**Cigarette Smoke and Marijuana Smoke as**

**Environmental Health Hazards and Infringements on**

**the Civil Liberties of Those Subjected to Passive Inhalation**

**by**

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**And Two Supplemental Lists of References**

**Regarding Recent Research on Harmful Mental and Physical Effects**

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Air free of harmful pollutants is as essential to good health as uncontaminated water. Both are necessary to the protection and maintenance of public health. Government bears a responsibility for ensuring that the air and water required for sustenance are not hazardous to health. When a substance has been identified as a hazard to health, steps should be taken by the government to protect the public from the health hazard.

The inhalation of any of an infinite variety of hazardous substances comes under the heading of environmental health hazards. Substances that fall under such a heading span a wide gamut and include everything from carbon monoxide, chlorine, asbestos, kepone, and polyvinyl chloride, to coal dust and cotton dust. Because of its hazardous constituents, cigarette smoke should properly be added to this list. Because of the hazardous and psychoactive properties of marijuana smoke, marijuana smoke also rightfully belongs on this list. Cases will be made for the designation of both cigarette smoke and marijuana smoke as environmental health hazards.

Each case will be developed along similar lines. Each will begin with a discussion of the effect of smoke in an environment upon persons who are sharing that environment. When a person who is no smoking is in such a situation, he is said to be in “involuntary smoker” in that he is experiencing some effect as a result of passively inhaling the smoke that is being emitted in the immediate environment.

Each case will also include an overview of the health hazards that have been linked to the smoking of the substance in question. More time will be spent developing the case against marijuana because of the high degree of controversy that surrounds the use of that drug and the time lag in the assimilation, by the public as well as the research community, of the implications of the most significant findings concerning the hazards involved in using the drug.

Governmental policies will be recommended in the case of both substances. These policies reflect a concern for the environmental health hazards posed by each substance. Criticism of present policies and approaches will be included.

**Cigarette Smoke and Cigarette Smoking**

Exposure to cigarette smoke is demonstrably harmful to non-smokers who are afflicted with certain health or respiratory problems (2, 9, 10, 13, 60). Such passive exposure, “passive inhalation,” can affect mood and mental functioning, as well as the physical health of normal persons (2, 7, 23, 33, 56, 57, 82, 107,120, 131, 145). While such effects may be of only temporary duration, in some cases they may be of long duration.

In a recent paper, Dr. Dietrich Hoffman and Dr. Klaus Brunnemann have reported that “during one hour in a smoke-polluted indoor environment, we may inhale air polluted with volatile nitrosamines in amounts equal to those in the sum of 5 to 30 cigarettes” (22,28). A further quote from this report is as follows: “The side stream smoke of cigarettes and cigars contains at least a 10 times higher quantity of volatile nitrosamines than (directly) inhaled smoke” (22, 28).

Nitrosamines have been under strong suspicion as a carcinogen in man for some time (82). Dimethylnitrosamine was found to be carcinogenic in animals over twenty years ago (85). Since then over 100 more N-nitrosamine compounds have been shown to produce carcinomas in animals (86).

High nicotine concentrations have been found in conditions where ventilation has been poor or non-existent. Nicotine and its metabolite, cotinine, have been found in the urine of non-smokers as well as smokers exposed to a smoke-filled environment (56). This finding is similar to a finding in the field of marijuana research where cannabinoids have been found in the urine of a non-smoker subjected to marijuana smoke in and experimental situation (143). In each case, the finding could explain effects on the cognitive and/or physical functioning of the non-smoker.

Carcinogenic benzo(a)pyrene has also been found in smoke-filled environments (47), as have acrolein and acetaldehyde (47, 56) and a wide range of other substances (12, 34, 62, 108).

Carbon monoxide is also emitted in the smoking process. The carbon monoxide produced by tobacco smoke can reach toxic levels in a crowded smoke-filled room (above 50 ppm) (131). The effect of such a situation on the mental functioning of persons in the room can be great (119). With a dwindling amount of oxygen and with increasing amounts of carbon monoxide, dizziness and drowsiness can result and organized thinking can be rendered difficult at best. Attentiveness and cognitive functioning have both been shown to be affected (131).

The risks to the health of the smoker have been well researched. DNA synthesis has definitely been shown to be impeded and cellular and precancerous changes have been shown to take place in the respiratory system of the smoker (80).

The higher incidence of a wide range of diseases affecting internal organs has also been shown (129, 130, 132). Smokers who are asbestos workers have a far higher incidence of lung cancer than smokers who are not asbestos workers who are similarly exposed (122). The asbestos particles would appear to be entering into some form of synergistic interaction with elements in the tobacco smoke (123).

It is of particular interest to note that twice the expected levels of cadmium have been found in smokers than in non-smokers in a case study involving autopsies of 120 persons (55).

Deleterious effects on the health of the offspring of women who smoked in pregnancy have been documented in the literature (24).

**Policy Implications Following from the Negative Effects**

**Caused by Smoking and Exposure to Smoke**

Negative effects on the health of the smoker have long been documented. Awareness of these negative health findings has spread among the medical profession, scientific researchers, and the public in general. Many who know of these findings are rejecting them out of unwillingness or reluctance to accept their implications. The results nonetheless stand as valid, accepted or not.

Newer evidence of hazards to the health of non-smokers subjected to breathing smoke-filled air is not so widely known or recognized. This evidence may be summarized in the following manner:

* People whose health cannot tolerate exposure to smoke or whose health conditions are exacerbated by smoke – are being deleteriously affected by such exposure.
* People in smoke-filled rooms are being exposed to high levels of nitrosamines as well as to a wide range of other toxic and carcinogenic or suspected carcinogenic substances.
* High levels of carbon monoxide can negatively affect normal persons as well

as persons with low tolerances for psychoactive substances

In light of these hazards and risks, what should policies on smoking in public places be? In addition, what should the role of government be with respect to smoking? Should government take a neutral stance? What are the implications of a neutral stance? Should government act to discourage use? Should it take care not to encourage use?

Are the civil liberties of the non-smoker being infringed when he must be subjected to smoke and when his health along with his ability to function normally and think clearly may be impaired, either temporarily or for a long period of time?

**Present Government Policies**

Federal government policies that bear upon tobacco production, cigarette smoking and its consequences are inconsistent and contradictory, some policies being wholly at odds with other policies, mutually negating their intended effect or purpose, explicit or implicit. Major policies bearing on tobacco production and cigarette smoke and its consequences can be enumerated in the following way:

1. USDA provides a substantial subsidization of tobacco growing estimated at 460 million a year in 1976 (144);
2. The U.S. Department of Health, Education, and Welfare (HEW) and the National Clearinghouse for Smoking and Health are waging an anti-smoking campaign;
3. The National Institutes of Health (NIH) is conducting research into the production of a less harmful, but nevertheless harmful cigarette;
4. Federal research efforts in the area of cardiovascular and respiratory diseases also aim at finding a cure for diseases that can be caused by and/or exacerbated by cigarette smoking;
5. Assistance payments are skyrocketing for medical costs incurred in caring for person with this “disease of choice”. The annual cost to the nation for medical care has been place at between 11 and 35 billion dollars (59);
6. Nicotine continues to be treated as if it were not a toxic or harmful substance; Congress has failed to designate nicotine a drug and place tobacco under FDA regulation *[Note: This continues to be the case in early 2009.]*;
7. A laissez faire policy continues to obtain for smokers in most public places. [[1]](#endnote-1)

*[Such policies have changed notably between 1977 and 2009.]*

**Recommended Changes in Federal Policies**

What would a sound government policy look like, a policy that was not similarly filled with contradiction, one that did not obviously reflect wholly conflicting values concerning life and health? Such a policy might well include the following:

1. *Withdrawal of government subsidies from the tobacco industry and the provision for incentives for diversification of farm production to crops that do not harm health;*
2. *Continuation of anti-smoking health education efforts and their augmentation by new efforts to help smokers become aware of motives underlying the use of cigarettes and by efforts to address underlying causes contributing to tobacco smoking.* Health education efforts should also stress the harmful consequences of the effects of smoking on non-smokers, particularly on those with health problems. Health education efforts should also stress the dictates of common courtesy and the right of individuals to breathe unpolluted air. Policies need to be implemented that protect the air rights of non-smokers and persons with any of a wide variety of health problems, persons who are either allergic to smoke or for whom smoke can have particularly deleterious effects, e.g., persons with cardiovascular disease, lung disease, ex-smokers, women who are expecting and others. A person trying to give up smoking can also have a negative and hypersensitive reaction to being subjected to tobacco smoke;
3. *Serious consideration of the curtailment of present Federal research efforts to develop a so-called less dangerous cigarette as such efforts imply a Federal sanctioning of smoking and are tantamount to subsidizing the researcher and development efforts of the tobacco industry*;
4. *Continuation of the search for cures for cancer and cardiovascular and respiratory problems. The support of such research efforts through the heavy taxation of cigarettes and tobacco products in order to substantially defray the cost of such research.* (A bill is presently being introduced in the Senator by Gary Hart of Colorado that would support a graduated tax of tobacco products depending upon the amount of nicotine and tar that they contain (59);
5. *Making it mandatory that tobacco smokers take out special health insurance that would cover illnesses and diseases linked to tobacco smoking.* The burden of medical expenses could thereby be shifted from the general population to those who by choice engage in the smoking of tobacco;
6. *Designation of nicotine as a drug and regulation of nicotine by the Food and Drug Administration with the possible placement of it in a special category;*
7. *Designation of no smoking areas within Federal buildings and instating of no smoking policies that limit smoking to areas and situation in which no involuntary exposure to tobacco smoke will be allowed to take place;*
8. *Development of health standards bearing on smoking in public places and policies that would serve as a model for any state governments or local jurisdictions wishing to adopt such standards on their own.*

**Marijuana Smoke and Marijuana Smoking**

The effects of smoking marijuana have been a subject of heated debate. Such debates seem rarely to be based in a common familiarity with the scientific literature.

In recent years there has been such a rapid generation of new research findings. It would take several people working full time to keep track of completed research and research in progress, let alone assess the findings and the significance or the potential importance of the research.

In 1976, an annotated bibliography was published that contains references for 3025 publications published between 1964 and 1974 (135). Few persons have had the opportunity or the requisite scientific background to cull out the most significant of these studies covered in this bibliography. Fewer still may be expected to be familiar with studies done subsequent to 1974. Two of the more noteworthy syntheses done in the past several years are these:

* a highly selective overview article appearing in the **1974 Toxicology Annual** written by B.R. Manno and J.E. Manno (87); and
* a book of papers edited by Gabriel Nahas, W.D.M. Patton, J.E. Idanpaan, **Marijuana: Chemistry, Biochemistry and Cellular Effects** (1975) (98).

H.B. Jones and H.C. Jones have offered a helpful overview assessment of the research on marijuana (66). M.C. Braude and S. Szara have edited a two volume set of papers, **Pharmacology of Marihuana**, published in 1976, covering many of the significant developments in the field of marijuana research in recent years (20).

**Why More Persons Do Not Know About Existing Research**

The phenomenon of information overload and the confusion it can generate plagues many fields of scientific endeavor today. This is particularly the case where research findings are increasing at exponential rates and where the synthesis of the implications of the findings is being attempted by very few. Yet a synthesis and overview are necessary in order reach an educated assessment of the nature of the action of marijuana and the implications that follow for individual and societal health and hence for social policy.

A wide variety of factors can impede the recognition and acceptance of facts concerning the effects of marijuana. These have been discussed in 1974 by Gordon (53). Aside from information overload and the failure to discern or assimilate the results of significant finds, other major factors impeding the acceptance of facts concerning the effects of marijuana include the following:

* A breakdown in basic values concerning the preservation of life and the sustenance and enhancement of the health and wellbeing of oneself and others;
* An absence of independent thinking informed by such values;
* A dearth of common sense and wisdom;
* A capacity to rationalize and ignore negative effects.[[2]](#endnote-2)

The first factor listed, the breakdown in basic values, is of key importance because all social policy reflects values. Even the absence of a social policy indicates that certain values have been selected over others. A policy stance may reflect an absence of concern, a failure to be concerned for certain values, such as the preservation of life and the preservation of individual and social health.

**The Effects of Marijuana**

The effects of marijuana are extraordinarily wide ranging. The effects that have the greatest significance for individual and social health, and, consequently, for public health and safety policy, will be focused on here. The first of these is a most recent finding, a finding that has not yet found wide circulation and, hence, a find whose importance has not been widely acknowledged and understood.

**Marijuana and Neuronal Dysfunction**

A landmark discovery was made in 1976 concerning the effect of marijuana’s active principle on neuronal functioning and hence on the central and autonomic nervous systems and brain (106). Small amounts of the active principle of marijuana were shown to impair the functioning of the central and autonomic nervous systems and of the brain, in that small quantities of the active principle act to block the sodium pump at synapse (106). *As the sodium pump is the major determinant of neuronal functioning, this change affects the functioning of nervous systems and the functioning of the brain.**[Emphasis added.]* Other research is uncovering similar findings concerning neuronal dysfunction that would in turn impinge upon brain functioning. As the insignificance of this finding is recognized and as the implications of this research finding are assimilated by those in policy making positions, widely held opinions that marijuana is an innocuous substance, and that it is a relatively harmless substance, should be supplanted with the knowledge that it is neither of these.

**Marijuana Smoke and Carcinogenic Cell Changes**

Research has shown that the smoke from marijuana cigarettes has a more deleterious effect on lung cells than cigarette smoke and that combined they have a more deleterious effect than either has separately (80). Cytological changes have been shown to occur. These changes lead to the same precancerous conditions found in the lungs of cigarette smoker (89). The same mechanism of action is involved: normal DNA synthesis is being interfered with by constituents in both tobacco and marijuana smoke (27). The implications of this finding for the health of marijuana smokers as well as those exposed to marijuana smoke are only beginning to be recognized.

**Marijuana and Psychotomimetic Effects**

**(Psychosis-Like, Psychosis-Mimicking Effects)**

Research published in 1967 showed that the active principle of marijuana, delta 9 tetrahydrocannabinol (THC), can have psychotomimetic effects in man (63, 89). The full implications of this research seem to have eluded many in the field. It is therefore not at all surprising that few lay persons appear to be aware of this research or to know of the importance of this finding. Not only has the significance of the fact that the active principle can cause psychotomimetic effects in man been overlooked, the importance of the major breakthrough leading up to this experiment has also eluded a majority of persons (31, 63, 89). It is important to understand what the significance of this previous breakthrough is.

The breakthrough involved the successful and economic synthesis of the active principle of marijuana, delta 9 THC. This was of utmost importance because the synthesis of the active principle of a drug of natural origin must be accomplished before methodologically sound scientific experiments can be performed to ascertain the effects of such a drug (31).

It is also important to note here that the study done by Isbell et.al. demonstrated the idiosyncratic and unpredictable nature of reactions to marijuana in human subjects (63). This study showed that an untoward reaction to delta 9 THC was not solely the function of a high dose level; some individuals can experience psychosis-mimicking reactions at relatively low dose levels (63). It is the case that hypersensitive reactions may be related to any or all of a wide variety of factors, including individual variations in biochemistry, mood, psychological predisposition, mental and physical health histories of the individual, history of use of other drugs, set and setting of use, dose level, etc. Because of the idiosyncratic nature to marijuana, there is no guarantee that the naïve, first time user will not have such a reaction. Neither does the veteran user have any guarantee that he will not experience a psychosis-mimicking reaction at some time as a result of using marijuana.

**The Contact High Effect:**

**Its Serious Implications for the Health, Functioning, and**

**Civil Liberties of Non-Users and Former Users**

The next effect of marijuana that will be cited here is the so-called “contact high” effect. Spreading recognition of this effect and widening appreciation of the implications of this effect may well be the prime factor in turning the tide of public opinion. Such recognition could lead away from acceptance of the use of marijuana as harmless and away from advocacy of policies that are neutral, pro-marijuana, or otherwise leading to advocacy of the use of the drug or the spreading use of the drug.

A “contact high” is a type of recurring phenomenon in which a drug-intoxicated state or drug-like high effects are experienced as a result of being in the vicinity of someone who is high (53, 101). The contact high effect can be found in person who are exposed to marijuana smoke as well as in those who are exposed only to persons who are high. It may be expected, however, that more persons would have the greatest sensitivity to exposure to marijuana smoke than to exposure to person who were high, but not smoking at the moment. The contact high effect can be found among persons who are in the vicinity of individuals who are high as a result of ingestion of other drugs that have psychoactive and psychotomimetic properties, such a LSD or mescaline. Sensitive non-users and former users appear to be particularly prone to experiencing the contact high effect. Children also appear to be particularly susceptible.

It bears noting here that thus far there is no scientifically plausible way of explaining the kind of contact high that can occur when there has been no exposure to marijuana smoke. This genre of “smokeless” contact high may be likened to a sympathy cry in small children. The process operating may also possibly be akin to the kind of transfer or contagion of emotionality that appears to take place in a mass hysteria reaction. The present discussion will not deal further with this kind of “smokeless” contact high. The discussion will be limited to the kind of contact high that occurs as a direct result of exposure to marijuana smoke.

The contact high effect, however little it may have been understood, is well known to users and has become increasingly recognized by researchers and others. It has, however, only occasionally been discussed in the literature (53, 73, 101). The implications of the contact high effect have been dealt with in 1974 by Gordon (53). These implications will be addressed further below.

Conclusive evidence providing the scientific explanation of a contact high effect involving exposure to smoke appeared in the **American Journal of Psychiatry** in January 1977 (143). This finding was reported by Drs. Zeidenberg, Bourdon, and Nahas. This explanation of the contact high effect was discovered by accident during an experiment in which one subject smoked placebo cigarettes while the other subjects in the experiment smoked marijuana cigarettes. At the end of a few days, the placebo smoker was found to be exhibiting some of the same drug-like high effects as those in the experiment who were smoking marijuana cigarettes. The “purity” of the placebo was questioned and the remaining placebo cigarettes were sent to the National Institute on Drug Abuse to ascertain whether or not they might contain contaminants. No contaminants were found. It was thereby established that the individual was not smoking impure placebo cigarettes. His behavior was also closely monitored and it was determined that he was not smoking marijuana cigarettes. Nonetheless he was experiencing a marijuana-type high. A urine sample was taken from the placebo smoker. This sample showed traces of cannabinoids. (Two different analytic technique were use to determine the presence of cannabinoids. Both showed positive findings.)[[3]](#endnote-3)

*A most significant implication following from this research finding is that the results of studies that have involved some subjects smoking of marijuana cigarettes and other subjects smoking placebo cigarettes in the same room must now be reinterpreted. The placebo smokers, in light of the research of Zeidenberg, Bourdon, and Nahas, were most likely experiencing at least a mild high-like effect by inadvertent inhalation of marijuana smoke. A greater disparity in effects would have been noted had the subjects, the placebo smokers and the marijuana smokers, been isolated from each other in these experiments. In this way they would not be breathing the same smoky air.*

This research finding of Zeidenberg, Bourdon, and Nahas would also explain why great differences were observed in the behavior of placebo subjects in two different research studies, one in which marijuana cigarettes and placebo cigarettes were smoked and where marijuana was ingested in an oral form while a placebo was ingested in an oral form. Marijuana-like highs were observed in the study in which marijuana cigarettes and placebo cigarettes were being smoke, but were not observed in the study in which the administration of the drug and the placebo was oral.[[4]](#endnote-4)

It should also be noted that in the same way that exposure to cigarette smoke can prove harmful to person with allergies, cardiac and respiratory problems and other health problems, so can marijuana smoke result in similar negative effects on health (9, 10, 11). Implications for the health of unborn offspring are similarly negative (46).

The implications of this phenomenon for the mental and physical health and functioning and for the civil liberties of others who share the same environment with one or more marijuana users are myriad. Not only are children likely to suffer consequences as a result of being in such an environment, sensitive adults and hypersensitive individuals in general may be expected to experience negative effects as a result of being in the environment of one or more marijuana users. Other individuals who are not similarly sensitive may nonetheless be rendered slightly high or high as a result of being in the same environment of marijuana users.

Some person will be able to recognize the effect and its cause. They may react to such an imposition of a changed state of consciousness or alteration of mood or functioning in a wide range of ways. They may react with total acceptance or violent antipathy. Other persons may recognize a change in consciousness or mood but may not realize that there is an external cause. Such persons may develop serious self-doubts about their mental stability. Indeed, the situation can be seen as being somewhat analogous – generally on a far less dramatic scale – to someone who has been slipped LSD with his knowledge. More serious and longer term psychological effects may be experience when a person has no way of knowing that an external agent is responsible for his altered state of consciousness, mood, visual perceptions, etc., and when he has no way of knowing how long such a change will continue, or if it will stop.

Repeated subjection to contact highs can be expected to have serious effects on the mental and emotional health of the persons affected, particularly children and extremely sensitive individuals.

The contact high effect raises serious civil liberties questions in a free society. The mental functioning and the emotional state of individuals, aware or unaware, willing or unwilling, can be affected by being in the presence of persons smoking marijuana. Should a free society protect its citizens from such a fundamental infringement on thought, mood, functioning, and health?

**The Subtle and Not-So-Subtle Side Effects of Marijuana Use**

Long term subtle side effects, including the distortion of judgment and difficulty in synthetic reasoning, have been found to occur as a result of the continued use marijuana. Impairment of mental functioning, concentration, and short-term memory have been demonstrated in clinical testing as well as documented in case studies (1, 2, 3, 39, 94, 116, 128, 137). Impairment of the decision-making process, learning ability, synthetic reasoning, and problem solving capabilities, including information retrieval, has been cited in other studies (1, 4, 39, 116 ). Disorders in focal attention and thinking are also noted in Wurmser and others (141, 142). Temporal disorientation is reported on elsewhere (90, 91). “Interruptive phenomena” such as mind wandering and visual fantasies have been noted in experimental situations (11). Focused verbal communication was shown to be diminished under the influence of marijuana in the same study (110). Impairment of judgment and will power have also been noted. (122, 124).

The most subtle, but nonetheless detrimental side effects accruing to the user of marijuana are not always recognized or admitted to by the user when they are recognized. One reason for this is that the use of marijuana can distort a user’s judgment, and thereby make it difficult for him to perceive that his powers of judgment have been distorted. The researcher who is unfamiliar with these effects is not likely to know what to look for. When he does know what to look for, he may fail to discern when the user is deluding himself or when the user is consciously trying to delude others. Perceptive former users who have been intimately involved with drug users and others who have had a long-term involvement with drug users are perhaps most familiar with such stratagems and self-delusionary tactics.

The implications that these effects hold for anyone called upon to function responsibly in an increasingly complicated technological society – are obviously great. Persons who use marijuana can experience distortions of judgment and visual perceptions that make them unfit as drivers, pilots, or operators of any kind of complicated machinery. It has been shown that the train operator investigated for his role in the elevated train disaster in Chicago in 1976 had traces of marijuana in his body fluids.[[5]](#endnote-5) This would indicate either that he had used marijuana within three days of the accident or that he had been exposed very recently to marijuana smoke. If in fact the train operator was suffering from a distortion of judgment or visual perception at the time of the accident, such distortion might have been a result of recent marijuana use or exposure to marijuana use or use of marijuana that predated the accident by days, weeks, or even longer. Spontaneous recurrences of a marijuana-like high will be discussed shortly, along with several plausible explanations concerning the mechanism of such an effect. It is important to note here only that a person may experience a marijuana-like high, or a distortion of judgment and perception –subtle or marked—at a time post-dating the time of last use, even as much as six months or later. Stressful situations have been known to trigger such recurrent effects. Youthful drivers under the influence of marijuana have been known to be more accident prone (41). Research on adults driving under the influence of marijuana involved in non-fatal as well as fatal automobile accidents have been most disquieting (95, 96, 126 ). The implications these effects hold for public health and safety are indeed great.

In the complicated technological society in which we live, it is essential that all of those engaged in the operating of complicated machinery, be it a car, a bus, a train, a plane, or industrial machinery – should have no impairment to their judgment or visual perception (87, 88). Their health and safety depend upon their ability to concentrate on what they are doing, their ability to make sound judgments, their ability to think and make decisions under pressure, and their ability to visually perceive their immediate environment accurately. They need to have their full wits about them in order to avoid injury to themselves and possible injury to others.

It seems quite obvious that if a thoughtful person fully understood the risks involved, and if he were given the choice, he would not volunteer to be a passenger in a car, a bus, a train, or a plane that was being operated by someone who was under the immediate or lingering influence of marijuana. Similarly no thinking person, no person who cared about his welfare or that of others, would wish to have a nuclear power plant, a weapons system, or any complicated machinery or technology mismanaged or improperly operated as a result of marijuana use or exposure. This is particularly true when his life and the lives and wellbeing of scores, hundreds, thousands, or even, in the case of nuclear power plants, millions, could be instantly placed in jeopardy.

**Recurrent, Spontaneous Effects: “Flashbacks”**

Research has shown that marijuana users have experienced recurring effects. These effects are similar in their basic nature to the recurring effects that result from the use of stronger psychoactive and psychotomimetic agents such as LSD, mescaline, and psilocybin. “Flashbacks” resulting from the use of marijuana alone, are generally of a lesser intensity.

“Flashbacks,” “spontaneous recurrences,” can be a shadow, a mirror image or an oversized enlargement of the drug-intoxicated state. They occur at a time when an individual is not using the drug. In the 1972 **Marijuana Commission Report**, “flashbacks” were defined in a nearly identical way as “spontaneous recurrences of all or part of the drug-intoxicated state when not under the influence of the drug” (101).

Spontaneous recurrences of marijuana intoxicated states are discussed in Keeler (70), Weil (41), Bialos (15), Blumenfeld (16), Milman (92, 93), and Annis and Smart (8). These researchers, former users, and sensitive occasional users are best acquainted with the flashback phenomenon. The chronic user would not be in a very good position to ascertain the cause-effect relationship of marijuana use to such symptoms because he would be – to a greater or lesser degree - perpetually under the influence of the drug. Others who experience flashbacks and who are only occasional users may either look upon the flashback as a trick of the mind or accept it as a purely natural phenomenon. Some may be in a state of denial that they are actually experiencing a phenomenon that was unknown to them prior to their involvement with drug use. Some individuals may possibly increase the frequency of use so that flashbacks could be attributed to recent highs rather than to some possibly permanent dysfunction. Weil (41) has indicated that such spontaneous recurrences decrease in frequency and intensity the longer a person abstains from using the drug. It should be noted that the flashback effect may be explained at least in part by the finding that two active constituent of marijuana, Delta 9 THC and Delta 11 THC both “remain in the plasma of human subjects for several days and are excreted in the urine and feces for more than eight days” (104, 105, 140). Delta 9 THC can remain in the fatty tissues of heavy set individuals for extended periods of time thereby taking an even longer time to become expunged from the body and constituting a source of high-like effects or recurring high while it remains in the body (78). Recurrent effects may also be explained by Olmsted’s finding that the half-life of delta 9 THC in the brain is 37 days (106). Another possible explanation of recurrent effects could be the memory of the high may be retained in such a vivid form, that it may be readily triggered or rekindled by similar circumstances or stressful circumstances.

Marijuana Use and Motivation

Marijuana use has been widely cited in the international literature as being a major factor contributing to an amotivational syndrome of behavior. This syndrome is characterized by diminishing will power and by loss of previously held goals, values, and ambitions. Since the 1960s Western researchers linking marijuana use and amotivation include: West (138), Kolansky and Moore (75), Brill (21), Farnsworth (44), Wurmser (141, 142), Campbell (25), and Rozett (121).

The amotivational syndrome effect of chronic marijuana use in and of itself provides sufficient grounds for neither condoning nor promoting the use of marijuana in a free and democratic society. A free and democratic society cannot afford to sanction the use of a soporific drug that renders any of its citizens passive and affects their ability to act in good conscience for however long a period of time. A free and democratic society cannot afford to allow its rising generations to be exposed to such substances. The stability and the viability of a free society depend upon the health of society overall. A free and democratic society depends upon an alert and aware citizenry. Citizens need to exercise their responsibilities, use their best judgment, and not lapse into mindless passive states that reflect a devaluing of life and health and a devaluing of the basic value of freedom. Responsibility for oneself and for others and conscientious action are intrinsic to freedom and its preservation.

**Creation of New or Aggravation of Latent or**

**Manifest Psychological Problems and Pathologies**

A propensity for paranoid feelings and a diminished ability to cope with stressful situations have been noted among users of marijuana, particularly sensitive or long-term users (68, 115). Kleber (74) and Kaplan (67) cite cases in which marijuana use exacerbated existing psychoses. Wikler (139), Janowitz (64), and Wurmser et al. (142), have also written of chronic paranoid symptoms and thought disorders in users of marijuana. The contention that psychotomimetic drug use only aggravates preexisting problems or pathologies (however amoral the assumptions in such a contention may be) is refuted by Glass and Bowers (48) and in others (6, 75) who note that untoward reactions to psychotomimetic drugs are not necessarily dependent upon the psychological predisposition of the user. In this regard, it should also be noted that various researchers have cited cased in which the experiencing of hallucinatory phenomenon was linked to marijuana use. These include Keeler (69), Wurmser (141, 142), Keup (71), and Dally (36). Because of the idiosyncratic nature of the effects, dose level for marijuana need not necessarily be high in order for hallucinatory activity to occur. This is not to imply anything concerning the frequency of this effect.

**A Wide Range of Physiological Effects**

**That Can Result From Marijuana Use**

All of the following effects of marijuana use have been discussed in the literature:

* effects on the lowering of immune response (99, 100, 118),
* effects on the altering of hormonal balance (42,76, 77, 117),
* effects on the propensity of some male users to undergo development of their breasts (58), and
* effects on the propensity of some male users to suffer from sexual impotence (29, 97).

Work by Nahas et al. (97) has been abstracted in the following way:

Depression of plasma testosterone levels, oligospermia [low sperm volume] and impotence observe in chronic marijuana users is not only due to a hypothalamic or pituitary dysfunction but may also be related to a direct action of THC on DNA metabolism of the cells of the testes (97).

Some preliminary evidence has indicated the possible development of a propensity to hypoglycemia in some users of marijuana (127). Other research has indicated possible hepatoxicity (72). Cardiovascular effects have been noted in man and in animals (6,9, 87). Several researchers have seen evidence of cerebral atrophy in chronic marijuana users. This finding strongly suggests that marijuana use has been the causative factor. Air encephalographic techniques have been used in these studies (26, 43).

The teratogenicity and mutagenicity of marijuana remains uncertain in the minds of many researchers. Animal studies conducted by P.A. Fried and others show very disconcerting effects. Their work indicates that marijuana smoking when compared to tobacco smoking may be every bit as hazardous, if not more so, to the health of the unborn (14, 17, 18, 79, 103, 109, 111, 112, 113). The long-range consequences for the sound functioning of infants born to marijuana-using mothers and fathers, who used before, during or after birth, are not at all clear. One quite alarming report concerns the exposure of two infants to hashish smoke. In separate home situations in Paris, these infants were rendered comatose as a result of exposure to hashish smoke and had to be hospitalized. [[6]](#endnote-6) The facts of the two cases in question have not been widely circulated as yet, but when they are they may generate a great deal of thought concerning the seriousness of the consequences of direct or indirect exposure to marijuana in any of its varying strengths or forms.

Bourne has assessed the implications of the potential effects of marijuana on fetal development in the following way: “Intense use of marijuana during critical stages of pregnancy might result in disruption of normal sexual differentiation patterns in the male embryo” (19 with 77 cited). Collu and others have been concerning with the same problem (32). Bourne continues in his assessment of the literature:

High material intake of marijuana might be required to produce adverse effects, but there is also a possibility that testicular or hypothalamic tissue might be more sensitive to drug effects during this time than during adulthood. While there is an absence of clinical evidence for these consequences, it would appear unwise for pregnant women to use marijuana (19 with 117 cited.)

**Policy Implications**

Acceptance of the proof of any one of the effects that has been described above would be ample grounds for continuing to make the use and growing of marijuana unlawful. There presently exists more than ample grounds for launching a massive campaign to discourage the use of marijuana, to help people become aware of the wide variety of risks that they are taking with respect to their own mental, emotional, and physical health, functioning, and wellbeing, as well as to that of others. This would include those who willingly or unwillingly are being exposed to marijuana smoke in the environment or in the case of the unborn, in utero.

The implications of the widespread or even minimal or moderate use of marijuana for individual and societal health and for the stability and viability of a free society are very great. How can a free society long survive when a growing percentage of its citizenry countenance or indulge in even the occasional use of drugs that numb the conscience, distort judgment, and affect the will power, whether temporarily or over a longer period of time? How can the use of a drug that so affects health and functioning be condoned or fail to be vigorously discouraged? When the chronic use of such a drug is condoned and indulged in, the bulwark of a free society, a thinking, responsible, and healthy function citizenry, is seriously and perhaps even irreparably weakened.

Present policies with respect to marijuana provide scant safeguards against such an eventuality. Decriminalization in Oregon, as it has been formulated and implemented there, has apparently resulted in the increase in the use of marijuana (40, 82, 102). This increase in use has been particularly alarming among those in the 18 to 29 year old age bracket.[[7]](#endnote-7) A diversion approach that would include an education/counseling component and that would be designed to actively discourage cited users from continuing their use of marijuana, will be discussed shortly.

It does not make sense to pursue any policy that will increase marijuana use. The challenge that faces responsible person in government is to come up with policies that discourage use and lead to a continuing decrease in use while approaching the problem humanely, but firmly, continuing to keep growth, possession, and use of marijuana against the law. Indeed U.S. international treaty obligations would seem to dictate that all of these continue to be regarded as unlawful activities.[[8]](#endnote-8) Implementing any of a variety of kinds of citation/diversion approaches to the problem of drug use and possession could prove particularly successful in discouraging and decreasing overall use of the drug.

There is definite urgency to evolve and implement Federal, State, and local policies to deal with the problem of marijuana use.[[9]](#endnote-9) Use has spread and the more commonplace the use of marijuana becomes, the more difficult it will be to turn the tide. If marijuana use continues to spread, the number of those non-smokers being deleteriously affected or subjected to risks to their health and functioning would increase. This would include friends, family, children, innocent bystanders, and others. The harm accruing to the individuals using would also increase. The risk to generations yet unborn would similarly increase. In many ways the problems resulting from marijuana use are even more insidious than the problems resulting alcohol use or cigarette smoking because of the effects that even short-term use can have on users and non-users alike. The impact of the use of marijuana on the growing children of users can only be guessed at this time. Chronic exposure to marijuana smoke, particularly in the earliest stages of development, and extending through early adulthood, may well impair the health and particularly the nervous systems of these individuals in very serious ways, ways that will impair their functioning throughout adulthood. Chronic exposure to marijuana use during the earliest stages of development may well prove to be even more harmful than exposure to cigarette smoke is proving to be.

The many adults who are advocates for the free use of marijuana may simply be failing to consider the differential effects that the use of the drug can be expected to have on those who have not attained their full growth as compared with those who have. Other individuals advocating the free use of marijuana may share the same unconcern that many cigarette smokers have for their own health and the effect of their smoking on the health and wellbeing of others. Such unconcern may reflect an absence of a sense of responsibility for one’s actions and an absence of a sense of concern that one’s actions may be having on others. Such unconcern may also reflect an ignorance of the risks to which they are exposing themselves and others. They simply may never have taken the time to become knowledgeable concerning the effects and health risks of a drug that they may believe to be harmless.

What specific policies follow from all that has been said here? What should the government’s role be in addressing this problem?

The policies of the Federal government need first of all to reflect fully the most significant evidence there is concerning the effects of marijuana use. This evidence must be pulled together and synthesized in light of its implications for individual and social health, and the viability of a free society. The ***mere*** compilation of facts divorced from any consideration or scant consideration of values for protecting, maintaining, and enhancing human health, can effectively constitute a disservice to the public’s wellbeing and even result in a wasteful and meaningless use of public resources if there is not a subsequent effort to apply such facts and knowledge to the development and implementation of meaningful social policies and approaches.

Policies should reflect as well, cognizance of the fact that the actions of the marijuana smoker are depriving others of the right to breathe clean air and the right to be free from interference with their mental functioning and their physical health.

The full range of policies and programs that are needed to discourage the use of marijuana and to humanely and fairly deal with those who persist in the use of the drug have been discussed at length in Gordon (49, 50, 51, 52, 53).

The kinds of policies and approach that are needed are as follows:

* The possession of one marijuana cigarette of under an ounce of marijuana should be made punishable by a citation/diversion approach (84). The individual would be cited and fined and then remanded to a traffic court type of school where he would take part in an educational/counseling program and be exposed to information concerning the harmful ways in which the use of marijuana can affect himself and others.[[10]](#endnote-10) The individual would be helped to develop an understanding of these effects and their implications for mental, emotional, and physical health. The civil rights implications of his actions and the responsibility he has for his actions and the way they affect others would be stressed. The fact that his actions effectively deprive others of the right to breathe clean air and of the right to be free from interference with their mental functioning and their physical health would also be stressed. Counseling would be provided as needed. Referral of persons with serious psychological problems to appropriate services would also be included.
* Repeat offenders should be given the option of incarceration with extensive rehabilitation services and programs provided or the option of participating in community service as providers of direct or indirect services to those in need. The latter would include participating in an intensified and personalized education/counseling program as well. Community service could involve such activities as working with severely mentally impaired children or adults. In this way a better appreciation of a fully functioning mind might be developed. Perhaps, most importantly, the individual would be provided a “forced” opportunity to be of serve to others and to develop a sense of concern of the well being of others. Intensive counseling or rehabilitation programs should be an option for those who persist in using marijuana and other drugs that are deleterious to their mental and physical health and to that of others as well.
* There should be early intervention approaches and policies implemented in every public school in the nation, at all grade levels where problems warrant. Non-punitive policies should be adopted to deal with all those persons touched by the program. Persons who continue in the use of marijuana after exposure to counseling and educational approaches should be treated with some degree of severity and provided options along the same lines as those suggested above for adults. This would include participation in service-oriented projects along with involvement in intensified and personalized education/counseling programs. Approaches and policies directed toward early intervention in drug-taking behavior for those in school are outlined more fully elsewhere (49, 52, 54).
* There should be effective prevention programs throughout the public school system. The success of such programs depends upon their reflecting an in depth awareness of the nature, causes, and effects of drug-taking behavior. Prevention strategies need to address in an effective, wise, and humane way – the unmet needs and root causes, as well as the possible misinformation or misconceptions, that have given rise to drug-taking behavior in the first place. Prevention strategies, including approaches stressing alternatives to drug-taking behavior, are more fully discussed and outlined elsewhere (51).
* The Federal law to keep the growing of marijuana unlawful should be a continued.

**Summation**

In a day when increasing attention is being paid to the plight of the handicapped and the mentally ill, it seems ironic that so little is being done to effectively discourage behavior that can lead needlessly to the temporary, chronic, or even permanent handicapping of individuals. The implications of such failure are enormous. The health and stability of many persons presently in roles of responsibility and leadership are also imperiled. In addition, there can be cumulative negative consequences for the future of the nation and the future of a free society. Owing to the role that America plays in the world and the example that America sets for the world, these cumulative negative consequences can have implications for the mental, social, and physical health of the entire world.

Psychoactive and psychotoxic substances threaten physical as well as mental health and functioning. The kind of synthesis of knowledge and understanding that are needed to interpret and understand these dangers in our environment would seem to be in short supply today. The kinds of action required for effective mitigation of the threats posed by moo altering psychoactive and psychotoxic substances seems also to be in short supply.

A major roadblock to the development of effective and response Federal policies in the wide range of health-related areas has been the value neutrality that has come to permeate governmental problem-solving efforts. Science at its best reflects a concern for life and health and concern for humanity. This is the perspective that needs to infuse the work and concern of scientists, policymakers, and administrators who work in public service, who have obligated themselves by virtue of the roles they have accepted, to serve the public in ways that protect and preserve the values of life and health. There are consequences that can follow from value neutrality. These include the likelihood that individuals who maintain a value neutral stance will show no concern for the problems facing the nation. As a result, there can be a serious lack of commitment to addressing, understanding, or even identifying the most pressing problems of the day. In such cases, such deficiencies may result in partial solutions or simply in a failure to identify and investigate even the most obvious symptoms. Resulting policies and approaches may also ignore the conditions and unmet needs that gave rise to the problem in the first place. Such policies and approaches also fail to result in taking the actions that are needed.

Policymakers with responsibilities for shaping and implanting health policy are being challenged to rise to the occasion by combining the insight and expertise of a scientist, a social psychologist, an administrative generalist, and a social philosopher. They are being called upon not only to synthesize existing knowledge, but to examine such knowledge in light of the values of preserving life and of preserving and enhancing both individual and societal health. In the case of marijuana use, the very future of a viable and free society is in jeopardy. A free society relies for its strength on the full and healthy functioning of each member of that society. It relies on a healthy rising generation that will be able and willing to assume roles of responsibility and leadership. If policymakers and implementers in a free society fail to recognize these realities, the future of that society is in certain danger.

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1. Congressman Drinan of Massachusetts has introduced legislation that would address the issue of unwilling subjection to smoke. See the Extended Remarks to the House of Representatives, **Congressional Record**, Vol. 123, No. 15, January 27, 1977. [↑](#endnote-ref-1)
2. Additional factors impeding the recognition and acceptance of facts concerning the effects of marijuana are enumerated as follows in the Gordon article (53): social and cultural pressures, cognitive dissonance, believing what one wishes to believe, maintaining a viewpoint in order to save face, generalizing on the basis of personal biases and narrow personal experience, accepting view of “experts” as being infallible, time lag and the difficulty of assimilating new information, the tendency to overlook hard to explain phenomenon, and a lack of imagination concerning viable policy options. The groupthink syndrome and other patterns of flawed judgment and decision-making may all be coming into play. [↑](#endnote-ref-2)
3. The results of only one of the analyses were reported on in the article. A standard assay technique was not reported on in the article. Both analyses, however, showed positive findings. (Personal communication with Dr. Nahas, April 25, 1977). [↑](#endnote-ref-3)
4. Dr. Reese Jones and Dr. Louis Lemberger discuss these (then) unexplained differences in Braude and Szara, **Pharmacology of Marihuana** (20, p. 134). One of the participants in this discussion has since acknowledged in a personal communication on May 17, 1977 that the passive inhalation effect shown by Zeidenberg, Nahas, and Bourdon, might well explain the effects that placebo using volunteers experienced in experimental situations in which they smoked placebo cigarettes in the midst of subjects smoking marijuana cigarettes and after inhalation of marijuana smoke in the environment. [↑](#endnote-ref-4)
5. First tests were negative, but a second test using a newer more sensitive analytic procedure revealed the presence of cannabinoids in the urine. [↑](#endnote-ref-5)
6. These findings are soon to be reported by Dr. Bourdon (Separate personal communications with Drs. Zeidenberg and Nahas, April 25, 1977. [↑](#endnote-ref-6)
7. In a Today Show interview, August 4, 1977, Congressman Robin Beard of Tennessee cited a 35% increase in the use of marijuana by those in the 18-29 year old age bracket in Oregon between 1975 and 1976. At the same time there was a 4% increase for all those 18 and over. He stated that proponents of decriminalization in the administration (e.g., Dr. Peter Bourne) were focusing on this smaller statistic and ignoring, even refusing to recognize, the 35% statistic. Both percentages were drawn from the same set of data gathered by the Drug Abuse Council (40). Also see (96, Vol.3, pp. 30-31) for statements regarding increases in usage. Of particular concern is the fact that the number of non-smokers giving “possibility of health dangers” as a reason for not smoking, dropped sharply from the 23% of 1974 and the 28% level of 1975 to 7% in 1976. The effect of the drastic change in the law and the effective sanctioning of use may well be responsible for this dramatic shift. [↑](#endnote-ref-7)
8. For a discussion of the United States’ international treaty obligations as they pertain to the control of marijuana, see (96, pp.83ff.) [↑](#endnote-ref-8)
9. Federal laws and Federally recommended models for state and local laws and policies can play a most important role by serving as examples. The vast majority of marijuana arrests are made at the State and local levels. The attitudes and practices concerned with discouraging and prohibiting the use of marijuana can be greatly influenced by Federal pronouncements regarding policies. [↑](#endnote-ref-9)
10. Citation/diversion programs have reportedly been working successfully in Minnesota; Cook County (Chicago), Illinois; San Diego, California (Probation Department); Glendale, California (Police Department); and Sacramento, California. For further information concerning the approach being taken in Minnesota (96, Vol. III, pp. 240 ff.) For information on the Cook County Program, contact the Office of the State’s Attorney of Cook County. For information concerning the Sacramento “601” Program, contact the State Office of Narcotics and Drug Abuse.

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    **Two Supplemental Lists of References**

    **Regarding Recent Research on Harmful Mental and Physical Effects**

    “Marijuana Legalization: A Man-Made Public Health Disaster Currently Unfolding in Two States in the U.S.” Presentation December 5, 2014 Dupont Summit 2014, Washington, DC. (Posted at <http://GordonDrugAbusePrevention.com> and includes references to major studies on the negative effects of marijuana use, including research involving brain scans, that have been released since April 2014. A 33-page list of references on the harmful effects of marijuana is also posted on that website.)

    “The Illegality of Legalizing Marijuana Use: An Open Plea to the President and All Other Sworn Federal, State, and Local Public Officials Concerning Marijuana Policies and Laws in the United States: What Part of ‘I swear to take Care that Laws be faithfully executed’ or ‘I swear to support and defend the Constitution’ Do You Not Understand?” August 4, 2014. Posted at <http://GordonDrugAbusePrevention.com> and published by Family Security Matters.

    “A Case for Protecting the Brain:  Keeping the Federal Controlled Substances Act in Place and Providing Non-Punitive, Justice System-Based Public Health Options to Address the Use of Marijuana, Opiates, and Other Psychoactive and Mood-Altering Drugs in America”. Presentation at the International Criminology Conference, Washington, D. C., October 14, 2016. (See <http://GordonDrugAbusePrevention.com>).

    “Viewing Marijuana Use and Policy from a Public Health Perspective”. Presentation at The George Washington University: University Seminar on Reflexive Systems, November 3, 2014. (See <http://GordonDrugAbusePrevention.com>).

    Submission to the Federal Register concerning the Classification of Marijuana under the Federal Controlled Substances Act emphasizing the harmful effects of marijuana on the reproductive health of males and females and harmful effects on maternal and child health, and other harmful mental and physical health effects, as well as the connection between exposure to and use of marijuana to brain anomalies and sensitization to opioid use and addiction, April 24, 2018. (Posted at <http://GordonDrugAbusePrevention.com> .)

    “A Way of Framing the Nation’s Drug Crisis and the Role That Marijuana is Playing in That Crisis”. Presentation to the leadership of the American Council on Addiction and Alcohol Problems on September 11, 2018.

    “Values in Public Administration and Governance in America” Published December 29, 2018by the American Center for Democracy” at <http://acdemocracy.org/values-in-public-administration-and-governance-in-america/>) [includes an “Ethics Map”]

    “Ways in Which Marijuana Use & Marijuana Legalization Are Fueling the Opioid Crisis”. Presentation to the Drug Enforcement Administration, U.S. Department of Justice. May 30, 2019. (Posted at <http://GordonDrugAbusePrevention.com> .)

    “Drugs, Homelessness and a Growing Public Health Disaster”, December 11, 2019, DomesticPreparedness.com at <https://www.domesticpreparedness.com/healthcare/drugs-homelessness-a-growing-public-health-disaster/> and **DomPrep Journal**, December 2019.

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    “Why Marijuana Legalization is a Very Bad Idea **~** Marijuana as a Contributor to the Opioid Crisis, the Homeless Problem, and Societal Unrest and Its Harm to the Brain, Body, Future Generations, and Environment”. Published October 22, 2020by the American Center for Democracy” at <https://acdemocracy.org/why-marijuana-legalization-is-a-very-bad-idea/>.

    “Predictable and Unpredictable Effects of Marijuana”. Published March 4, 2021 by Moms Strong at <https://momsstrong.org/2021/03/04/marijuana-predictable-and-unpredictable-effects/> .

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    | |  | | --- | |  | |  |   **SELECTED SHORT LIST OF KNOWN HARMS OF MARIJUANA USE**  1.                  Reece A.S.  “Known Cannabis Teratogenicity Should be Carefully Considered”  BMJ Rapid Response.  Accepted 06/08/2018.  URL:  [https://www.bmj.com/content/362/bmj.k3357/rr-0](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.bmj.com%2Fcontent%2F362%2Fbmj.k3357%2Frr-0&data=04%7C01%7Cfillip.nelson%40akelius.us%7C980905bc0988471d043408d9197299ff%7Ceba98254c2b44db29cc28f4aa10c2ab2%7C1%7C0%7C637568803634926343%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=NcWJgdOwQSVqX%2B5z%2B%2BfqM8MAhgg%2BjnZpxdIyCWDscCk%3D&reserved=0)  Chosen as Editors Choice for BMJ 23/10/2018.    2.                  Rapid Response to Cardenas A, Villaba A., de Juan Romero C., Pico E., Kyrousi C., Tzika A.C., Tessier-Lavigne M., Ma L., Drukker M., Borrell V.  (2018)  “Evolution of cortical neurogenesis in amniotes is controlled by robo signaling levels.”  Cell 174(3): 590-606.  Published on Cell website.  [https://www.cell.com/cell/fulltext/S0092-8674(18)30732-3?\_returnURL=https%3A%2F%2Flinkinghub.elsevier.com%2Fretrieve%2Fpii%2FS0092867418307323%3Fshowall%3Dtrue#comments-heading](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cell.com%2Fcell%2Ffulltext%2FS0092-8674(18)30732-3%3F_returnURL%3Dhttps%253A%252F%252Flinkinghub.elsevier.com%252Fretrieve%252Fpii%252FS0092867418307323%253Fshowall%253Dtrue%23comments-heading&data=04%7C01%7Cfillip.nelson%40akelius.us%7C980905bc0988471d043408d9197299ff%7Ceba98254c2b44db29cc28f4aa10c2ab2%7C1%7C0%7C637568803634926343%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=DsOiI%2BtCdzeeQaXk1qteMGRzYRVS7k7AgjHX7qIZY9M%3D&reserved=0)    3.                  Alblooshi H., Al Safar H., Fisher H.F., Cordell H.J., El Khasef A., Al Ghaferi H., Shawky M., Reece S., Hulse G.K., Tay G.K.. 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