], with AMPH injection resulting in elevation of crossing frequency. Interestingly, a main effect of sex [$F(1,28) = 6.64$, $p < 0.05$] and a sex by treatment interaction [$F(1,28) = 9.49$, $p < 0.01$] also appeared.

To better depict the effects, we analyzed the data from the two sexes separately (see Figure 4C,D). For males, the ANOVA evidenced a main effect of drug [$F(1,14) = 37.7$, $p < 0.01$], with AMPH resulting in elevation of crossing frequency. Moreover, a main effect of treatment [$F(1,14) = 10.7$, $p < 0.01$] and a drug by treatment interaction [$F(1,14) = 6.34$, $p < 0.05$] emerged. Specifically, multiple comparisons revealed that AMPH administration resulted in elevation of crossing in control but not in treated subjects. Conversely, for females, only a main effect of drug [$F(1,14) = 20.5$, $p < 0.01$] appeared. AMPH administration resulted in elevation of crossing in both control and BPA-treated subjects. As a whole, these results suggest that BPA exposure impaired the response to AMPH only in male subjects.

**Rearing.** The ANOVA yielded a main effect of drug [$F(1,28) = 22.5$, $p < 0.01$], AMPH resulting in elevation of rearing. Interestingly, a main effect of sex just missed significance [$F(1,28) = 3.27$, $p < 0.081$] and the sex by treatment interaction was significant [$F(1,28) = 6.25$, $p < 0.05$]. To better depict this effect, the two sexes were analyzed separately (Figure 4A,B). For males, the ANOVA evidenced a main effect of drug [$F(1,14) = 18.5$, $p < 0.01$] and treatment [$F(1,14) = 7.03$, $p < 0.05$]. Specifically, as is evident from Figure 4A, AMPH-induced elevation of rearing was less marked in BPA-treated than in control subjects. Conversely, for females, only a main effect of drug [$F(1,14) = 8.19$, $p < 0.05$] appeared. Specifically, AMPH administration resulted in elevation of rearing in both control and BPA-treated subjects. As a whole, these results suggest that BPA exposure impaired the response to AMPH in male subjects.

**Discussion**

As a whole, the present results can be summarized as follows: a) Rats of both sexes, perinatally exposed to BPA and tested during adolescence for novelty seeking, were associated with more marked levels of novelty-induced hyperactivity, compared with controls. However, BPA-exposed females spent a lower percentage of time in the novel environment (an index of neophobia). b) BPA-exposed rats of both sexes were associated with a more marked preference for the LAD reinforcer during the whole experiment (an index of decreased impulsivity). Compared with controls, BPA-exposed males exhibited a feminization in the frequency of inadequate nose poking at the IAS hole during the length of the delay. c) As expected, AMPH injection induced an elevation of crossing and rearing in control male subjects and in both groups of females. Perinatal BPA exposure was able to impair the classical response to AMPH in male subjects.

**Novelty seeking in adolescent rats.** Periadolescent rats and mice express elevated levels of behavioral activation in specific forms. For instance, they show elevated levels of social play and affiliative behaviors (Meaney and Stewart 1981; Pankepp 1981) that progressively shift toward aggressive and competitive behaviors (Terranova et al. 1993, 1998). Moreover, rodents at this age exhibit a marked peak in novelty-seeking behavior (Adriani et al. 1998; Bardo et al. 1996) and low levels of exploration-induced anxiety (Macrì et al. 2002). The psychobiology of novelty-seeking behavior has been widely implicated in mediating the
incentive response to novelty (Bardo et al. 1996), whereas the limbic–hypothalamo–
pituitary–adrenal axis determines the indi-
vidual stressful responses to novelty (Kabbaj et al. 2000).

In the present experiment, female rats spent less time than did males in the new
environment at the beginning of the free-
choice exploration, suggesting a lower interest
of females in exploring the novel side. These
findings are consistent with other previous
results, suggesting that females show lower
levels of novelty seeking than do males in
both rats (Hughes 1966) and mice (Palanza et al. 2001). Compared with controls, BPA-
treated females spent a minor percentage of
time in the novel compartment of the appar-
atus, remaining most of the time in the famil-
iar compartment. These data indicate that,
rather than being attractive as is normally
reported for rats (Bardo et al. 1988), the
experience of novelty was avoided by females
after maternal BPA exposure. In other words,
prenatal exposure to BPA was apparently
responsible for an increased neophobia in
adolescent female rats. In a previous study,
parameters of motor activity and motivation
to explore were depressed in adult female rats
after maternal exposure to BPA (Farabollini et al. 1999). These findings suggest that,
compared with control subjects, BPA-treated
females were less prone to explore a novel
environment.

Regarding locomotion in the novel com-
partment, rats treated with BPA expressed
elevated levels of activity and a less marked
profile of habituation, an effect that was evi-
dent in both sexes. In the novelty-seeking
test, exploratory activity and emotional
reactivity represent two different dimensions
based on different mechanisms (Zimmer-
mann et al. 2001). A profile of hyperlo-
comotion during exploration of novel
environments has been proposed as an index
of novelty-induced stress (Exner and Clark
1993; Misslin and Ropartz 1981; Misslin et
al. 1982). Present data may suggest that
pre-
natal treatment with BPA produced rats that
were more likely to experience novelty-
induced stress during adolescence or, alterna-

tively, a slowing down of the process of
habituation. This behavioral profile could
be related to alterations in the function of brain
neurochemical systems involved in the loco-
motor response to novelty-induced stress
and/or in the locomotor habituation to
novelty.

**Impulsive behavior.** Impulsivity, defined
as a reduced ability to tolerate a delay of
gratification (Evenden 1999), has been studied
in rats by means of various procedures,
providing a choice between a large but
delayed food reinforcement versus a smaller
and immediate one (Bizot et al. 1999;
Evenden and Ryan 1996, 1999). Delay has
actually been shown to have a discounting
effect on the subjective value of a given rein-
forcement (Bradshaw and Szabadi 1992;
Richards et al. 1997).

In the present study, food-restricted
animals were trained in operant chambers,
where nose poking resulted in food delivery.
As expected, all animals significantly pre-
ferred the hole associated with the large rein-
cforcement (LAD hole) and also exhibited a
shift toward the small, immediate reinforce-
ment (IAS hole) as the length of the delay
was increased. Rats exposed perinatally to
BPA were associated with a more marked
preference for the LAD reinforcer during the
whole experiment—that is, with a rightward
shift of the delay–preference curve—suggest-
ing a reduction of impulsive behavior.
In previous studies involving a similar para-
digm, a marked increment in the preference
for the large-but-delayed reward was induced by
serotonergic uptake inhibitors such as
indalpine, zimelidine (Thiebot et al. 1985),
fluoxetine, and fluvoxamine (Bizot et al. 1999).
These data support the idea that
serotonergic mechanisms are involved in the
regulation of impulsive behavior, suggesting
that an elevated serotonergic tone may result in
elevated tolerance to reward delays. On
this basis, it may be supposed that perinatal
BPA exposure affected the ontogenesis of
this central neurochemical system.

Nose poking in either hole during the
length of the delay had no scheduled conse-
quences. However, in the course of the present
experiment, animals kept on demanding the
food reinforcement even during the signaled
nonreinforced component of the schedule. This
might happen because animals were unable to
modify response patterns with changes in the
experimental contingency, being under the
behavioral urge of doing something and unable
to simply wait. This kind of behavior has been
defined as “inadequate responding” (Sagvolden
2000; Sagvolden and Sergeant 1998; Sagvolden
et al. 1998), and its measure might hence pro-
vide an index of restlessness and reduced ability
to wait.

Interestingly, a sexual difference emerged,
both at basal level and in the response to
BPA: a) females showed lower levels of inade-
quate responding than did the correspond-
group of males; b) no effect of BPA
exposure was found in females; and c) levels
shown by BPA-exposed males resembled
those shown by both groups of females.
Results in control subjects suggest that males
have a stronger preference for the immediate
reinforcer than do females, which is progres-
sively more expressed during the length of the
delay. Alternatively, these results suggest that
male subjects are less able than females to
inhibit nose poking behavior during the
delay. Interestingly, BPA-exposed males
were specifically associated with lower levels
of inadequate nose poking in the inactive hole,
compared with controls. This suggests that
BPA-treated males are less restless and more
tolerant to the delay and/or more able to
inhibit the inadequate behavior. Interestingly,
early BPA exposure results in males whose
profile is comparable with that expressed by
females, suggesting a demasculinization for
this measure. Consistently, modifications of
sociosexual behavior in the direction of a
demasculinization have been observed in
adult male rats perinatally exposed to BPA
(Farabollini et al. 2002).

**Open-field test and response to amphet-
amine.** As expected, the AMPH-induced
elevation of both crossing and rearing was
significantly reduced in BPA-treated male
subjects. Such a picture suggests that early
BPA exposure impaired the function of cen-
tral neurochemical systems targeted by
AMPH in the male offspring. A reduced
dopaminergic function can be hypothesized for
BPA-exposed males, which may also par-
tially account for the particular hypoactivity
shown by these subjects during the length of
the delay in experiment 2 (discussed above).
We may suppose that perinatal BPA exposure
interacted with some steps in the develop-
ment and organization of the dopaminergic
system during the perinatal period of male
offspring.
Regarding possible mechanisms, BPA exhibits weak estrogenic activity in adult rats of both sexes. Specifically, BPA administration causes a significant increase in uterine and vagina weights in ovariectomized females (Kim et al. 2001), whereas it directly inhibits testicular functions and produces a reduction in the negative feedback of testosterone (Tohei et al. 2001). Long-term exposure of adult female rats to BPA induces modifications in β-estrogen receptor immunoreactivity in various brain areas regulating reproductive and maternal behavior (Aloisi et al. 2001). Many studies have addressed the adverse effects of perinatal exposure to BPA on various indices of sexual development and maturation (Anastassova et al. 2000; Fisher et al. 1999; Rubin et al. 2001; Williams et al. 2001a, 2001b). Unfortunately, little is known about the effect of estrogen-like compounds on developing monoamine systems. One paper reported, however, that intraperitoneal exposure to estradiol has a significant effect on the organization of monoamine systems within the fetal hypothalamus (Kaylor et al. 1984). More is known about interactions of estrogens with the adult dopaminergic and serotonergic systems (for a review, see, e.g., Cyr et al. 2002; Dluzen 2000; Fink et al. 1996, 1999; Rubinow et al. 1998).

Conclusions

As a whole, perinatal treatment with the estrogenic pollutant BPA resulted in marked alterations in rats’ behavioral repertoire. Specifically, an increased novelty-induced stress and/or a reduced habituation to novelty was found during adolescence, as well as reduced levels of impulsivity at adulthood. Both findings may well be seen as indexes of a reduced reactivity or readiness to react to environmental challenges. It could be argued that BPA exposure resulted in individuals that do not easily adapt to environmental changes (see Benus et al. 1987). Interestingly, some of these effects were sex dependent. The perinatal treatment with BPA affected the restlessness profile in male rats, with BPA-treated animals becoming indistinguishable from females. This finding, together with the reduced sensitivity of BPA-treated adult males to AMPH, suggests that the perinatal exposure to BPA interacts with some steps in the organization of the serotonergic and dopaminergic neural systems in the male offspring. On the contrary, perinatal BPA exposure produced neophobia in adolescent females but not in males. This effect was possibly determined via a different mechanism from that controlling impulsivity, because BPA exposure had no effect upon behavior of adult females in the impulsivity test or in the open-field test. On the basis of the scientific literature, the various behavioral alterations reported in the present study could be ascribed to an altered development of dopaminergic and/or serotonergic pathways. It can be hypothesized that both these systems were affected by perinatal BPA treatment, but further work is needed to clarify the neural basis of long-term neurobehavioral deficits induced by BPA.

The present results acquire even more importance on the basis of recent reports, indicating that performance in operant tasks is used also in children to evaluate adverse consequences of exposure to polychlorinated biphenyls (Stewart et al. 2001). As a general conclusion, the present findings provide indirect evidence of long-term consequences of perinatal BPA exposure at the level of neurobehavioral development. These alterations should be further investigated by means of biochemical testing. However, our results might be a cause of concern for public health, indicating that exposure to a weak environmental estrogen in the period of sexual differentiation of the brain may influence adult behavior. Further research is needed to better understand which exposure levels would not be potentially dangerous for human health.

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