Intern. J. Neuroscience, 1994, Vol. 75, pp. 203–212
Reprints available directly from the publisher
Photocopying permitted by license only

COGNITIVE IMPAIRMENTS IN ADOLESCENT DRUG-ABUSERS

BYRON BERNAL

Centro Neurológico de Bogotá, Bogotá—COLOMBIA

ALFREDO ARDILA

Instituto Colombiano de Neuropsicologia, Bogotá—COLOMBIA

and

JOSÉ R. BATEMAN

Fundación Universitaria "Konrad Lorenz," Bogotá—COLOMBIA

(Received August 24, 1993)

A basic neuropsychological test battery was given to 64 adolescents (57 males and seven females; mean age = 15.5) divided in two groups: (1) drug-abusers ("experimental group," $n = 26$), and (2) non drug-abusers ("control group," $n = 38$). Psychoactive substances included marijuana, "crack," solvent inhalation, gasoline sniffing, and alcohol. The following tests were used: (1) language, (2) perceptual recognition, (3) memory, and (4) praxic abilities. In general, performance was mildly (but nonsignificantly) lower in the experimental than in the control group. Only some neuropsychological test scores correlated with lifetime and amount of psychoactive drugs used. It was proposed that cognitive impairments in this sample of young drug-abusers may have been not evident because: (1) lifetime use was limited, due to the age of the subjects; and (2) in adolescents and pre-adolescents, toxic effects of drug-abuse might be manifested as a decrease in the rate of cognitive development rather than as a general cognitive decline.

Keywords: Drug-abuse, cocaine, cognitive impairments, neuropsychological evaluation.

During the last several years, a great importance has been given to the medical and social analysis of drug abuse (e.g., Pérez, 1987). This has been particularly true with regard to the effects of alcohol, marijuana and LSD (Adams, Rennik, Schooff & Keegan, 1975; Carlin & Trupin, 1977; Grant, Adams, Carlin & Rennik, 1977; McKittrick, Grinvalds, Haut & Franzen, 1992; Parsons & Farr, 1981; Satz, Fletcher & Sutker, 1976; Wright & Hogan, 1972). In general these studies have shown the existence of some cognitive deficits with chronic drug abusers; these effects appear particularly evident with regard to memory, attention, and abstraction abilities (Brunhn & Maage, 1975; Brhun et al., 1981; Carlin, 1986; Carlin Strauss, Grant & Adams, 1978; Parsons & Farr, 1981; Rosselli & Ardila, 1993). This has led to the proposal of the existence of a group of toxic dementias (e.g., Ardila & Rosselli, 1986; Marsden, 1985). Much evidence has already been established in regard to alcoholic dementia and its manifestations of impairments in short-term memory, attentional deficits, and spatial defects (Victor & Adams, 1985).

Send correspondence to: Dr. Alfredo Ardila, P.O. Box 17021, Bogotá, Colombia (South America).

The research about the cognitive effects of chronic use of alkaloids extracted from the coca leaf (*Erythroxylum coca*), however, has been scarce. The acute effects of cocaine on behavior are much better known. It seems clear that due to the stimulant effect of cocaine on the nervous system, the subject displays euphoria, restlessness, and increased energy (Gawin & Ellinwood, 1988; Hartman, 1988). Cocaine intoxication can also produce some psychiatric symptoms (Gawin & Kleber, 1986; Miller, Gold & Milman, 1989). Frequent users may develop panic attacks (Washton & Gold, 1984), paranoid ideation, depression, anxiety, and loss of motivation (Washton & Tatarsky, 1984). Violent behavior is commonly seen also among cocaine patients (Manschreck et al., 1988). When given chronically cocaine can produce some behavior disorders similar to those seen in schizophrenic psychosis (Wyatt, Fawcett & Kirch, 1989).

Freebase cocaine ("crack") has been associated with cerebrovascular complication (Kaye & Fainstat, 1987; Levine et al., 1987; Golbe & Merkin, 1986). Cocaine intoxication can produce seizures, cardiac arrhythmias, and respiratory arrest (Miller, Gold, & Milman, 1989). Although the exact mechanism of cocaine on the nervous system is not presently understood, it has been hypothesized that it produces a direct neurotoxin effect or multiple microinfarctions due to hemodynamic changes. Drowsiness, unsteady gait and seizures have been correlated with passive smoke inhalation in children exposed to the smoke of free cocaine used by their adult caretakers (Bateman & Heagarty, 1989). The fetal effects of "crack" with its use during pregnancy has been recently studied by Cherukuri et al. (1988).

The cognitive consequences of chronic cocaine abuse are less clearly defined. Washton and Gold (1984) reported that 57% of the cocaine abusers interviewed experienced memory problems. Press (1983) found a better (although non significant) performance of normals when compared with cocaine abusers on the Luria-Nebraska Neuropsychological Battery. According to the author, verbal memory subtests were the most significantly impaired in cocaine abusers. Low scores in the range of impairment on Trials A and B have been reported also in freebase cocaine users (Reitan & Wolfson, 1985). Grigsby et al. (1992) reported significantly impaired cognition in chronic users of cocaine.

Ardila, Rosselli, and Strumwasser (1990, 1991) administered a neuropsychological assessment test battery to 37 chronic freebase cocaine ("crack") abusers. The following tests were used: Wechsler Memory Scale (Wechsler, 1945), Rey-Osterrieth Complex Figure (Osterrieth, 1944) (copy and immediate reproduction), Verbal Fluency (semantic and phonologic), Boston Naming Test (Goodglass, Kaplan & Weintrab, 1983), Wisconsin Card Sorting Test (Heaton, 1981) and Digit-symbol from the WISC (Wechsler, 1974). In general, performance was lower than expected according to their age and educational level. Subjects showed significant impairment in short-term memory and attention subtests. Neuropsychological test scores were correlated with lifetime amount of cocaine used, suggesting a direct relationship between abuse and cognitive impairment.

Freebase cocaine ("crack") is used in Colombia in a preparation popularly known as "basuco." The use of "basuco" is relatively recent in Colombia (Pérez, 1987). Its addictive power is notorious.

Solvent inhalation represents a type of addiction relatively frequent in some Latin American countries, particularly in Mexico. Most often, thinner is used. A few research studies have analyzed the neuropsychological effects of solvent inhalation. Headache, dizziness, impairments in memory, attention, general intellect and problem-solving, speed and initiative are reported (Edling, 1985; Mikkelson et al., 1985). With chronic solvent exposure symptoms of dementia can result (Hartman, 1988).

TABLE 1
Distribution of the Sample

	Experimental Group	Control Group
N	26	38
Age: mean	15.88	15.11
SD	1.03	1.59
Schooling (years): mean	5.38	6.39
SD	2.06	2.08
Gender: males	25	32
females	1	6

Berg and Kelafant (1992) observed decreased ability to focus and maintain attention and concentrations as well as generalized decrease in cognitive processing in a chronic solvent exposure sample. Grigsby et al. (1992) reported that toluene users performed worse than normal controls on tests of short-term memory, card sorting, free recall, verbal memory, verbal IQ, word learning, and comprehension of complex language. Several measures of processing and memory were correlated with duration and frequency of abuse.

Gasoline inhalation represents a rather frequent addition in homeless street children (*gamines*) in Bogotá (Colombia). However, gasoline sniffing is not limited to this social group. Gasoline vapors are rapidly absorbed by the lungs and symptoms begin within 3–5 minutes (Hartman, 1988). Intoxication is characterized by euphoria, hallucinations, sensations of lightness or spinning, and alteration in shapes and colors (Poklis & Burkett, 1977). Very few studies have analyzed the effects of gasoline sniffing abuse. Neurological and EEG abnormalities were observed in the majority of 50-subject sample of unleaded gasoline abusers in Winnipeg (Canada). These neurological and EEG abnormalities, however, resolved after eight weeks (Hartman, 1988).

The purpose of this research was further to analyze the effects of psychoactive substance abuse on cognitive abilities in a sample of adolescent subjects.

METHOD

Subjects

Sixty-four adolescents (57 males and seven females) were studied. Subjects were divided in two groups: (1) drug-abusers ("experimental group," $n = 26$), and (2) nondrug-abusers ("control group," $n = 38$). Table 1 presents the general characteristics of the sample.

Experimental group subjects met the criteria of psychoactive substance dependence according to the DSM-III-R (1987) but were abstinent for at least one week before the evaluation. They were recruited in a special center devoted to the rehabilitation of young drug-abusers located in Bogotá (Colombia). Most of the experimental subjects were polydrug-abusers, including solvent inhalation, marijuana, "basuco," gasoline sniffing, and alcohol. No subject presented a major positive neurologic (head trauma, epilepsy, etc.), or psychiatric (DSM-III-R, 1987) disorder at the moment of the evaluation, but several of them had presented some neurological and/or psychiatric symptomatology associated with substance abuse, including seizures, feeling of being persecuted, delirium, and loss of consciousness.

Marijuana and "basuco" were measured in number of cigarette per day the subject smoked. As a matter of fact, the amount of marijuana and "basuco" in a cigarette is somehow variable and depends upon its "quality." Solvent inhalation was measured by the number of times (daily or weekly) that the subject deliberately inhaled for intoxication. Gasoline inhalation was measured also by the number of times (daily or weekly) that the subject deliberately inhaled for intoxication. It has been calculated that 15–20 breaths of gasoline will cause several hours of euphoric intoxication (Hartman, 1988). Alcohol was measured in the reported number of bottles (litres) of *aguardiente* the subject drank daily or weekly (not other alcoholic drink but Colombian *aguardiente* was used). *Aguardiente* contents about 39% of alcohol.

Table 2 presents the characteristics of psychoactive substance abuse in the experimental group.

Control group subjects were taken from different schools in Bogotá. They were selected to match the experimental group subjects in age, socioeconomical status, and educational level. None of them presented a history of psychoactive substance use. No subject presented a major neurological disorder (i.e., head trauma, epilepsy), or psychiatric illness (DSM-III-R, 1987).

Instruments

A neuropsychological test battery was individually administer to each subject. The following sections and subtests were included:

Language:

(a) automatic language (days of the week): one point if correct; half a point if correct only after two-three attempts. Maximum score = 1;
(b) language repetition: four syllables (maximum score = 4), five words (maximum score = 5), and three sentences (maximum score = 3);
(c) naming of 20 objects with a different level of difficulty (maximum score = 20);
(d) language comprehension (six progressively complex verbal commands), maximum score = 6; and
(e) verbal fluency (to search words with four letters beginning with the letter "p" in one minute).

Perceptual recognition:

(a) Visual recognition of 10 overlapped Poppelreuter-type figures (maximum score = 10);
(b) Auditory recognition of 10 natural sounds (keys, hammering, sewing, etc) using a tape recorder (maximum score = 10);
(c) Tactile recognition of 10 objects (coin, key, pencil, etc.), with the left hand (maximum score = 10), and with the right hand (maximum score = 10).

Memory:

(a) Delayed recall of the three sentences used in language repetition section (maximum score = 3); and

TABLE 2
Characteristics of Addictions in the Experimental Group. Solvent and Gasoline are Presented in Frequency Per Day, Week, or Month. Marijuana and Crack Dosage are Given in Cigarettes Per Day. The Amount Correspond to the Last Dosage Used by the Subject.

			Solvents		Marijuana		"Basuco"		Gasoline		Alcohol	
Subject	Age	Gender	amount	lifetime	amount	lifetime	amount	lifetime	amount	lifetime	amount	lifetime
1	16	M	daily	1 month	10	4 months	10	2 months				
2	15	M			1	1 year						
3	15	M	3 weekly	1 year	2	3 months						
4	15	M					1	3 years				
5	15	M			6	8 months	3	4 months				
6	14	F							daily	2 years		
7	16	M			5	6 months						
8	15	M	daily	6 months	2	1 year	1	2 years				
9	16	M	daily	3 years	2	6 years	1	3 years				
10	16	M	daily	2 months	7	2 years						
11	16	M			4	2 years	5	7 years				
12	17	M			4	3 years	8	6 months			1 bt wk	6 mths
13	17	M			1	2 years	6	2 years	weekly	3 years		
14	16	M	daily	3 years	3	5 years	20	4 years				
15	16	M			5	2 years					1/2 bt dy	3 yrs
16	17	M	daily	3 years	8	8 years	2	8 years	daily	3 months		
17	15	M	monthly	1 year	10	2 years	2	2 years				
18	17	M			1	3 years	1	3 years				
19	14	M	daily	2 years	2	2 years	1	2 years				
20	14	M	daily	1 year	5	3 years			daily	3 years		
21	17	M	daily	18 months	3	7 years	20	7 years				
22	16	M			6	2 months	3	2 years				
23	17	M	daily	6 months	2	2 years	20	2 months				
24	17	M			1	6 months					1 bt wk	5 years
25	17	M			6	5 years	2	3 years	daily	4 months	2 bt wk	3 years
26	15	M			7	1 year	1	3 years			1 bt wk	2 years

TABLE 3
Average Scores in the Language Subtests

	Experimental Group	Control Group	Difference
Automatic language	.88	.95	.07
Repetition: syllables	3.96	4.00	.04
words	4.80	4.89	.09
sentences	2.61	2.80	.19
Naming	16.80	16.92	.12
Comprehension	4.36	4.78	.42
Verbal fluency	9.16	9.67	.51

(b) Delayed reproduction of the Rey-Osterrieth Complex Figure (Osterrieth, 1944). Taylor's scoring system (Lezak, 1983) was used (maximum score = 36).

Practice abilities:

(a) Alternating movements with both hands (maximum score = 1).
(b) Tapping following a rhythm with one hand and the other (maximum score = 1).
(c) Imitation of three movements: the examiner performs three movements with the right hand; the subject is required to repeat these movements (correct = 1; if two-three repetitions are required = .5); and
(d) to cross one's self (with the right and the left hand) (correct with both hands = 1; correct only with one hand = .5).

Procedure

Subjects were interviewed to determine eligibility. Using a structured interview, subjects were asked about demographic data, developmental, family, and medical history, and history of substance abuse. Subjects who met the criteria for participation in the study were then administered the battery of neuropsychological tests. Testing time was approximately 30 minutes.

RESULTS

Table 3 presents the results in the different language subtests. Although all the mean scores were higher in the control than in the experimental group, none of the differences reached a statistical level of significance.

Table 4 presents the results obtained in the different perceptual, memory, and praxic ability subtests. Scores were higher in the control group, excepting Recognition of Overlapped Figures, Tactile Recognition with the right hand, and Rey-Osterrieth Complex Figure-delayed reproduction. However, none difference reached a statistical level of significance.

Finally, correlations between subtest scores, and amount and lifetime use of marijuana, "basuco" and solvent inhalation were calculated. Results are presented in Table 5. In general, correlations are negative: higher the amount and longer the lifetime use of psychoactive agents, lower the scores in the neuropsychological testing. However, only for automatic language, language repetition, language compre-

TABLE 4
Average Scores in the Perceptual, Memory, and Praxic Ability Subtests

	Experimental Group	Control Group	Difference
PERCEPTUAL SUBTESTS			
Overlapped figures	9.55	9.16	−0.39
Auditory recognition	6.81	7.05	.24
Tactile recognition: left hand	9.08	7.97	−1.11
right-hand	6.65	5.45	−1.25
MEMORY SUBTESTS			
Recall of sentences	1.88	1.94	.06
Complex Figure—Delayed	19.77	19.16	−0.61
PRACTIC ABILITY SUBTESTS			
Alternating movements	.65	.84	.19
Tapping	.85	.95	.10
Imitation of three movements	.65	.66	.01
To cross one's self	.31	.50	.19

hension, tactile recognition, and alternating movements, statistically significant correlations are observed. Correlations between amount and scores are higher than correlation between lifetime and scores.

DISCUSSION

Several shortcomings must be emphasized in this research study. First, the sample was quite heterogenous with regard to the characteristics of psychoactive substance abuse. Our experimental subjects used from one to four different substances. Doses were quite variable. Some of the experimental subjects could be considered as heavy abusers, while others should be regarded just as mild abusers. Second, the neuropsychological testing was limited. No IQ testing was performed. No attentional or conceptual abilities were tested. Third, the sample size was small. And finally, lifetime use of psychoactive substances was notoriously variable, ranging from just several months to eight years. Potential differences between both experimental and control group may have been obscured because of all these reasons.

Nonetheless, control subjects in general outperformed experimental subjects, particularly in language and practic ability subtests. However, in no single subtest differences reached a statistical level of significance.

Our results, in consequence, point to a mild cognitive impairment associated with psychoactive drug abuse. The significant correlations observed with lifetime use and amount of psychoactive drug abuse support the assumption that drug-abuse could be responsible for the decreased performance in some neuropsychological tests. These results are consistent with previous research about neuropsychological effects of psychoactive substance abuse (e.g., Ardila & Rosselli, 1991; Brunhn & Maage, 1975; Brhun et al., 1981; Carlin, 1986; Carlin Strauss, Grant & Adams, 1978; Parsons & Farr, 1981; Press, 1983; Rosselli & Ardila, 1993).

It could proposed that cognitive impairments in drug-abusers were not evident because: (1) lifetime use was limited, due to the age of the subjects; and (2) in adolescents and pre-adolescents, toxic effects of drug-abuse could be manifested as a decrease in the rate of cognitive development rather than as a general cognitive decline.

TABLE 5
Experimental Group. Correlations Between Psychoactive Drugs Use (Lifetime in Months, and Quatification According to the Procedure Explained in the Text) and Scores in the Different Neuropsychological Subtests

	marijuana		"basuco"		solvents	
Subtest	amount	lifetime	amount	lifetime	amount	lifetime
Automatic language	.04	−.00	.03	−.23	−.16	−.31*
Repetition: syllables	−.49**	−.03	−.06	−.03	.01	.02
words	−.38*	−.04	−.19	−.19	−.11	−.29*
sentences	−.15	−.09	−.08	−.13	−.07	−.20
Naming	−.03	−.13	.16	.10	.05	.10
Comprehension	−.15	−.01	−.59**	−.05	.05	−.10
Verbal fluency	−.06	−.00	−.23	−.05	−.21	−.07
Overlapped figures	.04	−.02	.15	.04	−.08	.04
Auditory recognition	−.01	.02	.08	−.02	−.02	.01
Tactile recognition: left hand	−.03	−.22	−.08	.13	.12	.18
right-hand	−.10	−.30*	.06	−.12	−.07	−.10
Recall of sentences	.15	.15	.24	.08	.04	.07
Complex Figure—Delayed	−.17	−.03	−.01	−.13	.00	−.09
Alternating movements	−.29*	−.01	−.08	−.09	−.08	−.11
Tapping	−.12	−.05	−.08	−.12	−.12	−.17
Imitation of three movements	−.21	.15	.05	.10	.13	.08
To cross one's self	.00	−.08	−.16	−.13	.01	−.13

*$p < .05$
**$p < .01$

Evidently, further research is required to pinpoint the cognitive effects of psychoactive substance abuse in young subjects.

REFERENCES

Adams, K. M., Rennik, P., Schooff, K., & Keegan, J. (1975). Neuropsychological measurement of drug effects: polydrug research. *Journal of Psychodelic Drugs, 7*, 151–160.

American Psychiatric Association. *Diagnostic Statistical Manual of Mental Disorders-III-R*. (1987). Washington: American Psychiatric Association.

Ardila, A. & Rosselli, M. (1986) *Neuropsicologia del fenómeno del envejecimiento* [Neuropsychology of aging]. Medellin (Colombia): Prensa Creativa.

Ardila, Rosselli, M. & Strumbasser, S. (1991). Neuropsychological effects of cocaine abuse. *International Journal of Neuroscience, 57*, 73–79.

Bateman, D. A. & Heagarty, M. C. (1989). Passive freebase cocaine (crack) inhalation by infants and toddlers. *American Journal of Disabled Children, 143*, 25–27.

Berg, R. A. & Kelafant, G. A. (1992). Neuropsychological sequelae of chronic organic solvent exposure. Pittsburgh, PA.: The 12th Annual Meeting, National Academy of Neuropsychology.

Brhun, P., Arlien-Soberg, P., Gyldensted, C. & Christensen, E. L. (1981). Prognosis in chronic toxic encephalopathy. *Acta Neurologica Scandinavica, 64*, 259–272.

Bruhn, P. & Maage, N. (1975). Intellectual and neuropsychological functions in young men with heavy and long-term patterns of drug abuse. *American Journal of Psychiatry, 132*, 397–401.

Carlin, A. S. (1986) Neuropsychological consequences of drug abuse. In: I. Grant, & K. M. Adams (Eds) *Neuropsychological assessment of neuropsychiatric disorders*. New York: Oxford University Press, pp. 478–497.

Carlin, A. S., Strauss, F. F., Grant, I., & Adams, K. M. (1978). Prediction of neuropsychological impairment in polydrug abuse patients. *Addictive Behavior, 5*, 229–234.

Carlin, A. S. & Trupin, E. (1977). The effects of long term chronic cannabis use on neuropsychological functioning. *International Journal of Addiction, 12*, 617–624.

Cherukuri, R., Minkoff, H., Feldman, J., Parekh, A. & Glass, L. (1988). A cohort study of alkaloidal cocaine ("crack") in pregnancy. *Obstetric-Gynecology, 72*, 147–151.

Edling, C. (1985). Nervous system symptoms and signs associated with long-term organizc solvent exposure. *Chronic effects of organic solvents on the central nervous system and diagnostic criteria* (pp. 149–155). Copenhaguen: World Health Organization.

Gawin, F. H. & Kleber, H. (1986). Abstinence symptomatology and psychiatric diagnosis in cocaine abusers. *Archives of General Psychiatry, 43*, 107–113.

Gawin, F. H. & Ellinwood, E. H. (1988). Cocaine and other stimulants. Action, abuse and treatment. *New England Journal of Medicine, 318*, 1173–1182.

Golbe, L. I. & Merkin, M. D. (1986). Cerebral infarction in a user of free-base cocaine ("crack"). *Neurology, 36*, 1602–1604.

Grant, I., Adams, H. K., Carlin, A. S., & Rennik, P. M. (1977). Neuropsychological deficits in polydrug abusers. *Drug and Alcohol Dependence, 2*, 91–108.

Grigsby, J., Rosenberg, N., Dreisbach, J., Busenbark, D., & Grigsby, P. (1992). Chronic toluene abuse produces neurologic and neuropsychological deficits. Pittsburgh, PA.: The 12th Annual Meeting, National Academy of Neuropsychology.

Hartman, D. E. (1988). *Neuropsychological toxicology*. New York: Pergamon Press.

Heaton, R. K. (1981). *Wisconsin Card Sorting Test: Manual*. Odessa, Fla: Psychological Assessment Resources.

Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *The Boston Naming Test*. Philadelphia: Lea & Febiger.

Kaye, B. R. & Fainstat, M. (1987). Cerebral vasculitis associated with cocaine abuse (letter). *JAMA, 257*, 1175.

Levine, S. R., Washington, J. M., Jefferson, M. F., Kiernan, S. W., Moen, M., Feit, H., & Welsh, K. M. (1987). Crack cocaine-associated stroke. *Neurology, 37*, 1849–1853.

Lezak, M. D. (1983). *Neuropsychological assessment*. New York: Oxford University Press.

Manschreck, T. C., Laughery, J. A., Weinstein, C. C., Allen, D., Humblestone, B., Neville, M., Podlewski, H., & Mitra, N. (1988). Characteristics of freebase cocaine phychosis. *Yale Journal of Biological Medicine, 61*, 115–122.

McKittrick, T., Grinvalds, V., Haut, J. & Franzen, M. D. (1992). Verbal fluency in adolescent substance abusers. Pittsburgh, PA.: The 12th Annual Meeting, National Academy of Neuropsychology.

Marsden, C. D. (1985). Assessment of dementia. In J. A. M. Frederiks (Ed) *Handbook of Clinical Neurology, vol. 46: Neurobehavioral disorders*. Amsterdam: Elsevier, pp. 221–232.

Mikkelson, S., Browne, E., Jorgensen, M. & Gyldensted, C. (1985). Association of symptoms of dementia with neuropsychological diagnosis of dementia and cerebral atrophy. In *Chronic effects of solvents on the central nervous system and diagnostic criteria*. Copenhaguen: World Health Organization, pp. 166–184.

Miller, N. S., Gold, M. S. & Milman, R. L. (1989). Cocaine. *American Family Physician, 39*, 115–120.

Osterrieth, P. A. (1944). Le test de copie d'une figure complexe. *Archives de Psychologie, 30*, 206–356.

Parsons, E. S. & Farr, S. D. (1981). The neuropsychology of alcohol and drug abuse. In: S. B. Filskov & T. S. Boll (Eds), *Handbook of Clinical Neuropsychology, vol. I*. New York: Wiley, pp. 320–265.

Pérez, A. (1987). *Cocaina: surgimiento y evolución de un mito*. Bogotá: Catálogo Cientifico.

Poklis, A. & Burkett, C. D. (1977). Gasoline sniffing: A review. *Clinical Toxicology, 11*, 35–41.

Press, R. J. (1983). *The neuropsychological effects of cocaine and opiate use*. Ann Arbor: University Microfilms International.

Reitan, R. M. & Wolfson, D. (1985). *The Halstead-Reitan Neuropsychological Battery. Theory and Clinical Interpretation*. Tucson, Arizona: Neuropsychology Press.

Rosselli, M. & Ardila, A. (1993). Neuropsychological profile of cocaine abusers. Galveston, TX: XXI Annual Meeting International Neuropsychological Society.

Satz, P., Fletcher, J. M. & Sutker, L. S. (1976). Neuropsychological, intellectual, and personality correlates of chronic marihuana use in native Costa Ricans. In: R. Dornbush, A. M. Freedman & M. Fink (Eds), *Chronic cannabis use. Annals of the New York Academy of Sciences, 282*, 266–306.

Victor, M. & Adams, D. R. (1985). The alcoholic dementias. In: J. A. M. Frederiks (Ed), *Handbook of Clinical Neurology, vol. 46: Clinical Neuropsychology*. Amsterdam: Elsevier, pp. 335–350.

Washton, A. M. & Gold, M. S. (1984). Chronic cocaine abuse: Evidence and adverse effects on health and functioning. *Psychiatric Annals, 17*, 733–743.

Washton, A. M. & Tatarsky, A. (1984). Adverse effects of cocaine abuse. *National Institute of Drug Abuse: Research Monograph Series, 49*, 247–254.
Wechsler, D. (1945). A standardized memory scale for clinical use. *Journal of Psychology, 19*, 87–95.
Wechsler, D. (1974). *WISC-R: Manual*. New York: Psychological Corporation.
Wright, M. & Hogan, T. P. (1972). Repeated LSD ingestion and performance on neuropsychological tests. *Journal of Nervous and Mental Disease, 154*, 432–438.
Wyatt, R. J., Fawcett, R. & Kirch, D. (1989). A possible animal model of defect state schizophrenia. In: S. C. Schulz, & C. A. Tamminga (Eds), *Schizophrenia: Scientific progress*. New York: Oxford University Press.