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THE EFFECTS OF CIGARETTE SMOKE
ON GLOBAL/LOCAL TASK PERFORMANCE

by Mary L. Gonsalves, B.Sc., B.A., M.A. (Pastoral Studies)

A thesis submitted to the
Faculty of Graduate Studies and Research
in partial fulfilment of the requirements
for the degree of Master of Arts

Department of Psychology

Carleton University
Ottawa, Ontario
April 28, 1995

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ABSTRACT

Previous research determined a negative dose response relationship between maternal smoking during pregnancy and auditory/language processing in the offspring. Also, other previous research has suggested that local (detailed) and global (configural) processing of a visual scene parallel verbal and spatial processing respectively. An objective of the present study was to replicate the above findings, with a primary focus on examining the vulnerability of local processing to the effects of smoking. To accomplish the above objective, a global/local perception task was administered to smoking and non-smoking groups. Additionally, to determine the validity of the perception task, the local task scores were compared with a standardized verbal test scores (Peabody Picture Vocabulary Test - Revised (PPVT-R)), and the global task scores with a standardized spatial test scores (Raven's Progressive Matrices, (RPM)).

The subjects were first year Psychology students. Based on a premeasure smoking history questionnaire, a four group experimental design was created: Group 1, the controls, non-smokers, not exposed *in utero*, and not exposed to the smoke of others (n=26); group 2, non-smokers, maternal active and passive *in utero* exposure, and regular secondhand exposure (n=28); group 3, current smokers, not exposed *in utero*, but exposed recently to secondhand smoke (n=27); and group 4, current smokers plus exposed *in utero*, and to regular secondhand smoke (gp. 4, n=20).

Additionally, two passively exposed groups were created to examine the effects of secondhand smoke: Group 5, non-smokers, exposed only 2-3 years prior to testing ($n=24$); and group 6, non-smokers, exposed only 6-12 months prior to testing.

The subjects ($n = 147$) filled out a detailed smoking history questionnaire. They also completed a global and a local letter identification task (counterbalanced) presented on a PowerBook Macintosh computer. For the global task, they were required to identify only the large (global) letter, and for the local task, only the small (local) letter. Additionally, the subjects gave a self perception report on their performance on the global/local tasks. Finally, they completed the standardized tests (PPVT-R, and the RPM). All of the above tasks yielded six outcome measures. Two accuracy of recall and latency measures for each of the global/local tasks, and two correct responses for the standardized tests.

Several statistical analyses (e.g., multivariate analysis of variance, factorial analysis of variance, and Pearson product-moment correlations) were conducted on the data of the present study to test the following hypotheses: smokers (active, *in utero*, and secondhand exposure) will make more errors on the local task compared to the controls; there will be no difference in the global task performance for the smokers and nonsmokers; and the standardized verbal and spatial test scores will correlate with the local and global perception task scores respectively.

Two principle findings were noted in the present study. First, when performance was compared on the perception task, trend wise,

in utero effects (for gp. 2) seemed to indicate a vulnerability to processing the local task as predicted (higher errors). Second, contrary to the prediction, trend wise, the current smokers (gps. 3 and 4) performed better on the local task. The second results find support in the literature on current smoking and psychomotor performance which suggests that nicotine enhances higher accuracy responses, and faster reaction time by promoting concentration and focused attention on reaction time tasks. The direction of the results for the above two findings suggest that current smoking effects overwhelm *in utero* effects.

The results obtained for the current smoking plus exposed *in utero* group (gp. 4) are puzzling and difficult to interpret. That is, trend wise, their accuracy scores were higher than the non-smoking groups, but, when group 4 was categorized for dose response effects, the heavy smokers (compared to light and moderate) in the group performed the worst on the local task.

The global and local task scores did not correlate with the verbal and spatial test scores as predicted. On the verbal test, the current smokers (gp. 3) performed poorly, and the *in utero* groups (gps. 2 and 4) performed the best. Some suggestions are offered for these results.

In summary, the trends point to the vulnerability of *in utero* effects to processing the local task, or, to current smoking overwhelming *in utero* effects. Several limitations are discussed with respect to the non-significant findings in the present study, and some recommendations are made for future studies.

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To my mother, and my friend Charles, thank you for your continued faith in me.

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I INTRODUCTION

As the twentieth century draws to a close, we continue to see a definite and increasing concern in the literature on the use of tobacco as one of the most widespread forms of self-administered drugs. Epidemiological evidence suggests that cigarette smoking is frequently associated with the use of other soft drugs, which adds to health complications in the individual.

Two distinctly related areas associated with active and/or passive tobacco use that are of interest to health and educational professionals are: a) health issues; and b) incidence of smoking. The issues related to health and smoking imply a host of concerns, ranging from: *in utero* exposure; the physical formation of the newly developing fetus; the birth of the child; the impact of active and passive smoking; and, the continued physical and intellectual development of the human person into adulthood. Epidemiological data on smoking on the other hand provides information on the numbers and habits of a smoking population.

.1 Incidence of Smoking

Smoking among a General Canadian Population

National health surveys in Canada (Health and Welfare, 1976; 1977; 1985; 1992) map some very definite trends in the smoking habits of Canadians. There has been a steady decline in the percentage of Canadian smokers from the years 1965, to 1989. For instance, 45.3% smoked in the years from 1965 to 1977; 34% smoked in 1985; and the latest report (1992) for 1989 indicated that 32% Canadians still smoked.

The overall decline in smoking among Canadians is due to male smokers. That is, in the 1960s and 1970s, approximately 48% smoked, and this figure was later reported to be 34% in 1985, and 32% in 1989. For women smokers on the other hand, the decline in smoking was not a marked one. However, there was a stabilization in the smoking habits of women through the years 1965 to 1989, from approximately 32% to 31%.

Of particular interest to this study, are the smoking habits of teenagers and young adults, as the average age of the subjects in the present study is 21.9 years. The reports indicated that, although teenagers 15 to 19 years of age showed a steady increase in their smoking habits through the 1960s and 1970s (46%), the survey for 1989 suggested a decline in smoking among male and female teenagers (23%). However, a reversal in this downward trend has

since been reported (Fried, P. Personal communication, September 27, 1994).

Overall, the surveys indicate that although the percentage of current smokers in Canada has gradually declined (from 50% to 32%) from 1965 to 1989, the rate of smoking among Canadians is one of the highest in the world.

The latest (1992) report concluded the following on the smoking status for Canadians: men and women, 15 to 34 years of age, were similar in their smoking habits; of smokers older than 34 years of age, it was noted that there were 3 to 5% more male smokers than women smokers. In general, the highest number of smokers (35% to 37%) were found to be between 20 to 54 years of age for both sexes, and lowest among teenagers and older Canadians (23% to 19%).

The number of cigarettes smoked each day differed between men and women. For instance, 13% male, compared to 6% female smoked more than 25 cigarettes per day. Of those (male and female) who smoked more than 25 cigarettes per day, the report showed an increase for smokers 20 to 54 years of age, and a decrease for people younger than 20 and older than 54 years of age. This information is of interest to the pregnancy data (discussed later) for this study, as women of childbearing age represent the 15 to 45 age group.

Recently, there has been a marked change in the smoking habits of teenagers. Although Health and Welfare (1992) had reported an overall steady decline in the percentage of smokers in general and in teenage smokers since 1965, a recent study showed that the daily smoking rates among the 8th, 10th, and high school seniors had increased from 7.0, 12.3, and 17.2 percent in 1992 to 8.3, 14.2, and 19.0 percent in 1993 respectively (NIDA, 1994). The Health and Welfare (1992) figures for smokers in general showed a greater decrease for men (21%) than it did for women (3%) since 1965, but in 1989, 32% males, and 31% females still maintained their smoking habit.

Although reports from Health and Welfare Canada indicate a decline in the number of people who smoke, there is still a concern for the well-being for both the child and the adult by health and educational professionals. This concern is based on the information that the rate of smoking among heavy smokers has not changed.

Incidence of smoking among Canadian pregnant women

A most widely researched area is on the effects of cigarette smoke on the unborn child, which reflects to a certain degree the significant number of pregnant women who smoke (Fried, 1993). Fried and associates have conducted several studies as part of a local and ongoing project, the Ottawa Prenatal Prospective Study (OPPS) on the association between marijuana, cigarettes, and alcohol consumed during pregnancy and the effects upon the offspring.

In an early study by Fried, Innes, and Barnes (1984), a comparison was made between a 1978/79 cohort ($n=217$), and a 1980/82 cohort ($n=190$) in the amount of nicotine consumed. Results revealed a fairly consistent pattern in drug use over the years (1978-1982). It was found that 13% in both groups averaged more than 16 mg of nicotine per day in the year before pregnancy, and 8% continued that amount in the first trimester. The first group showed no decline in heavy smoking between the first and second trimesters, and a slight decrease (5%) between the first and third trimesters. However, for the second group there was a 19% decrease in heavy smoking between the first and second trimester and a 25% decrease between the first and third trimester.

In a subsequent study, the OPPS showed that there was a downward trend for heavy smokers (12%) in the first year before pregnancy; 7% in the first trimester; and 5% by the third trimester (Fried, Barnes, & Drake, 1985).

An OPPS summary report (Fried, 1992) indicated that those women ($n=288$) who had reduced their cigarette smoking during pregnancy, continued to smoke at a reduced rate during the first month after giving birth. For these women, the non-smoking rate was 80% and the heavy smoking rate was 4%. One year following the birth of the baby, the above figures for non-smokers was 75%, and the heavy smokers remained at approximately equal to that noted in the third trimester.

In general, compared with the national surveys cited earlier, the OPPS reported a smaller decrease in the number of women smokers of child bearing age. For instance, after pregnancy was confirmed, 50% of light smokers, and 90% of heavy smokers continued to smoke (Fried et al., 1985).

Information on heavy smokers is important for the present study. A number of studies suggest that many of the deleterious effects of smoking for the fetus are related to carbon monoxide (CO), which increases directly with the number of cigarettes smoked. CO is also known to add stress to the heart of the adult smoker. As a result, the heart has to work harder due to a 15% loss in oxygen-carrying capacity of the blood (Avis, 1993).

Adams, Brogan, Kendrick, Shulman, Zahniser, Bruce (1992) reported findings contrary to the OPPS studies. That is, 70% women from a population-based sample ($n = 6319$), who quit smoking during pregnancy, resumed or increased their smoking to nearly pre-pregnancy levels after delivery. Interestingly, their speculation on their findings was attributed to the powerful addictive nature of tobacco, and to a lack of postpartum counseling by health professionals on the effects of cigarette smoke. However, the authors state that further investigation is necessary to account for the resumption of smoking in pregnant women after giving birth.

A parallel concern addresses the involuntary nature of smoke inhaled by non-smoking pregnant women. For instance, studies

unrelated to the OPPS reported that 35% of non-smoking pregnant mothers had been regularly exposed to a smoke-filled environment (Martin, & Bracken, 1986; Smith, Austen, & Rolles, 1982). Other reports show that between one-third and one-half of non-smoking pregnant women are involuntary or passive smokers (Karakostov, 1985; Martin, & Bracken, 1986; Smith et al., 1982).

Constituents of Tobacco Smoke and associated Health Risks

At this point, it may be of interest to briefly look at the constituents of tobacco smoke (active and passive), and to speculate on who might be at high risk to suffer from its effects, both physically and intellectually. According to the National Research Council (1986), there are 3,800 compounds in cigarette smoke. Nicotine and carbon monoxide are suspected to be the two major compounds that cause deleterious effects on the fetus, the child, and the adult.

In general, each cigarette may contain up to 6-8 mg. of nicotine, and depending on the amount consumed, nicotine is known to have a vasoconstrictive effect on peripheral blood vessels. In the pregnant women, this constriction results in decreased fetal blood supply (Fried & Oxorn, 1980; Longo, 1982). In addition, when nicotine crosses the placenta, it directly affects the fetus. One known negative effect of nicotine, is on the development of the fetal respiratory system (Longo, 1982).

Carbon monoxide on the other hand, makes up 4% by volume of cigarette smoke (Meyer & Tonascia, 1977). The rate and depth of inhalation by the smoker determines the amount of possible damage. Carbon monoxide acts to reduce oxygen supply to the fetus, and it elevates the level of carboxyhemoglobin in the blood of the pregnant woman, as hemoglobin binds more readily with carbon monoxide than it does with oxygen. Like nicotine, carbon monoxide also crosses the placenta, but seems to have a stronger and longer lasting effect on the fetus than does nicotine, due to the slower metabolic and elimination rate of the fetus (Longo, 1982). Thus, it may be that the vasoconstrictive effects and carbon monoxide together are the contributors to the well known association between maternal smoking and lowered birth weight (Dunn, McBurney, Ingram & Hunter, 1977; Fried & Oxorn, 1980; Hardy and Mellits, 1972).

Having looked at the risk factors of tobacco smoke for the fetus and the neonate, we briefly turn to the literature that focuses on the adult. For the adult who may become addicted to nicotine and other substances present in tobacco, there is an added risk of becoming susceptible to diseases of the heart; to pulmonary diseases; and to various forms of cancer, such as lung, throat, esophagus, stomach, and bladder (Maisto, Galizio, Connors, 1991; Avis, 1993). Therefore, it appears that tobacco use may have a causal role in a number of potentially life-threatening disorders. These authors state that nicotine is linked to accelerated heart rate, and to possible cardiac problems due to stress on the adult heart. Furthermore, when

inhalation is deep, carbon monoxide also appears to facilitate many disease processes associated with smoking, which are known to target the brain and heart (Maisto et al., 1991).

More recently, there is an increased general interest in the effects of passive smoke, which is reflected in many campaigns to prevent or lessen smoking in public areas. This concern stems partly from the literature that indicates that the content of second hand smoke has a wide range of effects on the non-smoker who is exposed.

Passive smoke is smoke-contained air breathed in by a second person. This air is composed of smoke exhaled by a smoker, and of smoke that leaves the burning end of the cigarette, also known as sidestream smoke. Factors taken into account when looking at the adverse effects of passive smoke, are the amount of smoke produced by the smoker, which is related to the depth of inhalation; the ventilation available in the smoking area; the nearness of the non-smoker to the smoker; and the duration of the exposure to the smoke (Report of the Surgeon General, 1972).

The constituents of passive smoke, both secondhand and side stream are difficult to measure. Samples of blood, urine, saliva and hair of non-smokers have been analyzed to establish the amounts of nicotine, and its metabolite, cotinine, that may have been absorbed into the system. These two compounds are known to be sensitive and specific indicators of exposure to tobacco smoke. In addition,

carbon monoxide is a major toxic element by weight in passive smoke (Collishaw, Kirkbride and Wigle, 1984).

Studies have consistently demonstrated a dose response relationship in children exposed to passive smoke at younger ages to respiratory illnesses such as bronchitis and pneumonia (Fielding & Phenow, 1988). In addition, middle-ear effusions and related ear infections in children four years of age and younger have also been found in several investigations in children exposed to parental smoke (Etzel, Pattishall, Haley, Fletcher, & Henderson, 1992; Forastiere, Corbo, Michelozzi, Pistelli, Agabiti, Brancato, Ciappi, Perucci, 1992). The adult also is susceptible to a host of negative effects associated with exposure to passive smoke, including migraines, mild headaches, fatigue, and also, potentially adverse effects in patients with coronary heart disease (Wilbert, 1978).

In summary, in consideration of the findings on the effects of cigarette smoke presented above, when one looks at the various possibilities tobacco fumes has for causing ill health and/or death, it comes as no surprise that diseases caused by the effects of regular tobacco use, such as heart and lung diseases are one of the leading causes of death (Maisto, Galizio, Connors, 1991; Schlaadt, Shannon, 1990). Continued research in the incidence and effects of tobacco use is therefore of paramount interest to the well-being of all human beings.

The preceding has been a brief overview of the health consequences of active and passive smoking. This proposed thesis focused on another potential consequence of active and passive smoking, i.e., aspects of cognitive function.

2 Ottawa Prenatal Prospective Study (OPPS)

In keeping with an objective of the present study to examine the relationship between smoking (active, *in utero*, and secondhand) and performance on the perceptual task, a brief overview of the Ottawa Prenatal Prospective Study (OPPS) is outlined below (details summarized in Fried, 1992).

The OPPS is a longitudinal study which began in 1978. It initially involved 698 predominantly middle-class pregnant women from Ottawa, Ontario, who volunteered to participate in the testing of prenatal lifestyle habits and their effects on the offspring. Data were collected in a prospective fashion, and information on socioeconomic status, mother's age, health, previous pregnancy history, and father's medical history was collected. In addition, cigarette smoking, marijuana, and alcohol pattern use was recorded for these women, and a wide variety of pregnancy, neonatal, and early childhood outcome variables have been and are currently being assessed on these women. Of interest to the present study, are the offspring of the OPPS pregnant women who smoked.

The pregnant women of the OPPS study were categorized into non-smoking, light, and heavy smoking groups. The average number of cigarettes smoked per day was recorded, and a nicotine score was derived by multiplying the number of cigarettes smoked daily by the nicotine content of the brand specified. The heavy smokers smoked

the equivalent of 16 mg nicotine/ day or more, which corresponded to approximately one package of cigarettes of average strength. In addition, in order to study the possible effects of passive smoke, the women were asked if they had been regularly exposed to a smoke-filled environment.

OPPS - Auditory/Language Processing

Measurement Scales: The Ottawa Prenatal Prospective Study (OPPS) has conducted several longitudinal investigations on early childhood developmental performances on children born to smoking mothers. Among the tests from the OPPS neuropsychological battery administered to the infants and children, a number have involved auditory/language components. They include the:

Brazelton Neonatal Assessment scale (Brazelton, 1973);
Bayley Scales of Mental and Motor Development (Bayley, 1969);
Reynell Development Language Scales (Reynell, 1969);
McCarthy Scales of Children's Abilities Tests (McCarthy, 1972);
Peabody Picture Vocabulary Test - Form L (Dunn & Dunn, 1981),
Screening Test for Auditory Processing Disorders (Keith, 1986).

Aspects of the above scales which tested for the auditory system involvement, and auditory/language processing were of particular interest to the present study. They were, the Brazelton Neonatal Assessment scale, which is administered within the first few days of life, and measures the newborn's responsiveness to his

or her environment. The Mental Developmental Index (MDI), and the Infant Behavior Record (IBR) are components of the Bayley test. The MDI assesses sensory perceptual abilities, early acquisition of object constancy, memory, problem solving, vocalization and the onset of words, and is used to test children from one to 2 1/2 years of age, while the IBR evaluates the infant's attitudes, interests, and temperament. The Reynell Development Language Scales measures language comprehension and expression, and is standardized for children in the age range of 1-7 years. The McCarthy Scales of Children's Abilities is based upon six scales: verbal, perceptual performance, quantitative, memory, and motor, used in the age range of 2 1/2 to 8 1/2. The Peabody Picture Vocabulary Test - Revised is a measure of receptive or "use" vocabulary in children from 2 1/2 to 18 years of age, and adults 19 to 40 years old. Finally, Screening Test for Auditory Processing Disorders (SCAN) is standardized for children from 3 to 12 years, to screen for auditory processing disorders.

Auditory Processing Consequences of Smoking

Observations in the Neonate: A number of studies suggest a relationship between maternal smoking in pregnancy and altered behavior in the neonate (Fried, 1986; Saxon, 1978). To test for possible altered behaviors, the Brazelton Neonatal Assessment scale was administered within the first few days of life to measure the newborn's responsiveness to his or her environment. A study using

canonical analysis and multiple regression, and controlling for caffeine and other drug use, obstetric medication, age of testing, family income, and maternal age, analyzed data on 250 infants at 3 and 6 days of age with the above scale. The results showed that prenatal cigarette exposure was associated with poorer auditory habituation to an auditory stimulus (Fried & Makin; 1987).

The above findings have been reported in several non-OPPS studies. For instance, Saxon (1978) found a decreased hearing response and a decreased rate of habituation in 4- to 6-day-old babies born to pregnant women who smoked. And Picone, Allen, Schramm, and Olsen (1982), and Jacobson, Fein, Jacobson, Schwartz, and Dowler (1984), found poorer auditory responsiveness in 2- and 3-day-old, and 3- and 4-day-old infants born to smokers respectively. The results by Jacobson et al. however, were at marginal statistical significance.

Observations in Infants and Young Children: The OPPS and other studies indicate that regular and periodic monitoring of infants who have been exposed to active and passive smoke is essential for the examination of possible continuity effects in different aspects of auditory/language processing.

A study by Fried and Watkinson (1988) found results consistent with the neonatal observations reported above. That is, in 12 month old infants, prenatal exposure to cigarette smoke had a

significant negative association between auditory-related items as assessed by the IBR.

In another OPPS study (Kristjansson, Fried, Watkinson, 1989) on certain aspects of attentional behavior in four to seven year olds, the vulnerability of auditory functioning to prenatal cigarette exposure was noted when assessed by means of auditory and visual vigilance tasks. Cigarette smoking during pregnancy was statistically significantly related to auditory errors of commission but not to visual errors of commission.

Studies from the OPPS and others, consistently showed an association between maternal cigarette smoking and poorer performance by children on subscales of general tests that assessed the verbal domain and specific auditory/language tests. For instance, McCartney, Fried, and Watkinson (1994) examined whether *in utero* and postnatal exposure to maternal and passive cigarette smoke was related to central auditory processing in six to eleven year olds ($n=110$). A Screening Test for Auditory Processing Disorders (SCAN) was administered to the children. Three conditions, filtered words, auditory figure ground and competing words comprised the SCAN test. The results indicated a negative dose response association between maternal smoking and poor performance on the overall SCAN, and in particular, with the Competing Words subtest. This condition required that the child repeat pairs of words that were said in each ear separately and simultaneously. According to the authors, this task involved a greater degree of auditory processing than the

other two conditions of the SCAN test, and was therefore thought to be a more sensitive measure of the child's auditory maturation. As the SCAN task operates at a perceptual level, it was assumed that exposure *in utero* to smoke affected auditory processing, and this possibly resulted in impaired performance on auditory-based cognitive and memory tasks. This assumption was consistent with *in utero* neonatal observations of altered, non-verbal auditory responsiveness reported earlier (Fried & Makin, 1987; Jacobson, et al., 1984; Picone, et al., 1982; Saxton, 1978).

The study by McCartney et al. (1994) speculated on the underlying possible neurophysiological mechanisms for the relationship between maternal smoking and auditory functioning in the offspring. This involved examining the neurochemical alterations of the descending auditory system and its effect on altered responsiveness to sounds, and to poorer language acquisition and poorer performance on language-related tasks.

The studies cited above provide strong evidence that children with impaired auditory processing capabilities may experience difficulties in learning, and that this could be linked to *in utero* exposure to cigarettes.

General Measures of Language: The present section will look at some OPPS studies and their utilization of some widely used standardized measures (see p. 13) to assess aspects of language development. In an early study, Gusella and Fried (1984)

investigated 84 offspring at 13 months of age to test for verbal comprehension, spoken language, and fine motor skills. These children had been exposed to maternal social drinking, and to smoking associated with drinking. The three components of the Bayley test (Bayley, 1969) were administered. The Mental Developmental Index of the Bayley Test specifically measures aspects of language. After controlling for confounding variables, results indicated a negative relationship between verbal comprehension and smoking during pregnancy. These results were interpreted to indicate that these children experienced greater difficulty in understanding spoken language, which may be connected to delays in reading comprehension. Similar findings had been reported by Dunn, McBurney, Ingram, and Hunter (1977), who showed a negative association between maternal smoking and reading abilities in 7 year old "small-for-date" children.

Other OPPS studies (Fried & Watkinson, 1988; 1990; Fried, O'Connell, & Watkinson, 1992a; Fried, Watkinson, & Gray, 1992b) found significantly lowered Mental Developmental Index scores (many individual items are language based) in 12 month old infants ($n = 217$); this significance was not retained in 24 month old children ($n = 153$), nor was the Reynell Development Language Scales (Reynell, 1969) at this age. The authors concluded that postnatal environmental factors could play an increasingly greater role in determining the offspring's performance at two years of age.

A follow-up study (Fried & Watkinson, 1990) with the 36 ($n = 133$) and 48 ($n = 130$) month old children showed a negative dose-response association on the verbal subscale of the McCarthy, and on the expressive components on the Peabody and the Reynell, with maternal smoking after controlling for confounding variables (including a measurement of the home environment). At 60 ($n = 135$) and 72 ($n = 137$) months, similar findings were found as with the 36- and 48-month old children (Fried et al., 1992a). In addition, at 72 months, the key contributor, the Peabody Picture Vocabulary Test, a measure of receptive vocabulary remained significant after controlling for confounding variables (Fried et al., 1992a).

In addition to the OPPS studies, several other studies have looked at the relationship between maternal smoking and aspects of language processing (Dunn et al., 1977; Davies, Butler & Goldstein, 1972). As seen in the OPPS findings, Dunn et al. (1977) and Davies et al. (1972) reported an inverse relationship between maternal smoking and aspects of language processing. For example, Davies et al. (1972), working with a large sample ($n = 17,000$), found that smokers children, 7 years of age, were on average 3 to 5 months behind those of non-smokers children in reading ability. Follow-up studies indicated that these children continued to perform poorly in reading into their sixteenth year.

The above OPPS studies have consistently reported that in general, smoking during pregnancy was associated with a decrease in

verbal comprehension scores after adjusting for confounding variables. Of particular interest, were the McCarthy scores on the language subscale, as well as the other McCarthy subscales that showed a dose response relationship from 36 to 72 months. The children of the heavy smokers had average scores that were lower than the children born to the lighter smokers, who, in turn, did not perform as well as those born to non-smokers.

The negative effects of passive smoke are also apparent in language related problems. In one study, six to nine year old children of passive smokers performed more poorly on tests of speech and language abilities than did the children of non-smoking women, but less poorly than children of active smokers (Makin, Fried, & Watkinson, 1991).

Of importance to the present study, was the continuity of findings over various ages as demonstrated by the OPPS studies. That is, consistent effects were noted between auditory/language outcome variables and maternal smoking over a period of approximately 11 years. Such findings are encouraging with respect to one of the objectives of the present study. That is, the examination of the possible effects of cigarette smoke exposure on processes that are postulated to parallel auditory/language processing.

Thus far, a review of the health consequences of active and passive smoking, and the effects of maternal and passive smoking

and language impairment in offspring of smokers have been presented. The next section will discuss the perceptual processing of "global" and "local" visual stimuli with the objective of drawing a comparison between the processes underlying "local" analysis and verbal behaviour.

.3 A Cognitive View on Global/Local Processing

According to Navon (1977), the components or features of visual objects exist in a hierarchical order of different levels of perceptual organization, with the top of the hierarchy being more *global* and the bottom being more *local*. That is, the position of the visual objects within the hierarchy defines whether they are global or local forms (Navon, 1981). A hierarchy (Robertson & Lamb, 1991) refers to objects (local) nested or placed within other objects (global) which according to Palmer (1975), are interrelated by spatial relationships.

In keeping with the above definitions for global and local visual images, Navon (1977) designed stimuli called "compound letters." In general, the letters are large letters made up of similar (consistent) or dissimilar (inconsistent) smaller letters. For example, a consistent letter is a large H made up of small h's, and an inconsistent letter is a large H made up of small m's. Kimchi (1992) defines a compound letter as follows: "whenever small figures are positioned near each other in such a way that their positions form the pattern of a larger figure, the two levels of pattern structure (i.e., the global configuration and the local elements) are present regardless of the number and/or the relative size of the elements (p. 31)." Kimchi (1992) further states that "the larger and smaller figures of hierarchical patterns are levels of pattern structure, each is

assumed to be a stimulus on its own right, and not the property of the other level (p. 26)." Such a definition is supported by Kitterle, Christman, and Conesa (1993) who state that information at the global and local levels is distinct yet embedded within each other.

Working with the global/local construct, Navon (1977) took the position that a visual image is initially not clearly defined by the visual system, but that it becomes clearer and sharper the longer it is focused upon. Navon proposed a temporal organization of the components of visual objects such that processing of the global features is initiated prior to processing of local or fine-grained features. From the above, the ordering of the global to local processing formed the basis for Navon's (1977) global precedence theory which initially implied serial processing, with later (Navon, 1981) suggestions for parallel processing. The idea for serial processing was developed by Navon from earlier works (Flavell & Draguns, 1957) which state that processing of global features is done, or is terminated earlier than processing of local features. The processing of the local feature was considered optional (Navon, 1977).

In order to more fully explain global/local processing, the cognitive literature goes beyond the question of what level of the visual image is processed first. For instance, fundamental to the concept of global/local processing, is the concept of "spatial frequency," or "stimulus energy," a form of spectral information transmitted by the global/local stimuli. There are also specific

sensory parameters, such as exposure (presentation) duration, retinal eccentricity, spatial uncertainty, and directed attention to a particular level of the stimulus that influence global/local processing. According to Sergent (1983), the spatial-frequency spectral components of the stimulus extracted by the visual system is influenced by manipulating exposure duration, retinal eccentricity, and stimulus size, due to the level of stimulus energy available being affected.

Spatial Frequency

Several studies (Navon, 1981; Sergent, 1982; Paquet and Merikle, 1984; Shulman, Sullivan, Gish, & Sakoda, 1986) point to the relationship of spatial frequencies and global/local processing. Spatial frequency according to Sergent (1982) refers to an interplay of stimulus energy and luminance energy over time (exposure duration). That is, when luminance is constant, "stimulus energy covaries with variations in exposure duration, and influences the level of resolution (p. 348)." The author further states that global (larger letters) and local (smaller letters) aspects of a form are defined by spectral information, such that the global form transmits low spatial frequency information, and the local form transmits high spatial frequency information.

An important finding is that resolution by the visual system of spatial frequencies are directly effected by the length of time a stimulus is presented (exposure duration). According to Sergent

(1982), there is a differential effect on the global and local forms such that with decreased exposure duration, high spatial frequency is impaired, and therefore, local processing is impaired, and with increased exposure duration high frequency integration improves, thus facilitating local analysis.

Some studies suggest that the strength of global and local spatial frequency information is related to attention to a directed task. For instance, Shulman, Sullivan, Gish, and Sakoda (1986) showed a link between global level and low-frequency information interaction and between local level and high-frequency information interaction in a directed (global or local) letter identification task. Also, Paquet (1994) showed that when a subject is directed to attend to a particular task (global or local), identification of the attended local stimulus is delayed by the presence of global distracters, but that the attended global stimulus is not effected by the presence of local distracters.

Retinal Eccentricity

In global/local processing paradigms, the stimuli are generally presented either centrally (foveal) or in the periphery. Peripheral presentations are either in the left or the right visual fields. As the distance of the stimulus from the center of the screen (fixation point) increases towards the periphery, the visual angle (eccentricity) created from the fixation point, the stimulus, and the distance from the eye also increases. According to Navon (1981), most studies in

cognitive psychology employ stimuli subtended at no more than 5 to 6 degrees. The importance of peripheral presentations become apparent in studies (e.g., Kimchi, 1992) that report that sensitivity to both high and low spatial frequencies is greatest at the fovea (central) and diminishes with increased eccentricity. However, according to Shulman & Wilson (1987), the falloff in sensitivity with increased eccentricity is not as great for low as it is for high spatial frequencies. In other words, local level processing is impaired with increased peripheral presentation due to reduced high spatial frequencies in the periphery. The latter view is also reported by Navon (1981), who states that eccentricity favors low spatial frequencies (global processing), and thus local features are disadvantaged.

Exposure Duration

In addition to its effects on spatial frequencies, the length of time the stimuli are presented (exposure duration) also have important implications for the global and local stimuli interacting with each other. For instance, most studies (e.g., Navon, 1977) show that reaction time (RT) to identify the global stimulus is approximately 100 msec faster than RT to identify the local stimulus at most exposure durations. Additionally, Paquet and Merikle (1984) showed that short duration of the global and local levels (10-msec) results in the global stimuli inhibiting or interfering with the processing of the local stimuli, and long durations of both, the global

and local levels (40 and 100 msec respectively) results in a two-way interaction (facilitation of global to local, and local to global).

Several studies report the effects of exposure duration on impaired or degraded stimuli. For instance, a degraded stimuli may be of an inconsistent form where a large letter is composed of dissimilar smaller letters (e.g., a large H made up of small m's). Sergent (1982) looked at degradation of the stimuli and found that short exposure duration results in unidirectional interference. That is, for the local task, interference occurs when the stimuli are made up of inconsistent letters such that the global stimulus interferes with local processing. On the other hand, the above interference does not occur with a global task when the letters are inconsistent.

Spatial Uncertainty

Spatial uncertainty controls for habituation to the task. Knowing where the stimuli will appear (e.g., foveal vision) makes it easier to focus on the level of the stimuli (Navon, 1981; 1991), whereas if the location of the stimulus is uncertain (generally in the periphery and randomly assigned to different quadrants), (Lamb and Robertson, 1988) a mutual interference between the global and local levels is seen.

Directed Task

In his early work, Navon (1977) refers to the inevitability of global processing. That is, when attention is directed to a single level (global or local), Navon suggests that being aware of the other level will interfere with performance. In a similar line of thought, Navon (1981) suggests that "asking a subject to ignore them (global and local elements) may be as effective as asking him not to think of pink elephants (p. 8)." According to Moscovitch (1979), a directed task requires attention by the subject. However, he further states that in order to prime or facilitate the processing of the task, attention involves two critical aspects, a selection process, and effort by the subject. Thus, Navon's (1981) "pink elephants" and Moscovitch's "attention" both suggest a limited capacity by the subject to fully focus on a task that has more than one stimulus demands.

In an experiment involving attention to a directed task, Navon (1977) showed faster response time for the global level than for the local level. An important finding in his study was that the global pattern could be attended to without being affected by the local pattern, but that the local pattern was inhibited by the presence of the global pattern. Conversely, Paquet and Merikle (1984) found no significant difference due to directed attention, and concluded that longer exposure durations for both global and local levels (40 and 100 msec respectively) mitigate any effects attributed to directing attention to the task. Other findings (e.g., Hoffman, 1980) have shown that directing attention to a specific level (global or local)

facilitates performance equally for both global and local targets, while Paquet and Merikle (1988), and Paquet (1992) have shown that the global aspect of an attended object is identified faster and is more difficult to ignore than is the local aspect within an attended object. However, important to the above finding (Paquet, 1992) is that the direction of attention to the global or the local level of an attended object determines which level (global or local) of a nonattended object is harder to ignore.

.4 A Neuropsychological View on Global/Local Processing

Hemispheric Lateralization

In an attempt to address the global/local construct as a function of the brain, the neuropsychological literature points to several studies that provide an anatomical basis for the perception of visual stimuli using visuoconstructive, visuospatial tasks (Delis, Robertson, & Efron, 1986; Ober, Jagust, Koss, Delis, & Friedland, 1991; Robertson & Lamb, 1991; Delis, Massman, Butters, Salmon, Shear, Demadura, & Filoteo 1992). The question consistently addressed in the literature on visuospatial tasks is one of hemispheric lateralization. A helpful starting point offered by Moscovitch (1979) is a categorization of specialization for the two hemispheres: the left hemisphere is considered linguistic, voluntary, linear, logical, and sequential, and the right hemisphere as spatial, automatic, synthetic, appositional, and holistic.

Furthermore, Moscovitch (1979) emphasized a functional, rather than a localization approach in that both, brain-damaged and normal people demonstrate functional asymmetry as reflected in their performance on perceptual tasks. That is, in brain damaged patients damage to the left hemisphere will selectively impair one aspect of cognition, such as language, but not others, such as face recognition, and damage to the opposite hemisphere will have opposite effects. In normal people information presented to the sensory field that is opposite to the hemisphere that specializes in

processing that information is favored because sensory projections access the opposite hemisphere. Therefore, words are perceived better in the right visual field (left hemisphere) and faces in the left visual field (right hemisphere).

The neuropsychological literature supports the above with various studies based on unilateral (Delis et al., 1986; Robertson & Lamb, 1991) and diffuse (Ober et al., 1991; Robertson & Lamb, 1991; Delis et al., 1992) brain damaged patients that point to left hemisphere damage resulting in poor response to parts or details of a visual scene, and right hemisphere damage resulting in poor response to a whole or configural visual scene. In general, the hypothesis resulting from such an observation is that the left hemisphere functions analytically, or on fine grained analysis (local processing), and the right hemisphere functions holistically or on whole or configural parts (global processing).

In a series of research studies (Mcscovitch, 1979; Sergent, 1982; 1983) that suggest hemispheric differences in terms of perceptual analysis, Sergent (1982) suggests that hemispheric differences might be based on left and right hemispheric analysis of spatial waveforms (frequencies). That is, the left hemisphere seems to function for high spatial frequencies and the right for low spatial frequencies.

Spatial Frequency by Hemisphere

Versace & Tiberghien (1988), state that the left hemisphere is usually superior to the right in tasks that require processing of detailed and local information and composed of high frequencies, and that the right hemisphere is usually superior to the left in tasks that require processing of global and more general information, and composed of low frequencies. These researchers emphasize that each hemisphere is capable of processing the whole frequency range, but one is superior at processing relatively high frequencies, whereas the other one is superior at processing relatively low frequencies. With intermediate spatial frequencies, there is no difference between the two.

Sensitivity to spatial frequencies in the hemispheres seem to be affected by certain task parameters. For instance, when attention is directed to a particular task (global or local), Sergent (1983) states that the two hemispheres are not equally sensitive to the outputs of different spatial-frequency information, and that (Sergent, 1982) when the directed task is global, right hemisphere advantage is reported, and when the directed task is local, left hemisphere advantage is noted. Additionally, when retinal eccentricity is increased, that is, when the stimuli are placed more in the periphery, the ratio of low to high spatial frequency is increased, and the right hemisphere analysis is more efficient (Sergent, 1983). An important point made by Sergent is that to ensure that information is initially sent to the opposite hemisphere, the stimulus must be

presented for a brief duration, and in the retinal periphery. Sergent's (1983) theorizing has found support in other studies (Robertson & Lamb, 1991; Delis et. al., 1992) that show a left hemisphere advantage when stimuli are presented in the right visual field, and a right hemisphere advantage when stimuli are presented in the left visual field .

In their extensive work on part/whole organization of objects by the visual system, Robertson and Lamb (1991) reviewed both normal and neuropsychological evidence for the different parts of the brain functioning for global and for local processing. The authors point to a coordination of separate subsystems for global/local processing in the temporal-parietal regions (right and left respectively) of the human brain. The authors suggest that a function of the subsystems is to connect objects into hierarchical structures while at the same time keeping the objects perceptually separate. Two neurological sites are mentioned to support the above claim: the right posterior-superior temporal lobe (global), and the left posterior-superior temporal lobe (local). The authors argue that the local properties of the stimuli are handled in the left superior temporal parietal region in the brain. To put it differently, they state that the left hemisphere deals with analytic (local) analysis, and the right hemisphere deals with holistic (global) analysis.

Robertson and Lamb (1991) substantiate the above by pointing to clinical evidence where left hemisphere lesions result in patients omitting local aspects of drawings in a task involving memory while

right hemisphere lesions produce drawings with local aspects present but misplaced. Similar results are observed with block design tasks in that in left hemisphere injured patients, difficulty is observed with placing individual blocks in their correct position, and in right hemisphere injured patients, the overall configuration is broken.

Although the main focus of their (Robertson & Lamb, 1991) thesis is on a precedence effect, they draw on Sergent (1982) who showed that presenting hierarchical patterns in the right or left visual field of normals produced results consistent with their work with brain-injured patients. That is, a right visual field (left hemisphere) advantage results when responding to local targets of Navon-type (1977) patterns and a left visual field (right hemisphere) advantage in responding to global targets. These results are explained by the way the two hemispheres respond to spatial frequencies that differentiate global and local levels (Sergent, 1982).

Local Analysis and Language

An important correlate to the above hypothesis is the possible link between local processing and language. It has been shown that language is a function of the left hemisphere, while more recent studies with both restricted lesions and with diffuse brain damage suggest a possible link between local processing and language, therefore further substantiating the left hemisphere for the analysis of local stimuli.

Delis et al. (1986) used linguistic (letters) and non-linguistic (shapes) hierarchical stimuli to test the ability of unilateral right hemisphere damaged (RHD) patients, and unilateral left hemisphere damaged (LHD) patients, to remember hierarchical stimuli in a forced-choice recognition task. Their controls were elderly normal subjects. An ANOVA mixed-factorial design revealed no interaction between type of symbol and subject group. This finding indicated that the side of lesion did not differentially affect overall accuracy for stimuli containing linguistic vs. non-linguistic symbols. More importantly, a significant main effect was found for subject groups in the analysis of the larger- and smaller-form error ratio. That is, the RHD patients made significantly more errors in recognizing the larger forms relative to the smaller forms than the control subjects; and the LHD patients made significantly more errors in recognizing the smaller forms relative to the larger forms than the control subjects.

Delis et al. (1986) explain their results by proposing that the smaller (local) level elements of the stimuli are normally encoded verbally, while the larger (global) level elements are normally processed non-verbally. The authors utilized Sergent's (1983) hypothesis to explain how the initial stages of perceptual processing differs in the two hemispheres, which may determine what level of the stimulus will be analyzed verbally or non-verbally. As was stated earlier, Sergent (1983) suggested that the right hemisphere is normally more efficient at processing lower visual spatial frequencies, roughly defining the larger forms of the hierarchical

patterns, while the left hemisphere is normally more efficient at processing higher visual spatial frequencies, roughly defining the smaller forms.

In a more recent study, Delis et al. (1992) examined whether Alzheimer's Disease (AD) patients with diffuse brain damage could perform similar perception tasks as focal or unilateral lesioned patients. Two groups of AD patients and normal controls were administered a global/local recall performance task. The AD patients with higher spatial functioning abilities than naming abilities (as determined by standardized tests) scored significantly better on global recall scores than the high verbal group who were better at naming than at spatial functioning tasks (also determined by standardized tests). On the other hand, the high verbal group scored significantly better on local recall scores than the high spatial functioning group. Furthermore, the mean local and global recall scores was significantly higher for the normal controls than for the above two AD groups. It was also found that, consistent with other studies (Delis et al., 1986; Delis & Bihle, 1989), there was a dissociation in global/local processing between AD subgroups with both, linguistic symbols or nonlinguistic shapes. In other words, global/local processing is not restricted to language type stimuli, and that using stimuli with different shapes (nonlinguistic) will also result in identifying the global and local aspect of the stimuli.

Delis et al. (1992) also found a high correlation between the local recall scores and the standardized Boston Naming Test (BNT),

and a strong association between the global recall scores and the standardized WISC-R Block Design (BD) scores for both the AD groups. According to the authors, their findings suggest a relationship between language function and local analysis and global analysis. What is implied is that when language is impaired, local processing of visual images are also impaired. Therefore, they state that it is likely that language and local analysis are both mediated by the left hemisphere for most people. Furthermore, that if the above is true, then dysfunction in the left hemisphere may well be the common denominator that results in impairment in both cognitive domains, language, and local analysis.

Delis et al. (1992) extended their studies to two groups of children with neurodevelopmental disorders. One group were children with Down's Syndrome, and the other group were children with Williams Syndrome. According to the authors, for both groups of children brain damage is diffuse, and furthermore, there is evidence for atypical lateralization of cognitive functions in these children. Results from their study in whole/part organization with the above children showed a similar interrelationship between language and local/global analysis as with their AD patients described earlier. That is, the Down's syndrome children who performed more poorly on traditional language tests than at block construction type tasks also scored poorly on local tasks (as in the high spatial functioning AD group), and the Williams syndrome children who performed more poorly on block construction type

tasks than on traditional language tests also scored poorly on global tasks (as in the high verbal AD group). Based on their results, the authors suggest that language may be localized in the right hemisphere for the above children who also demonstrated local impairment. Interestingly, this led the authors to conclude that the part of the brain that is involved in aspects of language is also involved in local analysis, irrespective of whether it is in the right or left hemisphere. Although their findings are not conclusive, they provide a basis for speculating for a link between language and local analysis, and furthermore, that the location for language and local processing is dependent on the sample population, that is, normal subjects or specific types of brain-damaged patients.

.5 Summary and Objectives

In the previous sections, the present study reviewed the literature on the smoking habits of Canadians; the neuropsychological literature, and the findings within the Ottawa Prenatal Prospective Study (OPPS) on children from birth to early adolescence to look at the effects of maternal smoking on auditory/language processing; and at the cognitive and neuropsychological investigations to look for a possible link between local processing and left hemisphere functioning, and furthermore, for an association between local analysis and language processing.

In general, an inverse relationship between maternal smoking and aspects of language processing and auditory related problems is found in the smoking literature. For instance, a continuity effect was observed which suggests that children born to smokers show poor performance on tests of speech and language abilities to age nine; a decrease in verbal comprehension to age eleven; and poor reading performance to age sixteen.

The cognitive and neuropsychological literature on the global/local construct combine to provide a theoretical basis for speculating on a possible link between local analysis and verbal analysis in the left hemisphere of the brain for most individuals. The findings in general come from observations of normals, unilateral brain-damaged, and diffuse brain-damaged subjects' abilities to

perform on a perceptual task that calls for a hierarchical structuring of visual objects. Several studies point to a hemispheric laterality effect such that the left hemisphere processes local levels of a stimuli, and the right hemisphere processes global levels of a stimuli.

The literature on smoking effects and auditory/language processing in combination with the above literature on global/local analysis provides a theoretical basis for exploring the possibility of smoking effects on the vulnerability of local analysis, and thus on auditory/language impairment. Therefore, an important implication coming from a local and verbal processing link is that local processing occurs in the left hemisphere, and that auditory/language impairment is potentially a function of local analysis.

Based on the literature review mentioned above, the primary objective of the present study was to examine a potential link between local analysis and verbal abilities, and the vulnerability of local processing to the effects of smoking. In addition, a potential link between global analysis and spatial abilities was also examined.

To test the above objectives, Navon (1977) type compound letters (stimuli) were developed for a non-verbal perceptual task. Compound letters are hierarchically arranged letters, and when they are presented in the right and left visual field, they provide a memory component to the task. According to Delis et al. (1986), and Moscovitch (1979), a memory component is an important factor in lateralization studies.

In considering the objective in trying to tie together verbal and local processing, and global and spatial processing, two standardized tests, that is, the Peabody Picture Vocabulary Test- Revised (PPVT-R), and the Raven's Progressive Matrices (RPM) were administered in addition to the global/local perception tasks. The reasoning for the use of these standardized tests is to examine whether there is an association between the PPVT-R and local scores, and between the RPM and global scores.

Based on the above objectives, the hypothesis for this study is that offspring of smokers, and adult active and passive smokers will perform more poorly on the local task than will the non-smoking groups. Further, it is hypothesized that there will be no difference in performance on the global task for the smoking and non-smoking groups. And finally, the local component of the task will correlate with the performance of subjects on a verbal test, and the global component of the task will correlate with the performance on a non-verbal test.

II METHOD

.1 Subjects

The subjects for the present study were first year psychology students (Fall 1993, and Summer 1994) at Carleton University. These subjects were recruited in two parts, the first being a mass-testing procedure, followed by a selection of particular subjects. All students who participated in the mass testing and subsequent follow-up experiment for this study received credit as part fulfillment for the requirements for the psychology 100 experimental credits.

The present study went through three separate testing phases: a pilot phase ($n=50$); a pre-prospectus phase ($n=80$); and a post-prospectus phase ($n=149$). The perception task in the pre-prospectus group condition was modified after a Graduate committee review, and thus, the post-prospectus group was formed. Two subjects from the post-prospectus group were excluded from the study as they did not fit into the smoking groups defined for the present study. The decision was based on the inconsistent information provided by the subjects on two smoking history questionnaires. Only the post-prospectus group ($n=147$, 69 male; 78 female) data were considered for the analysis for the present study.

.2 Mass Testing Procedure

In the Fall (1993) a total of 2,300 premeasure smoking history questionnaires were administered among a large number of students who participated in a mass-testing procedure. Each student received a package containing several questionnaires pertaining to different studies. In order to increase the number of subjects for the present study, an additional 200 questionnaires were distributed to first year Psychology Summer students (1994).

Premeasure smoking history questionnaire (Appendix 1).

The premeasure smoking history questionnaire consisted of 10 questions. Questions one through three obtained the smoking history for the subject, and questions four through seven obtained information on the secondhand cigarette smoke exposure for the subject. Question eight determined right or left handedness, and question nine and ten controlled for difficulties with vision, and with the spoken English language. In addition, the age and sex of the subject was also obtained.

A total of 1,698 completed premeasure smoking history questionnaire responses were returned. These responses were divided into three major groups based on questions 1-3: non-smokers who never smoked; past smokers; and current smokers. All past smokers and those who responded "don't know" to questions

four through seven were eliminated from this study (after being given the opportunity to verify the information).

The non-smokers and current smokers were further divided into subgroups (Fig. 1) based on questions four through seven as listed below:

(1) the control group, who were non-smokers, and whose mothers did not smoke during pregnancy. This group was not exposed to secondhand smoke *in utero* nor exposed on a regular basis to secondhand smoke as children or as adults ($\underline{n}=26$);

(2) non-smokers, whose mothers smoked during pregnancy, and who were also exposed to secondhand *in utero* smoke, and regularly to secondhand smoke as children and adults ($\underline{n}=28$);

(3) current smokers, whose mothers did not smoke during pregnancy. This group was not exposed to secondhand smoke *in utero*, but were recently (only 6-12 months prior to testing) exposed on a regular basis to the smoke of others ($\underline{n}=27$); and

(4) current smokers, whose mothers smoked during pregnancy, and who were exposed to secondhand *in utero* smoke, and regularly to secondhand smoke as children and adults ($\underline{n}=20$).

[insert Figures 1 and 2 here.]

FIGURE 1STUDY GROUPS

Current Smoking Status of Subjects		
<u>In Utero Exposure</u>	Non-smokers	Smokers
	<u>Group 1</u>	<u>Group 3</u>
Mother did not smoke during pregnancy	No current smoking, not exposed <i>in utero</i> , and not exposed to regular secondhand smoke $n=26$	Current smokers, not exposed <i>in utero</i> . Regular secondhand smoke (min 6 months, max 12 months prior to testing) $n=27$
	<u>Group 2</u>	<u>Group 4</u>
Mother did smoke during pregnancy	Non-smokers, exposed <i>in utero</i> to mother's smoking, to <i>in utero</i> secondhand smoke, and to secondhand smoke as children and adults $n=28$	Current smokers, exposed <i>in utero</i> to mother's smoking, to <i>in utero</i> secondhand smoke, and to secondhand smoke as children and adults $n=20$

FIGURE 2SECONDARY STUDY GROUPS

Current Smoking Status of Subjects		
<u>In Utero Exposure</u>		
	<u>Group 5</u>	<u>Group 6</u>
Mother did not smoke during pregnancy	Non-smokers, not exposed <i>in utero</i> . Exposed to secondhand smoke (min 2 years, max 3 years prior to testing) $n=24$	Non-smokers, not exposed <i>in utero</i> . Exposed to secondhand smoke (min 6 months, max 12 months prior to testing) $n=22$

The obviously desired group of exposed *in utero* but not post-natal passive exposure could not be created due to lack of subjects fulfilling this criteria. Out of a total of 121 responses for exposed *in utero*, no more than 3 cases reported no maternal secondhand smoke exposure either as children, or young adults.

As a secondary aspect of this work, two additional groups were created to examine what effects can be attributed to exposure to smoke *in utero*, and what effects can be attributed to exposure to smoke in the past few years (see Fig. 2, p. 45):

(5) non-smokers, not exposed *in utero*, but exposed to secondhand smoke regularly in the past two to three years prior to testing, ($n=24$), and

(6) non-smokers, not exposed *in utero*, but recently exposed on a regular basis to secondhand smoke (only 6-12 months prior to testing) testing ($n=22$).

Groups 5 and 6 served as a preliminary investigation for isolating the effects of secondhand smoke, which may in turn assist in the interpretation of any effect of exposure to smoke *in utero*. In order to explore this possibility, groups 5 and 6 were compared with the controls (group 1).

.3 Experimental Procedure

The chronology of the testing session follows below. Details of each aspect are presented in subsequent sections.

The six groups described earlier were created on the basis of the responses to the premeasure smoking history questionnaires. The groups were coded from 1 to 6, and subjects were selected on the basis of sampling by convenience. That is, an attempt was made to get an equal number of subjects (maximum of 30) for each of the six groups (post-prospectus) by drawing on names of subjects as they appeared from the six group files. However, due to a large number of subjects ($n=80$) being used in the pre-prospectus group, it was not possible to reach the desired number of 30 subjects for each of the six post-prospectus groups. The selected subjects ($n=147$, see Figs. 1 and 2, p. 45 for the group n), approximately equal male and female per group, were invited by telephone by the experimenter to participate in the present study for which they received experimental credit.

All experimental tasks were administered individually at Carleton University (LOEB building, Tower A, room 318). A receiving chair was set up immediately outside the testing room, where the subject was asked to read and sign the consent form (Appendix 2); to fill out a detailed smoking history questionnaire (Appendix 3); and to read a two page instruction sheet for the letter identification task (Appendix 4). The instruction sheet was designed to familiarize the

subject with the procedure for the computer task. The instructions detailed in a step-by-step fashion what the subject was expected to do.

At the completion of the above, the subject entered the testing room, and went over the instruction sheet for the letter task with the experimenter. The subject was encouraged to ask any questions before starting the task.

The subjects were administered either the global or the local (described below) computer letter task first. That is, a counterbalancing procedure was used whereby for every group, alternate subjects were given either the global or local task first to control for order effects. A post-task questionnaire (described below and in Appendix 5) which included a self perception measure on the subject's performance on the task was filled out by the subject after each of the global and local tasks.

The global and local computer tasks were separated by standardized tests (described in a later section). That is, the subjects did the Peabody Picture Vocabulary Test - Revised (PPVT-R) (Dunn & Dunn, 1981) after completing one of the computer tasks, and then did the Raven's Progressive Matrices (RPM) (Raven, Court, & Raven, 1983) after completing the second computer task. The PPVT-R was administered by the experimenter and took approximately 10 to 15 minutes, while the RPM was self administered with simple and adequate instructions given by the experimenter.

After all the experimental tasks were completed, the experimenter debriefed each subject orally and provided a written debriefing (Appendix 6) to the subject. The debriefing outlined the purpose of the experiment, the use of the various tests, and the usefulness of the subjects participation. The subject was thanked for his/her time and efforts, and a receipt (Appendix 7) was issued for the course credit.

Detailed Smoking History Questionnaire (Appendix 3)

The subjects filled out the detailed smoking history questionnaire prior to the administration of the experimental tasks. The 19 questions obtained a breakdown of the smoking profile of the subjects, and also provided a reliability measure of subject response when compared with the premeasure smoking history questionnaire. In general, after separating the smokers from the non-smokers, this questionnaire provided information for current and past smokers regarding the brand, type and quantity of cigarettes smoked, length of smoking habit, exposure to active and possibly passive cigarette smoke (*in utero*, in childhood, and current), for both, the smoker and non-smoker. The data from this questionnaire was analyzed with one-way analysis of variance (ANOVAs) to compare the smoking habits of subjects. In addition, Pearson product-moment correlations were used to examine the relationship between the dependent variables and all the subjects, and with both the current and past smoking habits of group 3 and group 4.

Post-task Questionnaire (Appendix 5)

This self-measure questionnaire was administered immediately following each of the letter identification tasks. The subject was asked to estimate how many correct responses, errors, and guesses he/she made on the task. In addition, information on the level of difficulty in responding to the different configurations of the stimuli letters and to their location on the computer screen was provided by the subject. This questionnaire also determined the perceived level of distraction, strategy development, and personal difficulties that may have interfered with the task performance. The responses were analyzed using one-way ANOVAs, t-tests, and chi-squares.

Development of the Global/Local Task

The global/local stimuli letters for the letter identification task were developed from a MacLaboratory Software computer program, Reaction Time 2.05 (Chute, 1990). Reaction Time 2.05 is a computerized package designed to provide millisecond accurate timing for stimulus presentation, and for reaction time. The global/local stimuli letters were presented on a Macintosh PowerBook 165c (colour component not used) in the present study.

A total of four global/local stimuli letters (Appendix 9) were developed for the perception task. They are as follows:

- 1) a large M made up of small m's;
- 2) a large W made up of small w's;
- 3) a large M made up of small w's; and
- 4) a large W made of small m's.

The stimuli letters were assigned to the four quadrants as described below. They were positioned either 2 cm above or below the bottom and top edge, and 2 cm away from the side of the screen. The size of each stimuli letter was 5 cm in length, and 4 cm in width, and the viewing distance was approximately 40 cm (subjects' eye from the screen). The visual angle for each of the four quadrants was approximately 6.78 degrees, and the stimuli were 4.8 cm from the focal point (star).

The global and local tasks were initially developed with one block of 16 stimuli (trials). The placement of each letter stimuli was determined by sampling without replacement such that each letter stimuli appeared four times, once in each of the four quadrants. However, based on a Graduate committee decision to allow for a learning component within the task, and in addition, to provide a sufficient number of trials for the data analysis, the number of trials for each of the global and local tasks was increased from 16 to 208.

Thus, the final global and local tasks consisted of 13 blocks of 16 trials each. The 13 blocks provided a measure for learning the global and local tasks, as block 1 was compared with blocks 7, and

13, all three of which were identical in the arrangement and presentation of the letter. Each of the other blocks (2, 3, 4, 5, 6, 8, 9, 10, 11, 12) were also determined by sampling without replacement. That is, each letter stimuli appeared four times within each of the 13 blocks for a total of 52 times in each of the four quadrants. The total number of trials was therefore 208 for the global and 208 for the local tasks.

The global and local tasks began with a computer screen display of sample letters (Appendix 8). Following this, a brief instruction for the task appeared. These two computer screen displays stayed on till the subject was ready to start the task, at which time, the subject activated the OK key by pressing the bar on the computer panel at the bottom of the computer keyboard.

The timing selected for the visual presentations were as follows: Each trial started with a focus point (a star) which stayed on for 500 msec. This was followed by a letter stimulus which stayed on for 27 msec (global) and 90 msec (local) respectively. After a delay period of 2,500 msec a star appeared for the next trial. This was repeated for all of the 208 trials for each of the separate global and local tasks. These parameters were decided upon based on the pilot work described below.

During the data cleaning procedure however, two major technical difficulties became apparent. It was observed that although each global and local stimuli was set (programmed) to

appear for 27 and 90 msec respectively, the actual time each global and local stimuli appeared was for 160 and 140 msec respectively. Additionally, a total of 26 letter stimuli (13 large W's made up of small w's, and 13 large W 's made up of small m's) in the lower left quadrant appeared for 20 msec longer than the above 160 and 140 msec. Therefore, the longer appearing stimuli had to be eliminated from the global and local tasks. Thus, the total number of stimuli was reduced to 182 for each of the two tasks (i.e. 13 blocks of 14 trials each). The above variabilities were accounted for by the limitations of the PowerBook (communication, Chute, D. and Westall, R. Personal communication, October 7, 1994).

Pilot Work

The primary objective of the pilot study was a) to determine the parameters of the computer task designed by the experimenter, such that the individuals could do the task, but that they would make some errors; b) to approximately equate the local and global tasks in difficulty by manipulating the duration of the stimuli on the screen; c) to adjust for any technical difficulties that could possibly arise in the running of the experiment, and d) to familiarize the experimenter with administering the standardized tests.

In order to accomplish the above, 50 students from the Fall 1993 mass testing group who did not fit into the six established smoking groups for the present study were considered eligible for the pilot study. These fifty subjects were invited by telephone by

the experimenter to participate individually in one of two possible pilot test conditions for which they were given course credits.

The first condition involved filling out the detailed smoking history questionnaire, and doing the 16 trial counterbalanced global/local letter identification tasks. That is, alternate subjects were given either the global or local task first to control for order effects. The second condition involved filling out the detailed smoking history questionnaire, doing the above global/local letter identification task, and completing the two standardized (PPVT-R and RPM) tests. In both conditions, the subjects were debriefed at the end of the pilot test, and were asked their opinions on the global/local task.

In order to develop the global/local letter identification task, several letters (e.g., H and S; P and B; M and W) were tried at different msec settings (global - 18, 20, 25 and 27; local - 200, 150, 100, and 90). The optimum letters and settings that allowed the subjects to do the task, and at the same time make some errors, were the M and W set at 27 and 90 msec for the global and local respectively. However, as per the discussion on the previous page, the set time (27 and 90 msec) probably did not reflect the actual time (160 and 140 msec). As the global/local task was conducted on a PowerBook (portable) computer, a few minor alterations were included. First, the focus point for the screen which was set to be a star, was centered but shifted slightly lower than centered to adjust for a perception difficulty which made the upper quadrants appear

easier than the bottom quadrants. Secondly, a low chair was used so that the eye level of the subject would be centered with the screen. Third, the light in the testing room was turned off to avoid any uneven reflections from the portable screen lighting. The light left on in the adjacent room (with a one way mirror) was sufficient for conducting the experiment, and fourth, the quadrants for the letters or stimuli were placed as close as possible to the edge of the screen and as far away from the center of the screen.

Outcome Measures

The global/local task was scored for accuracy of response or number of errors made, and latency or reaction time. Accuracy called for correctly identifying the visual stimulus by pressing the M or W key on the computer keyboard (specified by either the global or the local task condition outlined in Appendix 4). Latency was the time (clocked by the computer) from which the visual stimulus first appeared on the screen, to the time the subject took to identify (correctly or incorrectly) the visual stimulus by pressing the appropriate key on the computer keyboard. In the event that a subject failed to respond (missed a trial), that trial was coded as "no response" and the latency for that trial was given a score of 2,500. This score represented the maximum delay setting for the visual letter stimulus and the star that followed.

A few additional response conditions were noted and treated as follows. When a double entry was recorded (i.e., two responses, either similar or dissimilar), the shorter latency along with its accompanying stimuli letter was considered to be the scored response, and the longer latency was discarded. When a response was made but not within 2,500 msec, the stimuli was still recorded by the computer, and was scored as being either correct or incorrect. However, the latency for the above response was recorded as 2,500 msec.

Standardized Verbal and Spatial Tests

The subject's scores on a verbal standardized test, the Peabody Picture Vocabulary Test - Revised (PPVT-R), and a spatial general intelligence standardized test, the Raven's Progressive Matrices (RPM) were obtained. The performances on the local task scores were compared with the PPVT-R scores, and the global task scores were compared with the RPM scores to determine whether a relationship existed between the perceptual tasks and measures of verbal and spatial abilities respectively.

Peabody Picture Vocabulary Test - Revised (PPVT-R)

The Peabody Picture Vocabulary Test - Revised (Dunn & Dunn, 1982) is an individually administered verbal comprehension test and developmental scale. It provides a rapid measure of "use" vocabulary and has been standardized for adults (18 to 40 years of age). The test was presented according to the instructions in the manual. The test was comprised of a total of 175 plates, each of which contained four pictures numbered 1 to 4. The examiner presented one plate at a time, and simultaneously stated the stimulus word. The subject responded by giving a number on the plate (below the appropriate picture) that corresponded to the stimulus word. The test was terminated when the subject made six errors within eight consecutive trials. The administration of this test was untimed, but it generally required from 10 to 15 minutes. Raw scores (correct responses) were converted to standard scores ($\bar{X} = 100$, $SD = 15$) and percentile ranks as outlined in the manual.

Raven's Progressive Matrices (RPM)

The Raven's Progressive Matrices (Raven et al., 1983) is designed as a measure of Spearman's g factor (Anastasi, 1988), and is a highly discriminating, non-verbal and culture-free test of general intelligence (Shipley, 1975). It is a test of a person's capacity to form relations among abstract items, and by so doing, to develop a systematic method of reasoning (Raven et al., 1983). This test

consists of five sets, A to E, with each set containing twelve items. Each item is a larger design or matrix from which a part has been removed, and the subject is required to examine the matrix and choose the correct part for completing it from a total of six choices. Of the five subtests, the easier items involve accuracy of discrimination, and the more difficult items involve analogies, permutations, and alterations of patterns, and other logical relations. The score, which is the total number of problems solved correctly was converted to a percentile rank based on norms provided in the manual. The RPM is reported to be a highly reliable test with retest reliability for adults ranging approximately from .70 to .90. When the RPM is correlated with other measures of intelligence tests, the range is between .40 and .75, tending to be higher with performance than with verbal tests. Upon administering the RPM, the subjects were informed that the test was self administered and untimed, and that they were required to complete all items. Generally, the test required very simple oral instructions and took approximately 45 minutes to complete. Overall, the RPM appeared to be a reasonable test compared to other traditional tests because it is known to correlate well with general types of performance tasks, and to function well for adults in that they can pace themselves for the task.

.4 Statistical Analysis

File Management

In order to analyze the data, a file management procedure involved converting the original Reaction Time (2.05) data from the global and local tasks and data from the smoking history questionnaires and feedback sheet into two readable Excel files. The Excel files were then read by SPSS for the Macintosh (version 4.0.4) to provide two SPSS files which were then combined into one to yield all the variables for the present study. The SPSS file was later transformed into 9 separate SPSS files in order to analyze different aspects of the dependent and independent variables. Both, the global and local scores were converted to aggregated percent error scores for the accuracy scores, and aggregated average scores for the latency scores.

Dependent and Independent Variables

Three separate experimental tests yielded the six dependent variables for the present study:

- 1) A letter identification task with a global and a local component. Each of the global and local tasks was analyzed for percent error (percent of incorrect and missed responses) and reaction time (latency) for a total of four dependent measures;

2) A standard score from the Peabody Picture Vocabulary Test - Revised (PPVT-R); and

3) A standard score from the Raven's Progressive Matrices (RPM).

The independent variables were (Appendix 3): the current smoking habits of subjects; exposure to *in utero* smoke (smoking habits of mother while pregnant); and the subject's exposure to secondhand smoke (see Fig. 2, p. 45 for groups).

In order to examine whether the items in the post-task (global and local) questionnaire (e.g., how often they thought they guessed the response, degree of difficulty of the task etc.) ought to be considered as potentially confounding variables, the responses of the 6 smoking groups were analyzed using one-way ANOVAs for continuous variables, and chi-square analysis for nominal variables. One-way ANOVAs were also conducted to compare the difference in age of the subjects in all the smoking groups. In addition, t-tests for ordinal variables (e.g., task order), and chi-square analyses for dichotomous responses (e.g., sex, handedness) were conducted.

The major statistical analyses carried out in the results section was divided into four categories to look at:

- Effects due to smoking;
- Performance on the global/local task as a function of stimuli parameters: consistent (large letters made up of similar letters) compared with inconsistent (large letters made up of dissimilar letters) stimuli presentations; stimuli divided into specific blocks, and stimuli presented in the left and right visual fields;
- Interactional effects of the above two categories; and,
- the relationship of the standardized PPVT-R, and RPM tests with the global and local tasks, and smoking effects on the PPVT-R and RPM.

Power to detect either a small, medium, or large effect size for the analyses described below was based on 80%, for a two-tailed alpha of 0.05, and was dependent on specific sample sizes. All the power calculations were based on Cohen (1977).

Smoking Effects on the Global/Local Task Outcome Measures

The data were analyzed using analysis of variance (ANOVAs), and multiple analysis of variance (MANOVA). One-way ANOVAs were conducted to look for a main effect of the differences in performance of the 6 smoking groups for potential smoking effects,

and to look for the effects of exposure to secondhand smoke. A MANOVA was conducted to look for a combined effect of the dependent variables on the 6 smoking groups. With a sample size of 24.5, the medium effect size was $f = .30$ for the above two analyses. Because the 6 smoking groups are not represented by a common n , the mean sample size was taken into consideration (Cohen, 1977).

One-way ANOVAs were conducted to look at the effects of light (1 to 10 cigarettes per day), moderate (10 to 20 cigarettes per day), and heavy (20 and over) smoking on the dependent variables for group 3 (current smokers), and group 4 (current smokers plus exposed *in utero*). A medium effect size ($f=.35$) for group 3 ($n=27$) and a large effect size ($f = .45$) for group 4 ($n=20$) was determined.

Additional analyses for smoking effects were conducted by Pearson product-moment correlations to examine the relationship between the dependent variables and all the subjects, and with both the current and past smoking habits (Appendix 3) of the current smokers (gps. 3 and 4). The number of years the subject smoked represented the current smoker's past smoking habit. Current smoking habits were represented by a nicotine score which was computed by multiplying the number of cigarettes smoked per day by the nicotine content of the brand specified. A small effect size ($r = \pm .25$) for all the subjects ($n=147$), and a large effect size ($r = \pm .55$) with a mean sample size of 23.5 (gps. 3, $n = 27$ and 4, $n = 20$) was detected.

Performance on the Global Local Task as a Function of Stimuli Parameters

In the analysis described in this section, only the main effects for the presentation of the global and local stimuli (consistent inconsistent stimuli, stimuli divided into specific blocks, and stimuli in the left and right visual fields) will be discussed.

In order to examine the subjects' performance on the global and local tasks, that is, to show how the performance with the consistent (large letters made up of similar letters) stimuli compared with the performance with the inconsistent (large letters made up of dissimilar letters) stimuli, 2x6 factorial ANOVAs were conducted. A small effect size ($f = .13$) was determined for a sample size of 147.

The global and local tasks were comprised of 13 blocks of 14 trials (stimuli) each. One-way ANOVAs were conducted to compare performance of all the subjects across all 13 blocks on the global/local tasks. A small effect size ($f = .10$) was determined for a sample size of 147. Additional one-way ANOVAs were conducted on the data for blocks 1, 7, and 13 for a learning component (block 1), for familiarity with the task (block 7), and for fatigue (block 13). Again, a small effect size ($f = .15$) was determined for a sample size of 147.

2x6 factorial ANOVAs were conducted to examine whether performance on the global and local tasks for all the subjects was different when comparing the stimuli presented in the left and right

visual fields (top and bottom quadrants collapsed). A small effect size ($f = .13$) was determined for a sample size of 147.

Examination of Interactional Effects

The description of the examination for the main effects in these factorial ANOVA designs have been covered above. This section will deal with the interaction of smoking and various aspects of the global/local task outcome measures.

2x6 factorial ANOVAs were used to examine whether there was a differential effects between the smoking groups in their performance on the consistent and inconsistent stimuli. A medium effect size ($f = .30$) was determined for a mean sample size of 24.5.

Chi squares were used as an alternative way of examining whether the 6 smoking groups differed in their performance on the consistent versus the inconsistent stimuli. That is, to look at the proportion of subjects within each of the six smoking groups who varied in their error rate and response time on the inconsistent versus the consistent stimuli. A medium effect size ($w = .30$) was determined for a sample size of 147.

6x13 factorial ANOVAs were run to look for a differential interactional effect between the 13 blocks of the global and local tasks, and the 6 smoking groups. A medium effect size ($f = .20$) was determined for a mean sample size of 24.5.

Chi squares were used as an alternative way to examine the proportion of subjects within each of the 6 smoking groups who fell either 1 SD above the overall mean, or 1 SD below the overall mean on the 13 block comparison. A large effect size ($w = .40$) was determined for a sample size of 147.

2x6 factorial ANOVAs were used to look for a differential effect with the left and right visual field presentations among the 6 smoking groups. A medium effect size ($f = .30$) was determined for a mean sample size of 24.5. Initially, 2x13 factorial ANOVAs were run to look for a differential effect between the left and right visual fields and the 13 blocks with the 6 smoking groups collapsed. A medium effect size ($f = .25$) was determined for a mean sample size of 24.5. Additionally, a 2x6x13 factorial ANOVAs were conducted to examine a three-way differential effect between the left and right visual fields, the 6 smoking groups, and the 13 blocks of the global and local tasks. A medium effect size ($f = .20$) was determined for a mean sample size of 24.5.

.5 Examining the Standardized Tests

Smoking Effects: One-way ANOVAs were conducted for each of the standardized Peabody Picture Vocabulary Test - Revised (PPVT-R) scores and the Raven's Progressive Matrices (RPM) scores to examine potential differences across the 6 smoking groups on the standard scores. A medium effect size ($f = .30$) was determined for a mean sample size of 24.5.

Chi squares were used as an alternative way of examining the standardized PPVT-R and the RPM scores. The scores were categorized in two different ways. For the first chi-square analysis, all subjects scoring 1 SD above the overall mean of the PPVT-R (and RPM) were compared with the rest of the sample across the 6 smoking groups. For the second chi-square analysis, all subjects scoring 1 SD below the overall mean of the PPVT-R (and RPM) were compared with the rest of the sample across the 6 smoking groups. A medium effect size ($w = .30$) was determined for a sample size of 147 (RPM), and is similar for a sample size of 141 (PPVT-R).

Pearson product-moment correlations were performed with each of the 6 smoking groups separately to examine the relationship of the global and local scores with both the PPVT-R scores and the RPM scores. A large effect size ($r = \pm .60$, and $r = \pm .50$ respectively) was determined with a sample size ranging from 20 to 28 for the 6 smoking groups.

Dose Response Relationship: Pearson product-moment correlations were conducted to examine the relationship between the standardized PPVT-R and RPM scores, and both the current and past smoking habits (Appendix 3) of the current smokers (gps. 3 and 4). A large effect size was determined for group 3 ($n=27$, $r = \pm .50$), and for group 4 ($n=20$, $r = \pm .60$).

One-way ANOVAs were also conducted for each of the standardized PPVT-R scores and the RPM scores to examine the relationship with the light, moderate, and heavy smokers among the current smokers (gps. 3 and 4). A medium effect size ($f = .35$) was determined for a mean sample size of 23.5.

Left and Right Visual Field Presentations: Pearson product-moment correlations were performed with the 6 smoking groups collapsed, and with each of the 6 smoking groups separately with the stimuli presented in the left visual field (and separately for the right visual field) with the top and bottom quadrants collapsed to examine the relationship of the global and local scores with both the PPVT-R and the RPM scores. A small effect size ($r = \pm .25$) for all the subjects ($n = 141$ PPVT-R, and $n = 147$ RPM) and each of the 6 smoking groups separately ($r = \pm .50 - .60$) was determined for a sample size ranging from 20 to 28.

III RESULTS

When the data were analyzed for the distribution of both the dependent and independent variables, they were found to be normal, and there were no outliers. In addition, homogeneity of variance was noted for all of the dependent variables.

.1 Limitations of the Macintosh PowerBook 165c

During the data cleaning, it was noted that some of the global and local task stimuli (W/w, W/m) in the lower left quadrant appeared longer on the screen than did the same stimuli in the other three quadrants. The above discrepancy was partly traced to a software problem arising due to the limitations of the PowerBook (communication, Chute, D. and Westall, R. Personal communication, October 7, 1994). In order to examine whether in fact the limitations of the PowerBook did result in behavioural differences across the subjects, the data were analyzed as described below.

2x6 factorial ANOVAs presented in Table 1 show that for all the subjects, the errors were fewer, and the response time slower for the stimuli of both the global and local tasks in the lower left quadrant when compared to the remaining three quadrants [global ($F(1) = 76.8, p < .001$) and local ($F(1) = 20.1, p < .001$) error scores,

and global ($F(1) = 5.4, p < .05$) and local ($F(1) = 7.0, p = .01$) latency scores]. Further, a two-way quadrant by group interaction showed that the pattern of the means were similar in direction to the above means for all the smoking groups, except the controls (gp. 1), who responded faster on the global task to the stimuli in the lower left quadrant when compared to the other three quadrants ($F(5) = 3.0, p = .01$).

[Insert Table 1 here.]

Based on the above differences, the longer appearing stimuli in the lower left quadrant was eliminated, thus changing the total number of stimuli to 182 from the original 208 in each of the global and local tasks.

2. Subjects

All subjects were first year psychology students. The age of the subjects ranged from 17 to 51 years of age ($\bar{x} = 21.9, SD = 5.88$). There were 80 females, and 67 males for a total of 147 subjects. The majority of the subjects were right-handed ($n = 122$), and were familiar with the keyboard ($n = 135$). All subjects reported being fluent in the English (spoken) language, and having no difficulty with their vision. The smoking history of the subjects indicated that 47 were smokers. The pre measure smoking history and the smoking history questionnaire (Appendix 1 and 3) provided the number of subjects that fell into specific categories (Table 2).

[Insert Table 2 here.]

TABLE 1COMPARING STIMULI W/w AND W/m IN LOWER LEFT WITH OTHER 3
QUADRANTS ON THE GLOBAL/LOCAL TASKS

		<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
<u>Stimuli</u>	<u>n</u>				
total stimuli	15288	8.7	12.6	940	1038
lower left stim	3822	5.2	10.5	950	1051
other 3 quads stim	11466	9.8	13.3	937	1034
group/stimuli					
1 low left	676	3.4	12.3	949	1071
1 3 quads	2028	8.5	15.1	973	1062
2 low left	728	5.9	11.0	942	1064
2 3 quads	2184	10.2	15.5	933	1058
3 low left	702	4.3	7.6	942	1000
3 3 quads	2106	10.1	10.3	932	975
4 low left	520	7.1	9.6	931	1041
4 3 quads	1560	8.4	12.7	913	1028
5 low left	624	6.3	11.1	962	1065
5 3 quads	1872	11.7	12.9	937	1038
6 low left	572	4.9	11.7	976	1069
6 3 quads	1716	9.9	13.0	926	1043

Cont'd...

Dependent Variables

	% Error Global	% Error Local	Latency Global msec	Latency Local msec
<u>Variables</u>	<u>F values</u>			
stimuli	76.8***	20.1***	5.4*	7.0**
stimuli by group	1.4	0.6	3.0**	0.4

- 1) controls (non-smokers, not exposed *in utero* or passively
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: 2x6 factorial ANOVAs was used to compare means of the six smoking groups on their performance on the lower left stimuli (W/m, W/w) with the other three quadrants

- * $p \leq .05$
- ** $p \leq .01$
- *** $p \leq .001$

TABLE 2

SMOKING HISTORY
(n = 147)
number of subjects (percentages)

	<u>n</u>	1	2	3	4	5
Number of cigarettes/day for all subjects Code:	147					
1=1 to 10, 2=10 to 20, 3=20 and over	25 (17.0)	14 (9.5)	8 (5.4)			
Number of cigarettes per day of smokers Code:	47					
1=1 to 10, 2=10 to 20, 3=20 and over	25 (53.2)	14 (29.2)	8 (17.0)			
Number of years smoker smoked Code:						
1= < one year, 2= 1 to 5 years, 3= 5 to 10 years, 4= > 10 years	2 (1.4)	28 (19.0)	15 (10.2)	2 (1.4)		
Age smoker first started smoking Code:						
1= <15 years, 2= 15 to 18 yrs, 3= >18 yrs	13 (8.8)	26 (17.7)	8 (5.4)			
Exposure to cigarette smoke as a child Code:						
1= yes, 2= no	46 (31.3)	101 (68.7)				

Cont'd...

Exposure to cigarette smoke as an adolescent Code:	n	1	2	3	4	5
147						
1 = yes, 2 = no	51 (34.7)	96 (65.3)				
Living with someone who smoked Code:	147					
1 = yes, 2 = no	49 (33.3)	98 (66.7)				
Number of cigarettes a day smoked by the person the subject was living with Code:	49					
1=1 to 10, 2=10 to 20, 3=20 and over	24 (16.3)	16 (10.0)	9 (6.1)			
The number of hours exposed to smoke at work and/or socially Code:	147					
1= 0 hours, 2= > 0 hours, < one hour, 3= 1 to 3 hours, 4= 3 to 5 hours, 5= > 5 hours	40 (27.2)	37 (25.2)	29 (19.7)	14 (9.5)	27 (18.4)	
Mother's smoking habit during pregnancy Code:						
1 = did not smoke, 2 = < 1 pack a day, 3 = > 1 pack a day, 4 = don't know	99 (67.3)	27 (18.4)	10 (6.8)	11 (7.5)		
Father's smoking habit when mother pregnant Code:						
1 = did not smoke, 2 = < 1 pack a day, 3 = > 1 pack a day, 4 = don't know	104 (70.7)	17 (11.6)	15 (10.2)	11 (7.5)		

.4 Potentially Confounding Variables

The subjects in the present study filled out a post-task questionnaire (Appendix 5) at the completion of each of the global and local tasks. There were no differential effects when the six smoking groups were examined for potentially confounding variables. However, when the subjects were compared for age differences, one-way ANOVAs with Scheffe's test presented in Table 3 show that the subjects exposed *in utero* (gp. 2) were older than the subjects in the other 5 smoking groups ($F(5) = 4.25, p = .001$). In order to examine whether age influenced the performance of group 2 on the global and local tasks, an analysis of covariance (ANCOVA) was conducted (see section on smoking effects below).

[Insert Table 3 here.]

The global and local tasks for the present study were counterbalanced to control for order effects. Results from t-tests presented in Table 4 show that those who did the global task first made more errors on the global task than those who did the local task first [$t(145) = 2.5, p < .05$]. The results did not reveal statistical differences for the local error scores, or for the global and local latency scores as a function of task order.

[Insert Table 4 here.]

2x6 factorial ANOVAs did not yield statistically significant group main effects, and did not yield an interaction between groups and task order on any of the dependent variables (Table 5). The means for the interaction

TABLE 3COMPARISON OF THE AGE OF THE 6 SMOKING GROUPS

	<u>Smoking Groups</u>						<u>F value</u>	
	<u>n</u>	Group 1 26	Group 2 28	Group 3 27	Group 4 20	Group 5 24	Group 6 22	
<u>Variables</u>								
Age		21.3	25.5	20.0	23.7	20.3	20.2	4.25***

1) controls (non-smokers, not exposed *in utero* or passively)

2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke

3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)

6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: one-way ANOVAs were used to compare the mean age of each
of the 6 smoking groups

*** $p \leq .001$

TABLE 4COMPARISON OF MEANS OF PERFORMING THE GLOBAL OR THE LOCAL
TASK FIRSTn = 147

<u>Variables</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
Global first	73	9.8	14.8	891	1057
Local first	74	6.8*	16.5	929	1052

Note : t-tests were used to compare means

* $p \leq .05$

show higher global errors and faster global latencies when the global task was done first by all of the 6 smoking groups. There was no definite trend for the local error and latency scores.

[Insert Table 5 here.]

.4 Smoking Effects on the Global/Local Task Outcome Measures

The data on the global and local tasks were analyzed using analysis of variance (ANOVAs), multivariate analysis of variance (MANOVAs), and Pearson product-moment correlations to look for differences in performance by the subjects depending on which smoking group they belonged to.

One-way ANOVAs (Table 6) comparing the subjects on each of the global and local error and latency (response time) scores did not result in statistically significant differences for any of the comparisons. The means for the six smoking groups however reflect an interesting trend. Current smoking appeared associated with the fastest response time. That is, the current smoking group (gp. 3) followed by the current smoking plus exposed *in utero* group (gp. 4) had the lowest global and local latency scores. Additionally, the global error scores were lowest for group 4, and highest for the passively exposed groups (gps. 5 and 6). Also, the local error scores

TABLE 5

COMPARISON OF MEANS OF PERFORMING THE GLOBAL OR THE LOCAL TASK FIRST

		<u>Dependent Variables</u>			
<u>Variables</u>	<u>n</u>	% Error Global	% Error Local	Latency Global msec	Latency Local msec
group/task order					
1 - global first	13	8.8	16.0	899	1075
local first	13	7.0	18.6	988	1078
2 - global first	14	8.4	18.7	905	1064
local first	14	7.7	18.0	920	1073
3 - global first	13	9.6	13.0	896	1076
local first	14	6.6	12.4	899	937
4 - global first	10	10.3	9.2	881	984
local first	10	4.1	20.1	901	1130
5 - global first	12	11.0	16.7	873	1079
local first	12	7.4	13.2	941	1049
6 - global first	11	11.3	13.3	888	1046
local first	11	7.7	17.2	922	1072
<u>Variables</u>		<u>F values</u>			
group/task order		0.35	1.42	0.36	1.86

- 1) controls (non-smokers, not exposed *in utero* or passively)
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: 2x6 factorial ANOVAs was used to compare means of the six smoking groups on the global and local task order

were highest for the group exposed *in utero* (gp. 2), and lowest for group 3.

[Insert Table 6 here.]

Table 6 also shows that statistical significance was not reached for the effects of exposure to secondhand smoke on the dependent variables when the controls (gp. 1) were compared with the two passively exposed groups (gps. 5 and 6), or for a comparison of group 5 with group 6. The means indicate that the controls had lower global, and higher local error scores, and that they were slower to respond on both the global and local tasks than groups 5 and 6.

A MANOVA indicated a non-significant statistical relationship for a combined effect of the dependent variables on the six smoking groups (see Table 6, p. 80 for group means). An additional between subject analysis was conducted to look for the difference in scores between the six smoking groups. The differences were not significant for the global and local tasks.

An ANCOVA was used to look for the influence of age on the performance of the group exposed *in utero* (gp. 2) on the global and local tasks. A factor by covariate interaction indicated non-significant differences on the global and local tasks after adjusting for age.

One-way ANOVAs with a follow-up Scheffe's test shown in Table 7 for the effects of light (1 to 10 cigarettes per day), moderate

TABLE 6
COMPARISON OF MEANS OF THE SMOKING GROUPS
ON THE DEPENDENT VARIABLES

		<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
<u>Smoking groups</u>	<u>n</u>				
total sample	147	8.3	15.6	910	1054
groups:					
1	26	7.9	17.3	944	1077
2	28	8.0	18.3	913	1069
3	27	8.0	12.7	897	1004
4	20	7.2	14.8	891	1057
5	24	9.2	14.9	907	1064
6	22	9.5	15.2	905	1059

<u>Variables</u>	<u>F values</u>			
smoking groups	0.30	1.08	0.42	0.66

- 1) controls (non-smokers, not exposed *in utero* or passively)
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: one-way ANOVAs were used to compare the 6 smoking group means

(10 to 20 cigarettes per day), and heavy (20 and over) current smoking for the current smokers (group 3) on the outcome measures indicate that the moderate smokers were the slowest to respond [global ($F(2) = 11.3, p < .001$ and local ($F(2) = 6.2, p < .01$ latency scores). The means also indicate that the moderate smokers made the most errors on the global and local tasks.

[Insert Table 7 here.]

One-way ANOVAs shown in Table 8 comparing the current smokers plus exposed *in utero* group (gp. 4) for the effects of light, moderate, and heavy current smoking on the outcome measures did not reach statistical significance. The pattern and direction of the results however are of interest to the present study. The heavy smokers in group 4 made the least errors on the global task and the most errors on the local task ($p=.08$), and they responded fastest on the global and slowest on the local tasks.

[Insert Table 8 here.]

The local error means of the heavy smokers ($n = 4$) in group 4 were examined for outliers. It was noted that although a single local error mean score ($\bar{x} = 57.0$) contributed to the near statistically significant differences described above, the means of the remaining 3 subjects on the local error scores ($\bar{x} = 18.0$) were still higher than the means on the global error scores ($\bar{x} = 6.0$) when the outlier was removed.

2

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TABLE 7COMPARISON OF MEANS OF THE CURRENT SMOKING GROUP (3) FOR
DOSE RESPONSE EFFECTS

		<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
<u>Smoking Group - 3</u>	<u>n</u>				
total sample	27	8.0	12.7	897	1004
cigarettes per day:					
a) light smokers	16	7.6	11.1	826	952
b) moderate smokers	7	10.8	17.3	1061	1157
c) heavy smokers	4	5.0	11.3	895	944

<u>Variables</u>	<u>F values</u>			
cigarettes per day	0.85	1.61	11.28***	6.21**
a) 1 to 10 cigarettes per day				
b) 10 to 20 cigarettes per day				
c) 20 and over cigarettes per day				

Note: one-way ANOVAs were used to compare means of current smokers
(group 3) for dose response effects

** $p \leq .01$

*** $p \leq .001$

TABLE 8

COMPARISON OF MEANS OF THE CURRENT SMOKERS PLUS EXPOSED
IN UTERO GROUP (4) FOR DOSE RESPONSE EFFECTS

		<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
<u>Smoking Group - 4</u>	<u>n</u>				
total sample	20	7.2	14.8	891	1057
cigarettes per day:					
a) light	9	7.8	10.9	906	1025
b) moderate	7	7.9	12.3	901	1036
c) heavy	4	4.7	27.6	839	1166

VariablesF values

cigarettes per day	0.31	2.91†	0.49	1.17
--------------------	------	-------	------	------

- a) 1 to 10 cigarettes per day
- b) 10 to 20 cigarettes per day
- c) 20 and over cigarettes per day

Note: one-way ANOVAs were used to compare means of
the current smokers plus exposed *in utero* (group 4) for dose response
effects

† $P \leq .10$

In order to compare the opposite direction in the means for the global and local tasks described above, additional analyses were conducted. The independent variable, cigarettes per day, was correlated both with the global error scores, and with the local error scores. Additionally, the global error scores were correlated with the local error scores. A t value was determined (Ferguson, 1959, p. 154) to look for statistically significant differences between the three correlation coefficients. The results were not statistically significant ($t=1.44, p > .05$).

Pearson product-moment correlations (Table 9) were computed to look for a possible dose response relationship between the global and local tasks and the smoking habit of the subjects. This was done by first collapsing across all of the six smoking groups, and then separately with the current smoking groups (gps. 3 and 4).

Collapsing across the six smoking groups, the local error scores were positively associated with the number of years smoked ($r(47) = .28, p = .05$) and number of cigarettes per day ($r(47) = .30, p < .05$). For the current smokers (gp. 3), a positive relationship was found between the global latency scores and the number of cigarettes per day ($r(27) = .39, p < .05$), as well as with the nicotine content per cigarette ($r(27) = .38, p = .05$). For the current smokers plus exposed *in utero* group (gp. 4), local error scores were positively associated with the number of cigarettes per day ($r(20) = .44, p = .05$).

[Insert Table 9 here.]

TABLE 9

RELATIONSHIP BETWEEN THE DEPENDENT VARIABLES AND THE SMOKING HABIT OF SUBJECTS

<u>Smoking Groups</u>	<u>n</u>	<u>Variables</u>	<u>Dependent Variables</u>			
			% Error Global	% Error Local	Latency Global msec	Latency Local msec
6 smoking groups	147	years smoked	-0.23	0.28*	0.01	0.25†
		cigarettes per day	-0.09	0.30*	0.16	0.26†
		nicotine per cig	-0.08	0.22	0.16	0.16
group 3	27	years smoked	-0.14	0.12	0.30	0.25
		cigarettes per day	-0.04	0.13	0.39*	0.19
		nicotine per cig	-0.04	0.09	0.38*	0.12
group 4	20	years smoked	-0.32	0.38†	-0.38†	0.16
		cigarettes per day	-0.15	0.44*	-0.20	0.30
		nicotine per cig	-0.14	0.34	-0.24	0.18

3) current smokers, exposed to passive smoke in the past 6-12 months

4) current smokers, exposed in utero, and regularly exposed to passive smoke

Note: Pearson product-moment correlations were used to look at the

relationship between subjects smoking habit and the dependent variables

* $p \leq .05$ † $p \leq .10$

Additional Pearson product-moment correlations were computed to examine the direction of relationship between errors made and response time on the global and local tasks. This was done by first collapsing across the six smoking groups, and then separately with each of the six smoking groups. The results presented in Table 10 show statistical, or near statistically significant (positive and negative) relationships for all the smoking groups on several aspects of the global and local comparisons.

[Insert Table 10 here.]

Of particular interest to the present study, is the magnitude of relationship between the local error scores and the local latency scores for the current smokers (gp. 3, $p \leq .10$, and gp. 4, $p \leq .001$) when compared with the controls (gp. 1) who did not reach statistical significance. A follow-up analysis for testing significance of the correlation between the local error and latency scores with a Fisher's z_r transformation (Ferguson, 1959, p. 153) revealed that group 4 differed from group 1 ($p \leq .05$).

.5 Performance on the Global/Local Task as a Function of Stimuli Parameters

This section reports results of the main effects of the global and local stimuli presentations depending on whether the stimuli were consistent or inconsistent, breakdown of stimuli or trials by specific blocks, and stimuli presented in the left and right visual fields.

TABLE 10

RELATIONSHIP BETWEEN THE GLOBAL AND LOCAL DEPENDENT VARIABLES

		<u>Dependent Variables</u>			
			Latency Global msec	Latency Local msec	% Error Global
<u>Smoking Groups</u>	<u>n</u>				
6 smoking groups	147	Latency Local ms	0.65***		
		% Error Global	0.07	-0.07	
		% Error Local	0.18*	0.48***	0.18*
group 1	26	Latency Local ms	0.66***		
		% Error Global	0.10	0.04	
		% Error Local	0.20	0.23	0.40*
group 2	28	Latency Local ms	0.77***		
		% Error Global	0.35†	0.33†	
		% Error Local	0.35†	0.62***	0.45*
group 3	27	Latency Local ms	0.61***		
		% Error Global	0.14	0.16	
		% Error Local	0.20	0.37†	0.54**
group 4	20	Latency Local ms	0.30		
		% Error Global	0.09	-0.28	
		% Error Local	-0.04	0.77***	-0.13
group 5	24	Latency Local ms	0.70***		
		% Error Global	-0.42*	-0.42*	
		% Error Local	-0.17	0.17	-0.16
group 6	22	Latency Local ms	0.79***		
		% Error Global	-0.02	-0.28	
		% Error Local	0.29	0.60**	0.03

Note: Pearson product-moment correlations were used to look at the relationship between the global and local dependent variables

* $p \leq .05$; ** $p \leq .01$; *** $p \leq .001$;

† $p \leq .10$

Consistent Inconsistent Stimuli

A stimulus was coded as consistent when a large letter was made up of the same smaller letters (i.e., W w), and inconsistent when a large letter was made up of different smaller letters (i.e., W m). To look for differences in performance by all the subjects on the global and local tasks depending on whether the stimuli were inconsistent or consistent, 2x6 factorial ANOVAs were conducted. Results presented in Table 11 indicate that there were more errors made with the inconsistent stimuli than with the consistent stimuli, and that the inconsistent stimuli were responded to slower than the consistent stimuli [global ($F(1) = 36.5$, $p < .001$) and local ($F(1) = 60.3$, $p < .001$) error, and global ($F(1) = 22.2$, $p < .001$) and local ($F(1) = 13.2$, $p < .001$) latency scores].

[Insert Table 11 here.]

Performance on the 13 Blocks of the Global and Local Tasks

The global and local tasks were divided into 13 blocks of 14 trials or stimuli each (Figs. 3 and 4). When the 13 blocks were compared with a one-way ANOVA with Scheffe's test (Table 12), block 1 contributed to higher error scores, and slower latency scores [global ($F(12) = 3.46$, $p < .001$) and local ($F(12) = 2.31$, $p < .01$) error scores, and global ($F(12) = 4.44$, $p < .001$) and local ($F(12) = 7.38$, $p < .01$) latency scores].

[Insert Figures 3 and 4, and Table 12 here.]

TABLE 11
COMPARISON OF SMOKING GROUPS ON INCONSISTENT AND CONSISTENT
STIMULI

<u>Stimuli</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
total stimuli	294	8.3	15.6	910	1054
Inconsistent	147	11.2	21.1	950	1090
Consistent	147	5.5	10.2	871	1019
group/stimuli					
1 - incon	26	11.0	24.7	990	1115
- con		4.8	9.9	897	1038
2 - incon	28	10.4	25.6	957	1112
- con		5.7	11.1	868	1025
3 - incon	27	11.0	16.9	933	1040
- con		5.1	8.5	862	968
4 - incon	20	10.3	20.4	935	1096
- con		4.1	9.1	847	1018
5 - incon	24	12.6	17.2	941	1094
- con		5.9	12.7	873	1033
6 - incon	22	11.9	21.0	937	1082
- con		7.1	9.4	873	1036

Cont'd...

<u>Variables</u>	<u>Dependent Variables</u>			
	% Error Global	% Error Local	Latency Global msec	Latency Local msec
	<u>F values</u>			
stimuli	36.5***	60.3***	22.2***	13.2***
stimuli x group	0.13	1.3	0.09	0.09

- 1) controls (non-smokers, not exposed *in utero* or passively
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: a 2x6 factorial ANOVA was used to compare means of the six smoking groups on their performance on the inconsistent and consistent stimuli

*** $p < .001$

FIGURE 3

COMPARISON OF GLOBAL/LOCAL ERROR MEANS ON THE 13 BLOCKS

$N = 147$

FIGURE 4**COMPARISON OF GLOBAL/LOCAL LATENCY MEANS ON THE 13 BLOCKS** $\bar{n} = 147$

TABLE 12
COMPARISON OF MEANS OF THE 13 BLOCKS ON THE DEPENDENT
VARIABLES

Blocks	n	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
total stimuli	1911	8.3	15.6	910	1054
block 1	147	13.0	20.0	985	1187
block 2		9.3	16.0	943	1090
block 3		8.3	15.5	916	1076
block 4		8.7	15.4	912	1050
block 5		7.1	18.3	923	1058
block 6		7.2	14.2	879	1030
block 7		7.7	15.9	909	1042
block 8		8.0	14.1	867	1038
block 9		8.3	15.0	904	1038
block 10		7.9	14.8	905	1029
block 11		8.2	15.0	901	1013
block 12		7.1	15.0	891	1026
block 13		7.4	14.4	899	1028
<u>F values</u>		3.46***	2.31**	4.44***	7.38**

Note: one-way ANOVA's were used to compare the means of the 13 blocks.

** $p \leq .01$

*** $p \leq .001$

In order to examine whether learning was taking place, error scores and latencies were compared in blocks 1, 7, and 13 using one-way ANOVAs with Scheffe's test. Each of the 3 blocks represented learning, familiarity with the task, and fatigue respectively. Results presented in Table 13 show that block 1 contributed to higher global and local error scores, and slower global and local latency scores in contrast to block 13 which shows fewer errors, and faster latencies [global ($F(2) = 11.5, p < .001$) and local ($F(2) = 6.3, p < .01$) error, and global ($F(2) = 10.5, p < .001$) and local ($F(2) = 25.1, p < .001$) latency scores].

[Insert Table 13 here.]

Left and Right Visual Field Presentations

The global and local letter stimuli were presented in the four quadrants on the computer screen. The top and bottom quadrants were collapsed to yield a left and right visual field.

For the left and right visual field comparison, 2x6 factorial ANOVAs did not yield statistically significant differences (Table 14) for all the subjects when examined on their performance on the global and local tasks. The pattern of the means for the right visual field show higher errors, and slower response time.

[Insert Table 14 here.]

A follow-up analysis compared the top left and top right quadrants only. The bottom left and bottom right quadrants were

TABLE 13
EXAMINING BLOCK PERFORMANCE FOR LEARNING

<u>Blocks</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
block 1	147	13.0	20.0	985	1187
block 7		7.7	15.9	909	1042
block 13		7.4	14.4	899	1028
<u>F values</u>		11.46***	6.30**	10.48***	25.42***

Note: one-way ANOVA's were used to compare means on blocks 1, 7, and 13.

** $p \leq .01$

*** $p \leq .001$

TABLE 14**COMPARISON OF GLOBAL LOCAL MEANS ON LEFT RIGHT VISUAL FIELDS**

<u>Variables</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
total stimuli	294	8.2	15.5	909	1054
left visual field	147	7.5	14.8	901	1051
right visual field	147	8.9	16.2	917	1057
group x visual field					
1 - left	26	7.6	16.3	926	1068
- right		8.1	18.1	957	1083
2 -left	28	6.7	16.4	907	1070
- right		9.0	19.8	917	1067
3 -left	27	7.0	12.1	885	999
- right		8.8	13.1	906	1008
4 - left	20	6.5	14.6	883	1052
- right		7.7	14.9	898	1061
5 - left	24	7.9	14.5	901	1067
- right		10.2	15.2	911	1061
6 - left	22	9.7	15.1	899	1052
- right		9.4	15.3	909	1064
<u>Variables</u>		<u>F values</u>			
left and right visual fields		2.18	1.21	0.98	0.09
left and right visual fields x groups		0.22	0.18	0.05	0.03

- 1) controls (non-smokers, not exposed *in utero* or passively)
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: 2 x 6 factorial ANOVAs were used to compare means of the six smoking groups on their performance on the left and right visual fields (top and bottom quadrants collapsed)

not compared due to the longer appearing stimuli in the bottom left quadrant which resulted in an unequal number of stimuli in the two bottom quadrants (see p. 68 for explanation). In contrast to the above comparison, 2x6 factorial ANOVAs presented in Table 15 resulted in higher error scores and slower latency scores in the top left visual field [global ($E(1) = 12.8$, $p < .001$ error scores)] across all subjects.

[Insert Table 15 here.]

6 Interactional Effects of Smoking Groups and Stimuli Presentations

This section reports results of the differential effects between the six smoking groups and different aspects of the global and local stimuli presentations.

Consistent/Inconsistent Stimuli

The 2x6 factorial ANOVAs showed that the six smoking groups did not interact differentially with the consistent/inconsistent stimuli (see Table 11, p. 89). For every comparison, the means on the global and local errors were higher, and the latencies were slower for the inconsistent stimuli.

Chi-square analyses were used to examine whether the proportion of subjects in each smoking group were making more errors (and responding more slowly) in the inconsistent versus the consistent stimuli. The subjects were categorized according to

TABLE 15

COMPARISON OF GLOBAL/LOCAL MEANS ON THE TOP LEFT AND TOP
RIGHT VISUAL FIELDS

<u>Variables</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
total stimuli	294	4.6	7.0	884	984
top left visual field	147	5.8	7.3	887	991
top right visual field	147	3.5	6.7	881	976
group x visual field					
1 - top left	26	5.5	8.2	916	1012
- top right		3.7	8.1	916	998
2 - top left	28	4.7	7.6	888	1019
- top right		3.5	8.8	874	988
3 - top left	27	5.9	4.7	878	936
- top right		3.4	3.9	882	933
4 - top left	20	5.1	8.4	871	979
- top right		2.7	5.6	854	961
5 - top left	24	6.0	7.5	891	1000
- top right		3.8	6.9	875	986
6 - top left	22	7.6	7.7	874	1000
- top right		4.0	6.8	876	990
<u>Variables</u>		<u>F values</u>			
visual fields		12.81***	0.24	0.15	0.66
visual fids x groups		0.26	0.21	0.05	0.05

- 1) controls (non-smokers, not exposed *in utero* or passively)
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: 2 x 6 factorial ANOVAs were used to compare means of the six smoking groups on their performance on the top left and top right visual field presentations

*** $P \leq .001$

whether they scored more errors on the inconsistent than the consistent stimuli, and whether they were slower on the inconsistent versus the consistent stimuli on the global and local tasks. These frequencies were then compared across smoking groups. Results presented in Table 16 show that the major contributor was the passive group (gp. 5), where a larger proportion of subjects made fewer errors on the inconsistent stimuli on the local task compared with the other five smoking groups ($\chi^2(5) = 12.6, p < .05$). The global error scores approached significance ($p = .07$), while the global and local latency scores did not reveal significant differences for the six smoking groups.

[Insert Table 16 here.]

Block Comparison

There were no differential effects between the six smoking groups and the 13 blocks with a 6x13 factorial ANOVA. Figures 5 through 8 for the global and local error and latency scores provide a visual means for examining the performance of the six smoking groups on the 13 blocks. In order to examine whether there were extreme scores across the 13 blocks and/or in any of the individual 13 blocks for the six smoking groups, several chi-square analyses were conducted.

[Insert Figures 5 to 8 here.]

TABLE 16

PERCENTAGE OF SUBJECTS SCORING MORE ERRORS AND SLOWER
RESPONSES ON THE INCONSISTENT THAN ON THE CONSISTENT STIMULI
percentage of subjects (number of subjects)

<u>Smoking Groups</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local*	Latency Global msec	Latency Local msec
group 1	26	89 (23)	92 (24)	92 (24)	88 (23)
group 2	28	79 (22)	89 (25)	96 (27)	89 (25)
group 3	27	82 (22)	96 (26)	96 (26)	93 (25)
group 4	20	95 (19)	100 (20)	100 (20)	95 (19)
group 5	24	92 (22)	71 (17)	100 (24)	92 (22)
group 6	22	64 (14)	86 (19)	95 (21)	86 (19)

1) controls (non-smokers, not exposed *in utero* or passively

2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke

3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)

6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Chi-squares were used to examine the percentage of subjects in each of the 6 smoking groups who made more errors and responded slower on the inconsistent than on the consistent stimuli

* $p \leq .05$

FIGURE 5

COMPARISON OF GLOBAL ERROR MEANS OF THE SIX SMOKING GROUPS ACROSS 13 BLOCKS

FIGURE 6

COMPARISON OF LOCAL ERROR MEANS OF THE SIX SMOKING GROUPS ACROSS 13 BLOCKS

FIGURE 7

COMPARISON OF GLOBAL LATENCY MEANS OF THE SIX SMOKING GROUPS ACROSS 13 BLOCKS

- 1) controls (non-smokers, not exposed *in utero* or passively)
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- ◆ 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- ◇ 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- ▲ 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- △ 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

FIGURE 8

COMPARISON OF LOCAL LATENCY MEANS OF THE SIX SMOKING GROUPS ACROSS 13 BLOCKS

The first part of the analysis was to compare proportions of subjects (entire sample, and each group separately) scoring at least 1 SD above the sample mean, and the second part of the analysis was to compare proportions of subjects scoring at least 1 SD below the sample mean.

Statistical significance was found only for blocks 5 and 9 (Table 17 and 18). In block 5, approximately 30% of groups 3, 4, and 6, and only 4 to 12% of groups 1, 2, and 5 scored 1 SD lower than the local latency mean ($\chi^2(13.30)$, $p < .05$). In block 9, 43% of group 2 and only 4% of group 3 scored 1 SD above the local error mean ($\chi^2(16.78)$, $p < .01$).

[Insert Tables 17 and 18 here.]

Left/Right Visual Field Presentations

There were no differential effects between the six smoking groups and the stimuli when presented in the left and right visual fields with a 2x6 factorial ANOVA. The pattern of the means show that when the top and bottom quadrants were collapsed, the means for the right visual field (except for gp. 6) were higher for the global and local error scores (see Table 14, p. 96). The global latencies were faster in the left visual field for all the groups, and except for groups 2 and 5, they were also faster in the left visual field for the local latency scores.

TABLE 17

PERCENTAGE OF SUBJECTS SCORING MORE THAN 1 SD ABOVE THE OVERALL
MEAN FOR EACH OF THE DEPENDENT VARIABLES IN BLOCK FIVE

Smoking Groups	n	% Error Global	% Error Local	<u>Dependent Variables</u>	
				Latency Global msec	Latency Local msec
group 1	26	15 (4)	12 (3)	12 (3)	8 (2)
group 2	28	14 (4)	18 (5)	18 (5)	18 (5)
group 3	27	7 (2)	15 (4)	19 (5)	22 (6)
group 4	20	5 (1)	10 (2)	5 (1)	15 (3)
group 5	24	8 (2)	9 (2)	8 (2)	13 (3)
group 6	22	27 (6)	0	14 (3)	23 (5)

PERCENTAGE OF SUBJECTS SCORING LESS THAN 1 SD BELOW THE OVERALL
MEAN FOR EACH OF THE DEPENDENT VARIABLES IN BLOCK FIVE

Smoking Groups	n	% Error Global	% Error Local	<u>Dependent Variables</u>	
				Latency Global msec	Latency Local*
group 1	26	0	15 (4)	8 (2)	4 (1)
group 2	28	0	32 (9)	21 (6)	7 (2)
group 3	27	0	26 (7)	22 (6)	30 (8)
group 4	20	0	25 (5)	15 (3)	30 (6)
group 5	24	0	21 (5)	8 (2)	13 (3)
group 6	22	0	27 (6)	18 (4)	32 (7)

1) controls (non-smokers, not exposed *in utero* or passively

2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke

3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)

6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Chi squares were used to examine the proportion of subjects who scored more than 1 SD above, and those who scored less than 1 SD below the overall mean on the dependent variables in block five

*p ≤ .05

TABLE 18

PERCENTAGE OF SUBJECTS SCORING MORE THAN 1 SD ABOVE THE OVERALL
MEAN FOR EACH OF THE DEPENDENT VARIABLES IN BLOCK NINE

Smoking Groups	n	% Error Global	<u>Dependent Variables</u>		Latency Local
			% Error Local* *	Latency Global	
			msec	msec	
group 1	26	8 (2)	23 (6)	15 (4)	15 (4)
group 2	28	14 (4)	43 (12)	14 (4)	14 (4)
group 3	27	15 (4)	4 (1)	11 (3)	19 (5)
group 4	20	10 (2)	20 (4)	10 (2)	15 (3)
group 5	24	17 (4)	13 (3)	8 (2)	25 (6)
group 6	22	27 (6)	9 (2)	14 (3)	18 (4)

PERCENTAGE OF SUBJECTS SCORING LESS THAN 1 SD BELOW THE OVERALL
MEAN FOR EACH OF THE DEPENDENT VARIABLES IN BLOCK NINE

Smoking Groups	n	% Error Global	<u>Dependent Variables</u>		Latency Local
			% Error Local	Latency Global	
				msec	msec
group 1	26	0	12 (3)	4 (1)	15 (4)
group 2	28	0	18 (5)	21 (6)	11 (3)
group 3	27	0	11 (3)	15 (4)	22 (6)
group 4	20	0	20 (4)	15 (3)	15 (3)
group 5	24	0	21 (5)	17 (4)	13 (3)
group 6	22	0	23 (5)	23 (5)	27 (6)

1) controls (non-smokers, not exposed *in utero* or passively)

2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke

3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)

6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Chi squares were used to examine the proportion of subjects who scored more than 1 SD above, and those who scored less than 1 SD below the overall mean on the dependent variables in block nine

** $P \leq .01$

Further, when the top right and top left quadrants were compared, there were no differential effects between the left and right visual fields and the groups. The top right visual field means were lower for the global and local error scores (except gp. 2, local errors), and faster for the local latency and global latency (except gp. 3, and gp. 6, global latency, see Table 15, p. 98) scores.

2x3 factorial ANOVAs were used to look for an interaction between the three blocks (1, 7, and 13) and the left and right visual fields (top and bottom quadrants collapsed) to look for learning effects (Table 19). The response time got faster for the global and local scores as the subjects progressed from block 1 to block 13. The error means were highest for the global and local scores on block 1, and lowest for block 13. When the means of the left and right visual fields were compared for the three blocks, blocks 7 and 13 had faster global and local latencies, and fewer global errors ($p = .07$) in the left visual field than in the right visual field. The local errors did not follow the above trend.

[Insert Table 19 here.]

2x3 factorial ANOVAs was repeated for the top left and top right visual fields with blocks 1, 7, and 13. Consistent with the above comparison, the response time was faster, and the errors were fewer for the global and local scores as the subjects progressed from block 1 to block 13. When the means for the left and right visual fields were compared for the three blocks, all three blocks had slower

TABLE 19

COMPARISON OF BLOCK PERFORMANCE FOR LEARNING THE GLOBAL
AND LOCAL TASKS IN THE LEFT AND RIGHT VISUAL FIELDS

<u>Variables</u>	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
blocks X visual fields					
1 - left visual field	147	13.2	19.6	1002	1203
- right visual field		11.2	17.8	973	1174
7 - left		6.6	13.8	900	1036
- right		7.5	16.7	916	1046
13 - left		4.9	13.5	887	1025
- right		7.8	13.2	907	1031

<u>Variables</u>	<u>F values</u>			
blocks x visual fields	2.7†	1.7	1.4	0.6

Block 1 - may represent learning of the global and local tasks

Block 7 - may represent familiarity with the global and local tasks

Block 13 - may represent fatigue

Note: 2 x 3 factorial ANOVAs were used to compare the means of the 3 blocks for learning by comparing performance in the left and right visual fields (top and bottom quadrants collapsed)

† $p \leq .10$

global ($p=.01$) and local latencies, and higher global ($p<.05$) and local ($p=.05$) errors in the left visual field than in the right visual field (Table 20).

[Insert Table 20 here.]

2x13 factorial ANOVAs presented in Table 21 show an interaction between the left and right visual fields and the 13 blocks. The pattern of the means (see Figures 9 and 10) show that for the global error scores, subjects performed progressively better (made fewer errors) on blocks 1 through 13 with the stimuli presented in the left visual field than with the stimuli presented in the right visual field [$F(12) = 2.2$, $p = .01$]. The local error scores show lower means in 8 out of 13 cases for the left visual field [$F(12) = 2.3$, $p = .01$]. The means for the global and local latency scores (see Figs. 11 and 12) when considered over the 13 blocks did not follow a general trend.

[Insert Table 21 and Figures 9 through 12 here.]

2x13 factorial ANOVAs presented in Table 22 show the interaction between the top left and top right visual fields and the 13 blocks. The pattern of the means (Figures 13 and 14) show that for the global error scores, subjects performed progressively better (made fewer errors) on blocks 1 through 13 with the stimuli presented in the right visual field than with the stimuli presented in the left visual field ($p = .06$). The local error scores in general showed lower means for the right visual field. The latency scores

TABLE 20COMPARISON OF BLOCK PERFORMANCE FOR LEARNING THE GLOBAL AND LOCAL TASKS IN THE TOP LEFT AND TOP RIGHT VISUAL FIELDS

		<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
<u>Variables</u>	<u>n</u>				
blocks x visual fields					
1 top left visual field	147	12.8	16.8	1020	1170
top right visual field		6.8	11.1	918	1086
7 - left		6.3	7.0	883	997
- right		4.3	6.8	866	951
13 - left		4.2	5.8	868	985
- right		3.6	5.8	861	958

<u>Variables</u>	<u>F values</u>			
blocks x visual fields	3.5*	3.1*	5.0**	1.2

Block 1 - may represent learning of the global and local tasks

Block 7 - may represent familiarity with the global and local tasks

Block 13 - may represent fatigue

Note: 2 x 3 factorial ANOVAs were used to compare the means of the 3 blocks for learning by comparing performance on the top left and top right visual fields

* $p \leq .05$

** $P \leq .01$

TABLE 21COMPARISON OF THE MEANS OF THE 13 BLOCKS ON THE GLOBAL LOCAL
TASKS IN THE LEFT AND RIGHT VISUAL FIELDS

<u>Variables</u> block x visual field	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
1 - left visual field	147	13.2	19.6	1002	1203
- right visual field		11.2	17.8	973	1174
2 - left		9.4	15.3	944	1102
- right		8.6	14.5	942	1082
3 - left		8.3	14.1	900	1056
- right		7.9	14.8	928	1091
4 - left		6.5	12.4	909	1046
- right		9.7	16.3	914	1053
5 - left		6.8	12.5	901	1054
- right		6.8	20.7	940	1061
6 - left		5.4	12.3	874	1030
- right		7.5	13.9	882	1030
7 - left		6.6	13.8	900	1036
- right		7.5	16.7	916	1046
8 - left		6.5	13.9	839	1043
- right		8.2	12.9	888	1034
9 - left		6.4	12.9	898	1026
- right		8.9	15.1	909	1048

Cont'd...

<u>Dependent Variables</u>					
<u>Variables</u>	<u>n</u>	% Error Global	% Error Local	Latency Global msec	Latency Local msec
10 - left visual field	147	4.3	12.8	894	1008
- right visual field		9.9	14.2	913	1044
11 - left		6.5	12.6	886	1010
- right		8.5	15.4	912	1015
12 - left		5	14.2	877	1022
- right		7.7	14	901	1028
13 - left		4.9	13.5	887	1025
- right		7.8	13.2	907	1031
<u>Variables</u>		<u>F values</u>			
visual fields x blocks		2.2**	2.3**	0.8	0.5

Note: 2 x 13 factorial ANOVAs were used to compare the means of the 13 blocks with the left and right visual fields (top/bottom collapsed)

** $p \leq .01$

FIGURE 9

COMPARING GLOBAL ERROR MEANS ON LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

FIGURE 10

COMPARING LOCAL ERROR MEANS ON LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

FIGURE 11

COMPARING LATENCY GLOBAL MEANS ON LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

FIGURE 12

COMPARING LOCAL LATENCY MEANS ON LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

(Figs. 15 and 16) when considered over blocks were lower for the right visual field global [$F(12) = 2.9, p = .001$] and local scores.

[Insert Table 22 and Figures 13 through 16 here.]

Based on the results for the left and right visual field comparisons (top and bottom quadrants collapsed) a between subjects analysis was used to compare the global and local error scores on the right visual field across the 13 blocks, and the global and local latency scores on the right visual field across the 13 blocks. The above comparison was then repeated for the left visual field. This was accomplished by first converting the global and local scores into standard scores. Results indicate statistically significant differences for the global and local latency scores ($F(12) = 2.3, p = .01$) only in the right visual field, and no significance for the global and local error ($p = .09$) or latency scores in the left visual field comparison.

A between subjects analysis was also used to compare the global and local error scores on the top right visual field across the 13 blocks, and the global and local latency scores on the top right visual field across the 13 blocks. The above comparison was then repeated for the left visual field. Results indicate statistically significant differences for the global and local latency scores ($F(12) = 2.56, p = .01$) in the top left visual field, and in the top right visual field ($F(12) = 2.58, p = .01$).

TABLE 22COMPARISON OF MEANS OF THE 13 BLOCKS ON THE GLOBAL/LOCAL
TASKS IN THE TOP LEFT AND TOP RIGHT VISUAL FIELDS

<u>Variables</u> block x visual field	<u>n</u>	<u>Dependent Variables</u>			
		% Error Global	% Error Local	Latency Global msec	Latency Local msec
1 - left visual field	147	12.8	16.8	1020	1170
- right visual field		6.8	11.5	918	1086
2 - left		7.5	8.0	932	1026
- right		3.9	6.0	892	1008
3 - left		6.0	7.0	887	994
- right		3.2	7.5	910	1028
4 - left		5.3	6.6	887	973
- right		5.4	8.0	893	969
5 - left		5.0	6.5	882	998
- right		2.4	6.1	914	971
6 - left		6.2	8.0	869	967
- right		2.4	6.4	854	975
7 - left		6.3	7.0	883	997
- right		4.3	6.8	866	951
8 - left		3.7	5.5	805	980
- right		3.1	5.3	860	961
9 - left		5.7	6.4	878	961
- right		2.9	8.9	862	971

Cont'd...

<u>Dependent Variables</u>					
<u>Variables</u>	<u>n</u>	% Error Global	% Error Local	Latency Global msec	Latency Local msec
10 - left visual field	147	4.3	5.2	887	936
- right visual field		3.1	5.0	880	946
11 - left		3.9	6.5	864	936
- right		2.4	5.8	871	924
12 - left		3.6	5.4	872	962
- right		2.4	6.0	869	940
13 - left		4.2	5.8	868	985
- right		3.6	5.8	861	958

<u>Variables</u>	<u>F values</u>			
visual fields x blocks	1.7†	1.2	2.9***	1.4

Note: 2 x 13 factorial ANOVAs were used to compare the means of the 13 blocks with the top left and top right visual field presentations

*** $p \leq .001$

† $P \leq .10$

FIGURE 13

COMPARING GLOBAL ERROR MEANS ON TOP LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

FIGURE 14

COMPARING LOCAL ERROR MEANS ON TOP LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

FIGURE 15

COMPARING GLOBAL LATENCY MEANS ON TOP LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

FIGURE 16

COMPARING LOCAL LATENCY MEANS ON TOP LEFT/RIGHT VISUAL FIELDS ACROSS 13 BLOCKS

2x6x13 factorial analyses looked at a possible interaction between the left and right visual field presentations, the six smoking groups, and the 13 blocks. The results did not reach statistical significance for any of the global and local error and latency scores for the left and right visual field comparisons (top and bottom quadrants collapsed, and top left and top right quadrant).

7 The Standardized Peabody Picture Vocabulary Test - Revised, and the Raven's Progressive Matrices

One-way ANOVAs, chi-square analysis, and Pearson product-moment correlations were conducted on the data for the present study to examine a potential link between the local scores and the Peabody Picture Vocabulary Test-Revised (PPVT-R), and the global scores and the Raven's Progressive Matrices (RPM).

Smoking Effects

One-way ANOVAs comparing the six smoking groups on their performance on the PPVT-R and RPM tests presented in Table 23 did not indicate statistically significant group main effects.

[Insert Table 23 here.]

The PPVT-R and RPM scores were further examined using chi-square analysis (Table 24) to look at the proportion of subjects scoring 1 SD above, and those scoring 1 SD below the mean of the entire sample (n = 141 and n = 147 respectively). Pearson's chi-

TABLE 23COMPARISON OF MEANS OF THE SIX SMOKING GROUPS ON THE
STANDARDIZED TESTS

		<u>Dependent Variables</u>		
		Peabody		Raven's
<u>Subjects</u>	<u>n</u>		<u>n</u>	
total population	141	105.2	147	50.4
smoking groups				
1	24	105.5	26	50.2
2	28	106.9	28	50.8
3	24	100.2	27	50.3
4	20	109.6	20	49.6
5	23	105.6	24	52
6	22	103.6	22	49.4

<u>Variables</u>	<u>F values</u>	
smoking groups	1.16	0.71

- 1) controls (non-smokers, not exposed *in utero* or passively
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: one-way ANOVAs were used to compare the 6 smoking group means on the standardized Peabody (PPVT) and Raven's (PRM) tests

square values were non-significant for the PPVT-R and the RPM analyses.

[Insert Table 24 here.]

Pearson product-moment correlations were conducted for each of the six smoking groups (Table 25) to look for a relationship between the standardized scores and the global and local scores. For the PPVT-R score comparison, the current smokers plus exposed *in utero* group (gp. 4) indicated a positive relationship with the local error scores ($r(20) = .48, p < .05$), and passive exposure (gp. 6) indicated a negative relationship with the global latency scores ($r(22) = -.49, p < .05$). For the RPM score comparison, there was a negative relationship for the current smokers (gp. 3) with the global ($r(27) = -.44, p < .05$) and local ($r(27) = -.38, p = .05$) error scores.

[Insert Table 25 here.]

Dose response Relationship

The scores on the standardized PPVT-R and RPM tests were analyzed using Pearson product-moment correlations for the effects of smoking (number of years smoked, number of cigarettes per day, and nicotine content of each cigarette). The results (Table 26) were not significant for the current smokers (gps. 3 and 4).

[Insert Table 26 here.]

TABLE 24

PERCENTAGE OF SUBJECTS SCORING MORE THAN 1 SD ABOVE THE OVERALL MEAN
OF THE DEPENDENT VARIABLES
 percentage of subjects (number of subjects)

		<u>Dependent Variables</u>		
<u>Smoking Groups</u>	<u>n</u>	Peabody	<u>n</u>	Raven's
1	24	13 (3)	26	15 (4)
2	28	14 (4)	28	14 (4)
3	24	8 (2)	27	26 (7)
4	20	20 (4)	20	15 (3)
5	23	17 (4)	24	13 (3)
6	22	9 (2)	22	36 (8)

PERCENTAGE OF SUBJECTS SCORING LESS THAN 1 SD BELOW THE OVERALL MEAN
OF THE DEPENDENT VARIABLES

		<u>Dependent Variables</u>		
<u>Smoking Groups</u>	<u>n</u>	Peabody	<u>n</u>	Raven's
1	24	13 (3)	26	0
2	28	18 (5)	28	21 (6)
3	24	21 (5)	27	11 (3)
4	20	10 (2)	20	10 (2)
5	23	17 (4)	24	29 (7)
6	22	32 (7)	22	18 (4)

- 1) controls (non-smokers, not exposed *in utero* or passively
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Chi squares were used to examine the proportion of subjects who scored ± 1 SD from the means of the entire sample on the standardized Peabody and Raven's tests

TABLE 25RELATIONSHIP BETWEEN THE GLOBAL AND LOCAL SCORES AND THE
STANDARDIZED TESTS

<u>Smoking Groups</u>		<u>Dependent Variables</u>			
		<u>Peabody</u>		<u>Raven's</u>	
		<u>n</u>		<u>n</u>	
all groups	Latency Global msec	147	-0.09		-0.08
	Latency Local msec		0.04		-0.07
	% Error Global		-0.14†		-0.10
	% Error Local		0.12		-0.18*
group 1	Latency Global msec	24	-0.04	26	-0.23
	Latency Local msec		-0.23		-0.23
	% Error Global		-0.04		0.10
	% Error Local		0.06		-0.31
group 2	Latency Global msec	28	-0.06	28	-0.11
	Latency Local msec		0.08		-0.12
	% Error Global		-0.19		0.00
	% Error Local		-0.14		-0.21
group 3	Latency Global msec	24	0.07	27	-0.00
	Latency Local msec		0.07		-0.02
	% Error Global		-0.16		-0.44*
	% Error Local		-0.02		-0.38*
group 4	Latency Global msec	20	-0.33	20	-0.04
	Latency Local msec		0.39†		-0.19
	% Error Global		-0.31		-0.01
	% Error Local		0.48*		-0.06

Cont'd...

<u>Smoking Groups</u>		<u>Dependent Variables</u>			
		Peabody		Raven's	
		<u>n</u>		<u>n</u>	
group 5	Latency Global msec	23	0.30	24	0.13
	Latency Local msec		0.25		0.14
	% Error Global		-0.17		-0.10
	% Error Local		0.39†		-0.01
group 6	Latency Global msec	22	-0.49*	22	-0.22
	Latency Local msec		-0.35		-0.12
	% Error Global		0.01		-0.06
	% Error Local		-0.03		-0.17

1) controls (non-smokers, not exposed *in utero* or passively)

2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke

3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)

6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Pearson product-moment correlations were used to look at the relationship between global and local tasks and the standardized tests

* $p < .05$

† $p \leq .10$

TABLE 26

RELATIONSHIP BETWEEN CURRENT SMOKING HABITS AND THE
STANDARDIZED TESTS

			<u>Dependent Variables</u>		
			Peabody		Raven's
<u>Smoking Groups</u>	<u>Variables</u>	<u>n</u>		<u>n</u>	
6 smoking groups	years smoked	44	0.05	47	0.01
	cigarettes per day		0.12		0.08
	nicotine per cig		0.11		0.09
group 3	years smoked	24	-0.27	27	0.07
	cigarettes per day		0.15		0.13
	nicotine per cig		0.19		0.17
group 4	years smoked	20	0.06	20	0.01
	cigarettes per day		0.04		0.03
	nicotine per cig		-0.01		0.05

- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

Note: Pearson product-moment correlations were used to look at the relationship between current smoking habits and the standardized PPVT and RPM tests

The current smoking groups (gps. 3 and 4) were categorized into light, moderate, and heavy usage to examine potential patterns of smoking effects on the standardized scores. One-way ANOVAs indicated that there was no association for the comparison between the dependent (PPVT-R and RPM scores) and the independent (number of cigarettes smoked per day: light, moderate, heavy) variables for either of the above current smoking groups (Table 27 and 28).

[Insert Tables 27 and 28 here.]

Left and Right Visual Field Presentations

Pearson product-moment correlations were conducted to examine the relationship between the standardized PPVT-R and RPM scores and the stimuli presented in the left and right quadrants (upper and lower quadrants collapsed to give a left and right visual field), for all the subjects, and with each of the six smoking groups separately.

Results from the left visual field with the PPVT-R scores (Table 29) reached statistical significance only for the passive group (gp. 6) to show a negative relationship with the global latency scores ($r(22) = -.52, p = .01$). The RPM scores did not reach statistical significance for any of the comparisons.

[Insert Table 29 here.]

TABLE 27DOSE RESPONSE EFFECTS OF CURRENT SMOKING ON THE
STANDARDIZED TESTS

		<u>Dependent Variables</u>		
		Peabody	Raven's	
<u>Smoking group - 3</u>	<u>n</u>		<u>n</u>	
total sample	24	100.2	27	50.3
cigarettes per day:				
a) light smokers	14	97.9	16	49.6
b) moderate smokers	6	105.7	7	51.7
c) heavy smokers	4	99.8	4	51.0
<u>Variables</u>		<u>F values</u>		
cigarettes per day		1.08		0.32

- a) 1 to 10 cigarettes per day
- b) 10 to 20 cigarettes per day
- c) 20 and over cigarettes per day

Note: one-way ANOVAs were used to examine the dose response effects of current smoking on the standardized PPVT and RPM tests

TABLE 28DOSE RESPONSE EFFECTS OF CURRENT SMOKING ON THE
STANDARDIZED TESTS

		<u>Dependent Variables</u>	
<u>Smoking Group - 4</u>	n	Peabody	Raven's
total sample	20	109.6	49.6
cigarettes per day			
a) light smokers	9	110.1	50.0
b) moderate smokers	7	107.0	48.1
c) heavy smokers	4	113.0	51.0

<u>Variables</u>	<u>F values</u>	
cigarettes per day	0.21	0.66

- a) 1 to 10 cigarettes per day
- b) 10 to 20 cigarettes per day
- c) 20 and over cigarettes per day

Note: one-way ANOVAs were used to examine the dose response effects of current smoking on the standardized PPVT and RPM tests

TABLE 29RELATIONSHIP BETWEEN THE GLOBAL/LOCAL TASKS IN THE LEFT
VISUAL FIELD, AND THE STANDARDIZED TESTS

			<u>Dependent Variables</u>		
			Peabody		Raven's
<u>Smoking Groups</u>		<u>n</u>		<u>n</u>	
all groups	Latency Global msec	141	-0.10	147	-0.10
	Latency Local msec		0.05		-0.08
	% Error Global		-0.14†		-0.09
	% Error Local		0.12		-0.14†
group 1	Latency Global msec	24	-0.03	26	-0.25
	Latency Local msec		-0.14		-0.23
	% Error Global		-0.10		-0.05
	% Error Local		0.19		-0.30
group 2	Latency Global msec	28	-0.05	28	-0.10
	Latency Local msec		0.08		-0.15
	% Error Global		-0.12		0.09
	% Error Local		-0.24		-0.17
group 3	Latency Global msec	24	0.12	27	0.02
	Latency Local msec		0.12		-0.01
	% Error Global		-0.02		-0.34†
	% Error Local		0.18		-0.17
group 4	Latency Global msec	20	-0.32	20	-0.11
	Latency Local msec		0.35		-0.26
	% Error Global		-0.37		-0.11
	% Error Local		0.38†		-0.02

Cont'd...

<u>Smoking Groups</u>		<u>Dependent Variables</u>			
		<u>n</u>	Peabody	<u>n</u>	Raven's
group 5	Latency Global msec	23	0.19	24	-0.01
	Latency Local msec		0.24		0.13
	% Error Global		-0.23		-0.22
	% Error Local		0.25		-0.17
group 6	Latency Global msec	22	-0.52**	22	-0.25
	Latency Local msec		-0.37†		-0.12
	% Error Global		-0.02		0.00
	% Error Local		0.00		-0.05

- 1) controls (non-smokers, not exposed *in utero* or passively)
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Pearson product-moment correlations were used to look at the relationship between the global/local tasks presented in the left visual field (top and bottom quadrants collapsed) and the standardized (PPVT and RPM) tests

** $p \leq .01$

† $p \leq .10$

Results from the right visual field with the PPVT-R scores (Table 30) showed a positive relationship with the local error scores ($r(20) = .56, p = .01$) for the current smokers plus exposed *in utero* group (gp. 4). For the passively exposed groups (gps. 5 and 6), there was a positive relationship with the local error scores ($r(23) = .42, p = .05$), and a negative relationship with the global latency scores ($r(22) = -.45, p < .05$) respectively. For the RPM scores, a negative relationship was noted for the six smoking groups collapsed, with the local error scores ($r(147) = -.19, p < .05$), and for the current smokers (gp. 3), with the global ($r(27) = -.46, p < .05$) and local ($r(27) = -.49, p = .001$) error scores.

[Insert Table 30 here.]

Pearson product-moment correlations were conducted to examine the relationship between the standardized PPVT-R and RPM scores and the stimuli presented only in the top left and top right quadrants (to yield a left and right visual field), for all the subjects, and with each of the six smoking groups separately.

Statistical significance was reached with the PPVT-R for the following correlations in the top left visual field (Table 31). A positive correlation with the local error score ($r(141) = .22, p = .01$) for all the subjects, and for the *in utero* group (gp. 4) ($r(20) = .50, p < .05$); a negative correlation with the global latency scores for the passive group (gp. 6) ($r(22) = -.54, p = .01$). The RPM scores

TABLE 30RELATIONSHIP BETWEEN THE GLOBAL/LOCAL TASK IN THE RIGHT
VISUAL FIELD AND THE STANDARDIZED TESTS

		<u>Dependent Variables</u>			
		<u>Peabody</u>		<u>Raven's</u>	
<u>Smoking Groups</u>		<u>n</u>		<u>n</u>	
all groups	Latency Global msec	141	-0.08	147	-0.06
	Latency Local msec		0.03		-0.06
	% Error Global		-0.13		-0.10
	% Error Local		0.11		-0.19*
group 1	Latency Global msec	24	-0.04	26	-0.22
	Latency Local msec		-0.29		-0.22
	% Error Global		0.01		0.19
	% Error Local		-0.04		-0.29
group 2	Latency Global msec	28	-0.06	28	-0.12
	Latency Local msec		0.08		-0.09
	% Error Global		-0.23		-0.06
	% Error Local		-0.07		-0.22
group 3	Latency Global msec	24	0.04	27	-0.03
	Latency Local msec		0.03		-0.03
	% Error Global		-0.22		-0.46*
	% Error Local		-0.16		-0.49**
group 4	Latency Global msec	20	-0.32	20	0.01
	Latency Local msec		0.41†		-0.14
	% Error Global		-0.26		0.06
	% Error Local		0.56**		-0.10

Cont'd...

		<u>Dependent Variables</u>			
<u>Smoking Groups</u>		<u>n</u>	Peabody	<u>n</u>	Raven's
group 5	Latency Global msec	23	0.36†	24	0.22
	Latency Local msec		0.25		0.15
	% Error Global		-0.12		-0.02
	% Error Local		0.42*		0.10
group 6	Latency Global msec	22	-0.45*	22	-0.19
	Latency Local msec		-0.32		-0.11
	% Error Global		0.04		-0.11
	% Error Local		-0.05		-0.23

- 1) controls (non-smokers, not exposed *in utero* or passively
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Pearson product-moment correlations were used to look at the relationship between the global/local task in the right visual field (top and bottom quadrants collapsed) and the standardized (PPVT and RPM) tests

* $P \leq .05$

** $p \leq .01$

† $p \leq .10$

correlated negatively with the global error scores for the current smokers (gp. 3) ($r(27) = -.42, p < .05$).

[Insert Table 31 here.]

In the top right quadrant, the PPVT-R scores correlated positively with the local error scores for both group 4 ($r(20) = .61, p = .01$) and group 5 ($r(23) = .44, p < .05$), and negatively with the global latency scores for group 6 ($r(22) = -.46, p < .05$). The RPM scores correlated negatively with the top right quadrant with the local error scores for group 3 ($r(27) = -.64, p < .001$) (Table 32).

[Insert Table 32 here.]

TABLE 31RELATIONSHIP BETWEEN THE GLOBAL/LOCAL TASK IN THE TOP LEFT
VISUAL FIELD AND THE STANDARDIZED TESTS

			<u>Dependent Variables</u>		
			Peabody		Raven's
<u>Smoking Groups</u>		<u>n</u>		<u>n</u>	
all groups	Latency Global msec	141	-0.10	147	-0.10
	Latency Local msec		-0.01		-0.15†
	% Error Global		-0.15†		-0.07
	% Error Local		0.22**		-0.05
group 1	Latency Global msec	24	0.01	26	-0.22
	Latency Local msec		-0.13		-0.25
	% Error Global		-0.12		0.05
	% Error Local		0.35†		-0.19
group 2	Latency Global msec	28	-0.06	28	-0.21
	Latency Local msec		-0.02		-0.26
	% Error Global		-0.20		0.02
	% Error Local		-0.11		0.03
group 3	Latency Global msec	24	0.12	27	0.03
	Latency Local msec		0.13		-0.05
	% Error Global		-0.13		-0.42*
	% Error Local		0.24		-0.25
group 4	Latency Global msec	20	-0.31	20	-0.02
	Latency Local msec		0.33		-0.27
	% Error Global		-0.20		0.09
	% Error Local		0.50*		-0.04

Cont'd...

		<u>Dependent Variables</u>			
<u>Smoking Groups</u>		<u>n</u>	Peabody	<u>n</u>	Raven's
group 5	Latency Global msec	23	0.13	24	0.04
	Latency Local msec		0.10		0.00
	% Error Global		-0.32		-0.10
	% Error Local		0.39†		0.07
group 6	Latency Global msec	22	-0.54**	22	-0.22
	Latency Local msec		-0.37†		-0.21
	% Error Global		0.06		0.01
	% Error Local		0.03		-0.04

- 1) controls (non-smokers, not exposed *in utero* or passively
- 2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke
- 3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)
- 4) current smokers, exposed *in utero*, and regularly exposed to passive smoke
- 5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)
- 6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Pearson product-moment correlations were used to look at the relationship between the global/local task in the top left visual field and the standardized tests

* $p \leq .05$

** $p \leq .01$

† $p \leq .10$

TABLE 32RELATIONSHIP BETWEEN THE GLOBAL/LOCAL TASK IN THE TOP RIGHT
VISUAL FIELD AND THE STANDARDIZED TESTS

		<u>Dependent Variables</u>			
		Peabody		Raven's	
<u>Smoking Groups</u>		<u>n</u>		<u>n</u>	
all groups	Latency Global msec	141	-0.08	147	-0.11
	Latency Local msec		-0.03		-0.11
	% Error Global		-0.06		-0.07
	% Error Local		0.11		-0.12
group 1	Latency Global msec	24	0.06	26	-0.23
	Latency Local msec		-0.18		-0.35†
	% Error Global		0.12		-0.04
	% Error Local		0.27		-0.30
group 2	Latency Global msec	28	-0.08	28	-0.22
	Latency Local msec		-0.03		-0.09
	% Error Global		-0.03		-0.01
	% Error Local		-0.33†		-0.17
group 3	Latency Global msec	24	0.03	27	-0.03
	Latency Local msec		0.04		-0.12
	% Error Global		-0.00		-0.22
	% Error Local		-0.17		-0.64***
group 4	Latency Global msec	20	-0.28	20	-0.09
	Latency Local msec		0.34		-0.24
	% Error Global		0.06		0.27
	% Error Local		0.61**		-0.15

Cont'a...

<u>Smoking Groups</u>		<u>Dependent Variables</u>			
		<u>n</u>	Peabody	<u>n</u>	Raven's
group 5	Latency Global msec	23	0.29	24	0.16
	Latency Local msec		0.09		0.06
	% Error Global		-0.35		-0.28
	% Error Local		0.44*		0.24
group 6	Latency Global msec	22	-0.46*	22	-0.24
	Latency Local msec		-0.32		-0.11
	% Error Global		-0.04		0.03
	% Error Local		0.13		0.13

1) controls (non-smokers, not exposed *in utero* or passively)

2) non-smokers, exposed *in utero*, and regularly exposed to passive smoke

3) current smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

4) current smokers, exposed *in utero*, and regularly exposed to passive smoke

5) non-smokers, exposed to passive smoke (max 2-3 years prior to testing)

6) non-smokers, recently exposed to passive smoke (max 6-12 months prior to testing)

Note: Pearson product-moment correlations were used to look at the relationship between the global/local task in the top right visual field with the standardized (PPVT and RPM) tests

* $p \leq .05$

** $p \leq .01$

*** $P \leq .001$

† $p \leq .10$

.8 Summary of Results

Results from the present study confirm that performance on the global and local tasks are consistent with studies in the cognitive literature that report less errors on the global task compared to the local task, and that response time is approximately 100 msec faster for the global task than the local task. In the present study, the above findings were replicated by the controls, the current smokers, and the secondhand exposed groups on all aspects of the global and local comparisons.

The following is a summary of the major results.

Effects of Smoking

In general, active or passive smoking did not appear to influence performance on the global and local tasks.

The error scores on the local task, and the latency scores on the global task were positively correlated with the smoking habit (cigarettes per day) of the current smokers plus exposed *in utero* group (gp. 4), and the current smokers (gp. 3) respectively. Of the light, moderate, and heavy smokers in group 4, the local errors approached significance, and were the highest for the heavy smokers (more than 20 cigarettes per day).

The local task error and latency scores were significant and positively correlated for the groups exposed *in utero* (gps. 2 and 4), and for the secondhand exposed group (gp. 6), while they approached significance, and were positively correlated for the current smokers (gp. 3). On the global task, the error and latency scores approached significance, and were positively correlated for the *in utero* group (gp. 2), and significant and negatively correlated for the secondhand exposed group (gp. 5).

Performance on the Global/Local Task as a Function of Stimuli Parameters

The general findings with respect to the consistent/inconsistent stimuli were that the error means for the inconsistent stimuli were statistically higher, and the latency means were statistically slower on the global and local tasks for all the subjects. Also, there were no differential effects among the six smoking groups on the consistent/inconsistent stimuli.

When the scores on the global and local tasks were examined on the different 13 blocks, there were significantly higher errors and slower latencies for the first block than any of the other blocks.

There were no statistical differences for the subjects on the global and local tasks with respect to the left and right visual field comparisons with the top and bottom quadrants collapsed (see Fig. 18, p.175, A+B and C+D). Trend wise, the error scores were lower

and latency scores faster in the left visual field for both the global and local tasks. When the comparison was only with the top left and top right visual fields (see Fig. 19, p. 175, A and C), the error scores for the subjects were significantly higher in the top left visual field for the global task only. Furthermore, the six smoking groups did not interact differentially with the left and right visual fields for the above two left and right visual field comparisons.

When each of the 13 blocks were compared with respect to the left and right visual fields with the top and bottom quadrants collapsed (see Fig. 18), in general, for individual blocks, the left visual field error scores were significantly lower for both the global and local tasks. The top left and top right visual field comparison (see Fig. 19) within each of the 13 blocks did not show statistical differences on the error scores.

Relationship between the Standardized Tests and the Global/Local Tasks, and the Effects of Smoking on the Standardized Tests

The standardized verbal Peabody Picture Vocabulary Test - Revised (PPVT-R), and the spatial Raven's Progressive Matrices (RPM) were not correlated with the local and global scores respectively.

Consistent with the prediction, the global error scores and the RPM scores were significant and negatively correlated for the current smoking group (gp. 3). However, not consistent with the prediction,

the local error scores were significantly and positively correlated with the PPVT-R scores for the current smokers plus exposed *in utero* group (gp. 4).

Limitations of the Macintosh PowerBook 165c

Prior to a detailed discussion of the summary of the main results outlined above, the following issues are noted.

First, the global and local tasks in the present study showed the expected direction (higher errors on local than on global, and faster global response than local) on all the comparisons in spite of a discrepancy in the 'set' time, and the 'actual' time the stimuli appeared on the screen.

During the pilot phase, the desired goal of getting the subjects ($n = 50$) to make more errors on the local task than on the global task was accomplished by programming the computer to present the stimuli on the screen for a time set at 27 msec and 90 msec for the global and local tasks respectively. However, during the data cleaning, it was noticed that the actual time the stimuli appeared on the screen was 160 msec and 140 msec for the global and local stimuli respectively. Communication with Mac-Laboratories revealed that the discrepancy was due to the limitations of the PowerBook (Chute, D. and Westall, R. Personal communication, October 7, 1994).

appeared associated with the highest errors. The results of current smoking effects and *in utero* effects on the local task are discussed separately below.

Current Smoking Effects

As stated above, current smoking resulted in higher accuracy scores, and faster latencies on the local task. These results, although inconsistent with the prediction based on *in utero* exposure, are consistent with some existing literature. That is, recent studies on current smoking and psychomotor performance have repeatedly reported similar findings to the present study for accuracy and/or latency responses. For example, improvement in motor function in terms of both accuracy and speed have been reported by Hindmarch, Kerr, & Sherwood (1990) in subjects who were allowed to smoke normally up to testing time, and then were given an acute dose of nicotine. In another study, independent of dose, nicotine reduced reaction time (Bates, Pellett, Stough, & Mangan, 1994). It has also been reported that the effects of current smoking are observed even with single puffs from a cigarette. That is, the subjects made more correct responses, and showed improved latencies on Rapid Visual Information Processing tasks (Revell, 1988).

Consistent with the literature on current smoking and psychomotor performance, the current smokers (gp. 3) in the present study had the highest accuracy scores, and the fastest latency scores (not statistically) on the local task when compared with the other

FIGURE 17GLOBAL/LOCAL STIMULI IN THE FOUR COMPUTER QUADRANTS

A 52 Stimuli	C 52 Stimuli
B 26 Stimuli	D 52 Stimuli

 $\Sigma = 78$ stimuli $\Sigma = 104$ stimuli

- A Upper Left Quadrant
- B Lower Left Quadrant
- C Upper Right Quadrant
- D Lower Right Quadrant

by all subjects, suggesting that 20 msec seemed to be effective enough to result in differences.

Third, during the pilot phase of the study, the stimuli in the two bottom quadrants of the computer screen were reported to be harder to process than the stimuli in the upper quadrants. This difficulty was also attributed to the limitations of the PowerBook. In order to counterbalance the difficulty in perception, the star or focal point was shifted slightly lower than the center. Possibly, the adjustment was not sufficient to correct the difficulty, as approximately 64% of the experimental subjects also reported having the same processing problem. The difference in perception for the upper and lower quadrants however was not statistically significant.

Exclusion of The Pre Prospectus Group

The decision to exclude the pre prospectus data from the final analysis was based on the difference in performance by the pre ($n = 80$) and post ($n = 147$) prospectus groups on the global and local tasks. A t-test comparison showed that the controls ($n = 8$) of the pre prospectus group scored higher errors on the global ($p \leq .05$) and local ($p > .10$) tasks, and were faster to respond on the global ($p \leq .05$) and local ($p \leq .05$) tasks than the controls ($n = 26$) of the post prospectus group. The difference was possibly due to the unequal number of trials (stimuli) the pre and post prospectus groups were given on each of the global and local tasks (pre group 16 and post group 208).

A probable explanation for the difference between the pre and post prospectus groups is that 16 trials are not sufficient to allow for learning the tasks, and possibly not sufficient for an accurate measure of performance. Also, the performance of the subjects may have been affected by the initial instructions they received. That is, the pre prospectus group was informed that the global and local tasks consisted of 16 trials each, and the post prospectus group was informed that each of the global and local tasks was comprised of a large number of trials which could take up to 20 minutes each to do.

IV DISCUSSION

The purpose of the present study was to determine whether the effects of current smoking, maternal smoking, and secondhand smoke exposure would affect performance on a visual perception task. The perception tasks and two standardized tests yielded the six outcome measures. The subjects were first year psychology students.

The hypotheses is summarized as follows: (1), smokers will perform more poorly on the local task than will the non-smokers; (2), there will be no difference in performance on the global task by the smokers and the non-smokers; and (3), there will be a correlation between the local task and the verbal test, and the global task and the spatial test.

.1 Major Results in Relation to the Hypotheses and the Literature

The results did not support the hypothesis for smoking effects on the local task. Also, the six smoking groups did not differ significantly in their performance on the global task. And finally, a significant relationship was not found between the verbal Peabody Picture Vocabulary Test - Revised (PPVT-R) and the local task, and between the spatial Raven's Progressive Matrices (RPM) and the global task as predicted.

The following section is a detailed discussion of the major results in relation to the hypotheses.

.2 Smoking Effects on the Local Task Outcome Measures

Navon (1977) type stimuli (small, or local letters nested in the large, or global letter, e.g., a large W made up of small w's) were used as a non-verbal tool to test the hypothesis that smokers (active followed by *in utero* and secondhand exposure) would have more errors on the local task than the non-smokers. The results of the local task were later compared with the verbal scores to test the first part of the third hypothesis (discussed in a later section).

The hypothesis for smoking effects on the local task was based on: (1), the negative effects consistently noted between auditory/ language outcome variables and the offspring of maternal smokers over a period of approximately 11 years in the Ottawa Prenatal Prospective Study (OPPS); and (2), the neuropsychological studies that suggest a link between local processing and verbal analysis. Thus, the hypothesis suggests a vulnerability in performance by the smokers on the local aspect of the perception task.

The principle findings pertaining to smoking effects on the local task are twofold. (1), the trends for current smoking (gp. 3, current smokers followed by gp. 4, current smokers plus exposed *in utero*) appeared associated with fastest response time, and highest accuracy scores, and (2), the trends for the group exposed *in utero* (gp.2)

appeared associated with the highest errors. The results of current smoking effects and *in utero* effects on the local task are discussed separately below.

Current Smoking Effects

As stated above, current smoking resulted in higher accuracy scores, and faster latencies on the local task. These results, although inconsistent with the prediction based on *in utero* exposure, are consistent with some existing literature. That is, recent studies on current smoking and psychomotor performance have repeatedly reported similar findings to the present study for accuracy and/or latency responses. For example, improvement in motor function in terms of both accuracy and speed have been reported by Hindmarch, Kerr, & Sherwood (1990) in subjects who were allowed to smoke normally up to testing time, and then were given an acute dose of nicotine. In another study, independent of dose, nicotine reduced reaction time (Bates, Pellett, Stough, & Mangan, 1994). It has also been reported that the effects of current smoking are observed even with single puffs from a cigarette. That is, the subjects made more correct responses, and showed improved latencies on Rapid Visual Information Processing tasks (Revell, 1988).

Consistent with the literature on current smoking and psychomotor performance, the current smokers (gp. 3) in the present study had the highest accuracy scores, and the fastest latency scores (not statistically) on the local task when compared with the other

five smoking groups. The errors and reaction time (latency) scores on the local task approached significance, and was positively correlated for group 3. That is, when they made more errors, their response time was slow.

The reaction time scores for group 3 suggest that the subjects were not hitting the response keys on the computer keyboard impulsively, suggesting that there was no association between errors on the local task and impulsivity. That is, when the subjects responded fast, their scores were the most accurate compared to the other five smoking groups, and when their local error and local latency scores were correlated, the slow latency scores support the notion of absence of impulsivity. This claim finds support in studies that have looked at the effects of nicotine on focused attention.

According to Callaway, Halliday, and Naylor (1992), one of the effects of acetylcholine, of which nicotine is a mimetic, is on information processing, and more particularly, on focused attention and vigilance. Several studies (Warburton & Wesnes, 1978; Bates et al., 1994) suggest that improved focused attention and concentration may function to enhance reaction time performance tasks. It was also observed that (Wesnes & Warburton, 1984) nicotine administered by cigarette smoking improved attentiveness. This was observed even in smokers who did not show withdrawal effects and in non-deprived smokers.

In the present study, for the local task, the subjects were instructed to identify only the small letter, and to ignore the large letter. Also, as has been described previously, the local component of the global/local stimuli is considered harder to process. Thus, it was expected that the subjects would attend to the local form. The above association found between reaction time and accuracy suggests that focused attention was possibly associated with higher accuracy on the local task.

Consistent with the current smokers in group 3, the current smokers plus exposed *in utero* group (gp. 4) also performed well on the local task. That is, group 4 had the second highest accuracy scores, and the second fastest latency scores on the local task. Group 4 performance seemed to indicate that they too were processing the perceptual information, rather than impulsively responding to the task. The above point is further substantiated by the significant and positive correlation between the error and latency scores on the local task, suggesting that as the errors increased, the response time was slow. Thus, the current smoking groups (gps. 3 and 4) both appear to indicate that the higher accuracy scores were not due to impulsive responding, but may be due to current effects of nicotine which is suggested to enhance focused attention and concentration.

However, the significant and positive dose response correlation found between current cigarettes per day and local error scores for the current smokers plus exposed *in utero* group (gp. 4) is puzzling and contradictory. That is, the correlation suggests that as the

number of cigarette intake increased, more errors were made on the local task, but when the six smoking groups were compared on their performance, group 4 was observed to have the second highest accuracy scores.

The above contradictory results for group 4 were possibly attributed to the quantity smoked by subjects in the heavy smoking group. When group 4 was categorized into light (1 to 10 cigarettes per day, $\underline{n} = 9$), moderate (10 to 20 cigarettes per day, $\underline{n} = 7$), and heavy (20 and more cigarettes per day, $\underline{n} = 4$) smokers, the heavy smokers in group 4 had the highest and near significant error means on the local task ($\underline{p} = .08$), and their latency scores were the slowest. According to the prediction of the present study, *in utero* effects may result in vulnerability to the processing of the local task. However, according to the literature on current smoking, and also observed in the present study, current smoking results in higher accuracy scores. Therefore, it seems strange that the heavy smokers in group 4 should make higher errors than the light and moderate smokers. The fact that they make higher errors is difficult to explain.

Before discussing *in utero* effects, it may be worth noting that one of the limitations associated with the heavy smokers in group 4 is the small number of subjects in the group ($\underline{n} = 4$). Perhaps, a larger sample of similar behaving heaviest smokers would have influenced the current smoking group in the direction predicted (high accuracy scores).

In Utero Effects

In the present study, *in utero* effects indicate trends consistent with the hypothesis for higher errors on the local task. As stated earlier, the prediction for higher errors on the local task among smokers in the present study was based on results of the OPPS children of active smoking mothers who scored poorly on language ability tests. Furthermore, the verbal test scores were linked to the local task scores based on neurological studies on hemispheric lateralization. Thus, the low verbal scores for the OPPS children were predicted to reflect in poor accuracy scores on the local task for the smoking groups in the present study.

Of the six smoking groups in the present study, the *in utero* group (gp. 2) most closely approximated the offspring of the active maternal smokers in the OPPS. As stated earlier, the effects of active maternal smoking resulted in poorer language related abilities in the OPPS children (Makin et al., 1991). Within the same OPPS neuro-psychological battery, these children showed an association between maternal smoking and increased motoric activity. That is, the offspring who had performed poorly on the verbal test outperformed the children of passive and non-smoking mothers on tests of fine motor speed. Like their verbal scores, they also had poorer accuracy scores than the passive and non-smoking offspring on a motor related task.

Consistent with the OPPS findings, the group exposed to the effects of maternal smoking, or to *in utero* effects (gp. 2) in the present study made the most errors (not statistically) on the local task, and had the second highest reaction time scores (were slow) on the local task when compared to the other five smoking groups. Group 2 also showed a significant positive correlation between the local error and local latency scores. That is, when their error scores were high, their response time was slow. The positive correlation was in the same direction for both the *in utero* groups (gps. 2 and 4). As suggested earlier, high errors and slow reaction time may possibly indicate vulnerability to the processing of the local task.

In the study by Makin et al. (1991), the fastest performance rate on tests of fine motor speed for the offspring of active maternal smokers (compared to offspring of passive and non-smoking mothers) was associated with increased activity levels observed by the authors, and reported in several OPPS and non-OPPS findings (e.g., Kristjansson & Fried, 1989; Naeye & Peters, 1984). These findings on increased activity levels cannot however be generalized to the group exposed *in utero* (gp. 2) in the present study, as reaction time was slow for group 2. The similarities for the two samples (OPPS and gp. 2, present study) lies in their higher error scores when compared to the other groups within each of the respective studies.

The higher errors were attributed to maternal smoking in Makin et al., but in the present study it was noted that the amount of cigarettes smoked by the parents (mother and father) did not

correlate with the local error and latency scores. In other words, how the subjects performed on the local task was not a reflection of their parent's smoking habit. Perhaps, an important distinction needs to be pointed out between the *in utero* (OPPS and gp. 2, present study) groups which may possibly explain the differences between them.

In the OPPS data collection procedure, the mothers provided a self report on their smoking habit, while in the present study, a retrospective gathering of the information of approximately 22 years is subject to recollection problems. Therefore, the validity of the dose response relationship may be questionable. Another limitation in the data collection procedure in the present study was that a significant minority of the subjects responded "don't know" to their mother's and father's smoke intake.

In summary, smoking effects on the local task indicate that current smokers seem to be 'primed' by nicotine effects. Evidence for this comes from the results of the present study, and from the literature on current smoking and psychomotor performance. Also, that *in utero* smoking suggests vulnerability to the effects of smoking on local processing as seen in the present study, and in the OPPS findings.

.3 Smoking Effects on the Global Task Outcome Measures

The second hypothesis was that there will be no difference in performance on the global task for the smoking and non-smoking groups. As predicted, the error means for the global task for the six smoking groups did not differ.

The results of the global task also support the findings that current smoking enhances accuracy and reaction time performance. The current smokers plus exposed *in utero* group (gp. 4) had the least errors and fastest reaction time compared to the other five smoking groups. The group exposed *in utero* (gp. 2) approached a near significant positive correlation between the error scores and the reaction time scores on the global task. That is, when their error scores were high, their reaction time was slow. Group 4 results are consistent with the current smoking effects, and group 2 latency results are consistent with the *in utero* effects reported for the local task, and need not be elaborated on further.

Before closing this section on smoking effects on the global and local tasks, a secondary aspect of the present study will be examined. That is, the objective was to isolate the effects of secondhand smoke in order to interpret the effects of *in utero* exposure. To accomplish this, the passively exposed groups (gps. 5 and 6) will be compared with the *in utero* group (gp. 2).

The results for the above passively exposed groups and the *in utero* group were non-significant on the global and local error and latency tasks. However, trend wise, group 6 followed by group 5 had the highest global errors, and group 2 had the highest local errors of the six smoking groups. The *in utero* effects for a vulnerability to processing the local task was discussed earlier. What we now see, is that secondhand exposure may also result in a vulnerability to psychomotor performance.

Of the two groups (gps. 5 and 6) exposed to secondhand smoke, group 6 was more similar to the *in utero* group (gp. 2). That is, the local error and local latency scores for both groups 2 and 6 were significant and positively correlated. In other words, when their errors were high, their reaction time was slow.

The following discussion provides evidence that group 6 may possibly be vulnerable to the effects of smoking. Makin et al. (1991) compared the offspring of maternal active and maternal passive smokers during pregnancy. They concluded that the consequences on the offspring of maternal passive smoking are similar to, though smaller in magnitude to maternal active smoking. The authors observed that, when compared to the children of maternal active smokers, the children exposed to maternal passive smoke performed better (more accurately) on tasks with a motor component that called for greater attention to detail. These children were also rated as being more anxious than the (maternal) active and non-smoking children. Their accurate responses may indicate that anxiety

resulted in their slowing down, and consequently being more attentive. In the present study, the longer local latency scores of group 6 paralleled the OPPS passively exposed children who responded slower on the timed fine motor speed task. Group 6 had only recently (6 - 12 months prior to testing) been exposed to secondhand smoke. Possibly their reaction time for psychomotor tasks was affected due to their 'new' smoky environment. It is interesting to note that unlike the OPPS children whose slow responses may have contributed to their higher accuracy scores, group 6 made more errors while they responded slower. In the present study, current smokers have consistently shown the highest accuracy scores of all the six smoking groups. Group 6 were non-smokers, with recent exposure to the smoke of others. Therefore, it is unlikely that group 6 would make more accurate responses than the current smokers. It is interesting to note that thus far, in the present study, the prediction for vulnerability to the effects of smoking has been demonstrated by the *in utero* group (gp. 2), and the group recently exposed to secondhand smoke (gp. 6).

Another observation worthy of note, is the performance of the controls (gp. 1) when compared with the other five smoking groups. When all parameters were considered on the local task, in general, the controls made the second highest errors. Additionally, they were the slowest to respond on nearly all the comparisons for both the global and local tasks, even though the comparisons with the other five smoking groups were non-significant. The behaviour

of the control group is puzzling, as they seem to mimic the *in utero* group (gp. 2) who had higher errors on the local task and slower latencies. The following explanation may partly explain the behaviour of the controls.

During the mass testing phase of the present study, a group classified as current smokers, not exposed *in utero*, nor exposed to secondhand smoke had been created. However, at the time of testing (approximately 6 to 12 months after mass testing), every subject in the above group reported being recently exposed to secondhand smoke (university/social). Based on this knowledge, it may be likely that a significant number of the controls (gp. 1) had also been recently exposed to some smoke. Perhaps, the controls failed to report this because their exposure to secondhand smoke was irregular. The implication here is that the present study may not have had a 'true' control group, and therefore, the predicted differences between smokers and non-smokers was not observed. If this assumption is correct, then the controls (gp. 1), like groups 2 and 6 also show trends (i.e., higher errors) consistent with the hypothesis for *in utero* and secondhand smoking effects.

4 Performance on the Global/Local Tasks as a Function of Stimuli Parameters

This section deals with how the subjects performed on a number of parameters within the global and local tasks, such as consistent/inconsistent stimuli; the arrangement of stimuli (trials)

into different blocks; and left and right visual field presentations. According to the literature, manipulation of the stimuli (exposure duration, eccentricity, degradation of the stimuli, etc.) will have an influence on global/local processing. One aspect of the present study was to examine how the different parameters would influence performance of the subjects, and whether the six smoking groups would interact differentially with the different parameters.

Consistent/Inconsistent Stimuli

Presentation of the consistent/inconsistent stimuli provides a way to examine global/local processing under conditions where the stimuli have been manipulated or degraded. As predicted, the following observations were made at 140 (local) and 160 (global) msec presentations: (1), in general, more errors were made on the local than on the global stimuli, and the local latencies were slower than the global latencies; (2), the subjects made significantly more errors and responded slower on the inconsistent stimuli for both the global and local tasks. The results based on the first two observations demonstrate that the parameters used in the present study, such as the size of the stimuli, the presentation time, and attending to a particular level of the task (only global or only local) gave the expected direction reported in the literature.

The third observation was that the six smoking groups did not interact differentially on the global and local tasks with respect to the consistent/inconsistent stimuli. Once again, consistent with the

psychomotor performance literature cited previously, current smoking (gp. 3 on local and gp. 4 on global) resulted in lower errors and faster latencies irrespective of whether the stimuli were perceived as easy (consistent) or difficult (inconsistent). Thus, groups 3 and 4 indicated paying more focused attention to the task.

The reaction time scores were not significantly different for the six smoking groups, but the controls (gp. 1) did perform the slowest on the consistent and inconsistent stimuli for both the global and local tasks. It is interesting to note that the inconsistent stimuli were responded to approximately 100 msec slower than the consistent stimuli across all six smoking groups. This difference is similar to that reported for the global and local latency response time. These results for the consistent/inconsistent stimuli confirm that degrading the stimuli makes it more difficult to process, and slows down reaction time.

Block Breakdown

A block comparison showed significantly higher errors, and slower latencies on the global and local tasks for block 1 than the other 12 blocks. The means suggest that the subjects had learned the global task by block 3, and that they maintained an approximately steady learning curve to block 13. For the local task, the steady learning curve is more prominent by block 8, due to a couple of fluctuations in the means, which could be attributed to chance. The means for the error scores indicate that the global task

is easier to process than the local task, which could imply that the global task is learned earlier than the local task.

An important observation is that there was no indication of fatigue across the 13 blocks for both the global and local tasks. This observation is based on the learning curve described above, and on the latency scores which also maintained a fairly steady curve. Each of the global and local tasks took approximately 20 minutes to administer, and were performed under reasonably comfortable conditions. In addition, the 208 trials in the present study are approximately similar to that seen in the cognitive literature, where typically 150 to 500 stimuli (trials) are presented under different conditions on a reaction time perception task. Further support for the absence of fatigue comes from the subjects' report which showed that the majority of subjects had concentrated on the entire global and local tasks.

In general, there was a decrease in global and local latencies from blocks 1 through 13 respectively. Interestingly, this decline was more evident and more steady for the local task although overall, it was reported to be more difficult than the global task. It is difficult to speculate on the above results. However, the local latency scores generally were slower than the global latency scores as consistently reported in the present study.

The literature on current smoking and psychomotor performance suggests that one of the motivating factors generally

reported for smoking is reduction of negative affective states (Wesnes and Warburton 1984; Warburton, 1988). Pritchard (1991) suggests that smoking affects the tonic psychological state of subjects. That is, nicotine may increase or refresh the mental state, and thus, inhibit fatigue. Wesnes and Warburton (1983) also report that the typical decline seen in performance tasks over time is not seen under nicotine induced conditions.

In the present study, the six smoking groups did not interact differentially with the 13 block arrangement. However, all six smoking groups generally indicated a fairly smooth learning curve (with a few chance fluctuations) on the local and global tasks with each block. This raises an important question. Why did the non-nicotine group (gp. 1, controls) indicate lack of fatigue like the nicotine groups?

Two possible explanations are offered for lack of fatigue for the controls. First, although the controls were predicted to have the highest accuracy scores, they behaved more or less like the group exposed *in utero* (gp. 2), who made higher errors on the local task, and had slower latencies on both the global and local tasks. As discussed earlier, it is likely that the controls were exposed to nicotine on an irregular basis, and thus they were not pure controls, which may account for their behaviour. Second, and perhaps a more likely reason, is that absence of fatigue may lie in the relative ease of the task. That is, the parameters, and the number of stimuli may not

have been challenging enough for fatigue to have set in across the six smoking groups.

Consistent findings reported thus far in the present study are higher accuracy scores, and faster latency scores for the current smokers. The above findings are in accord with the smoking group comparison across the 13 blocks. That is, although no significant differences were noted for the six smoking groups, the current smokers (gp. 3) had the highest accuracy scores on the local task, and their means generally showed minimum fluctuation across the 13 blocks. Importantly, when the means for the other five smoking groups were examined, there was no increase in the error rate across the blocks. Thus, the results from the present study for current smoking effects indicate that nicotine enhances reaction time performance, and improves accuracy performance.

Left and Right Visual Field Presentations

The purpose of comparing the performance of the subjects on the global and local tasks with respect to the left and right visual fields was to examine the hypothesis that the global stimuli is primarily processed in the right hemisphere (corresponding to the left visual field), and the local stimuli is primarily processed in the left hemisphere (corresponding to the right visual field). The above thinking is based on Moscovitch (1979) and others (Delis et al., 1986; 1992; Robertson et al., 1991) who hypothesized that local processing

and verbal analysis is primarily a function of the left hemisphere and global processing and spatial analysis is primarily a function of the right hemisphere.

The different functions proposed for the two hemispheres for whole/part organization (Moscovitch (1979) might be based on left and right hemispheric analysis of spatial waveforms or frequencies, which may be described as a sensitive combination of stimulus energy and luminance energy over time (Sergent, 1982).

Sergent (1983) states that the left hemisphere seems to function for high (local) spatial frequencies and the right for low (global) spatial frequencies. It is further suggested that local processing is facilitated with longer exposure durations due to an improvement of the integration of the high frequencies, while shorter durations handicap the local form (Sergent, 1982; Paquet et al., 1984).

According to Sergent (1983), to ensure that information is initially sent to the opposite hemisphere, the stimulus must be presented for a brief duration, and in the retinal periphery. Furthermore, when retinal eccentricity is increased, the ratio of low to high spatial frequency is increased, and the right hemisphere analysis is more efficient (Navon, 1981); Sergent, 1983; Shulman et al., 1987; Kimchi, 1992). It is also suggested that when the directed task is global, right hemisphere advantage is reported, and when the

directed task is local, left hemisphere advantage is noted (Sergent, 1982).

In the present study, the stimuli were assigned to the four corners of the computer screen. Each subject was given two global/local letter identification tasks, and were instructed to identify only the large (global) letters for one task, and only the small (local) letter for the other task.

The data for the left/right visual field presentations for all subjects, and for a differential interaction between smoking groups and the left/right visual fields were analyzed under two separate conditions: (1), the left top and bottom quadrants and the right top and bottom quadrants were collapsed to yield a left and right visual field, and (2), only the top left and only the top right visual fields yielding a left/right visual field.

As stated earlier, according to the neuropsychological literature, the assumption is that the left visual field corresponds to the right hemisphere and functions in global processing, and the right visual field corresponds to the left hemisphere and functions in local processing (Moscovitch, 1979).

Top and Bottom Quadrants Collapsed

No significant differences were noted for the subjects on both the global and local error and latency scores with respect to the left/right visual fields. Additionally, each of the 13 blocks were compared in the left/right visual fields for a learning component, and for signs of fatigue. Learning did not appear to occur differently in the two visual fields. Although significant differences were noted in block 10 (global) and block 5 (local) with higher error scores in the right visual field, these differences were attributed to chance fluctuations. Overall, there were no signs of fatigue in the two visual fields across the 13 blocks (see p. 169 for discussion on fatigue).

Two observations in the left/right visual field comparisons were noted. First, the trends generally indicated higher errors and slower latencies in the right visual field for both the global and local task. Second, the results for the global task are consistent with the prediction for better global processing in the right hemisphere, but not consistent with the prediction for better local processing in the left hemisphere.

A possible explanation for the right visual field resulting in more errors may be due to two of the limitations of the PowerBook (see p.149-51 for details). The first is with respect to the unequal number of stimuli in the left and right visual fields (Fig. 18), and the second being the difficulty in perception reported by the subjects in the lower quadrants. As a result of these limitations, the right visual

field had a larger number of "difficult" stimuli, which may account for the higher number of errors.

[Insert Figures 18 and 19 here.]

The results also indicate that the six smoking groups did not interact differentially on the global and local tasks with respect to the left/right visual fields. Trend wise, for the global task, the current smokers plus exposed *in utero* group (gp. 4) had the most correct responses and fastest latencies in the left visual field. These findings lend support to the effects of current smoking resulting in higher accuracy and faster latency scores consistently reported in the present study. Additionally, except for the passive group (gp. 6), the other five smoking groups performed better in the left visual field as predicted. For the local task, all six smoking groups made more errors on the local task in the right visual field. However, the exposed *in utero* group (gp. 2) had the highest errors (right visual field) to support the findings for *in utero* vulnerability to processing the local stimuli.

Top Left and Top Right Quadrants

When performance was compared for all subjects in the top two quadrants, the global and local error means were higher, and the latencies were slower in the left visual field. For this comparison, the top two quadrants had an equal number of stimuli (Fig. 19), and the subjects did not report any difficulties associated with the

FIGURE 18GLOBAL/LOCAL STIMULI IN LEFT/RIGHT VISUAL FIELDS
WITH UPPER AND LOWER QUADRANTS COLLAPSED

A + B 78 stimuli	C + D 104 stimuli
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A + B Upper and Lower Left Quadrants Collapsed
C + D Upper and Lower Right Quadrants Collapsed

FIGURE 19GLOBAL/LOCAL STIMULI IN TOP LEFT/RIGHT VISUAL FIELDS

A 52 stimuli	C 52 stimuli
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A Top Left Quadrant
C Top Right Quadrant

stimuli in any of the quadrants. These two points may well account for the opposite findings reported for the left-right visual field comparison (quadrants collapsed), where the stimuli in the right visual field were perceived as being harder.

The six smoking groups did not interact differentially with the top left and top right visual fields. It is interesting to note that only the group exposed *in utero* (gp. 2) made more errors on the local task in the right visual field compared to the other five smoking groups who made less errors. The implication here is that even when accuracy scores are high across the groups, the effects of maternal smoking still appear vulnerable to the local task.

The effects of current and *in utero* smoking on the global and local tasks can be summarized to show that although the main hypotheses were not confirmed, the trends were very interesting. That is, the group exposed *in utero* (gp. 2) that most closely approximated the OPPS maternal active smokers children behaved in the direction as predicted. Group 2 made the highest errors on the local task. However, unexpectedly, the current smokers (gps. 3 and 4) whether or not exposed *in utero* behaved in the opposite direction to the prediction. Groups 3 and 4 had the highest accurate scores on the local task. Their behaviour indicates not surprisingly that current smoking has a stronger effect. These trends were also noted in general when the stimuli were presented under different conditions.

.5 The Standardized Tests

One of the hypotheses of the present study is that the local component of the task will correlate more highly with the performance of subjects on a verbal test, and the global component of the task will correlate more highly with the performance of subjects on a spatial test. The hypothesis is based on hemispheric laterality studies that show that the left hemisphere of the brain is predominantly analytical, and involved with detailed (local) analysis, compared to the right hemisphere which is predominantly holistic, and involved with whole or configural (global processing) parts.

The Peabody Picture Vocabulary Test - Revised (PPVT-R)

The Peabody Picture Vocabulary Test - Revised (Dunn & Dunn, 1981) is a verbal comprehension test. According to the authors, the test scores are based on age equivalence which show a clear and consistent increase in performance with age. The PPVT-R is one of the measurement scales used in the Ottawa Prenatal Prospective Study (OPPS) battery to test for the auditory system involvement, and for auditory/language processing. Results from several OPPS studies (Gusella et al., 1984; Fried et al., 1988; 1990; 1992a; 1992b) over a period of approximately 11 years have shown a long-term maternal smoking effect on the offspring on various aspects of language impairment. This was demonstrated by a decrease in verbal comprehension scores in children of smoking mothers. Other

studies (e.g., Davies et al., 1972) have shown poor reading abilities into the teen years.

Furthermore, several neurological studies have shown that damage to the left hemisphere results in impaired verbal processing (Delis et al., 1986; 1992). In an attempt to replicate the findings of the OPPS and neurological studies, the present study tested young adults ($\bar{x}$ age = 21.9) on the PPVT-R, which is appropriate to age 40.

The results of the present study based on the standardized PPVT-R are discussed according to the following three findings: (1), the hypothesis for a correlation between the local scores and the verbal scores for all the subjects was not supported; (2), the OPPS findings which show the PPVT-R scores to be negatively correlated among the offspring of maternal smokers were not supported; and (3), opposite to the prediction, a significant positive correlation was noted only for the current smokers plus exposed *in utero* group (gp. 4) suggesting that when these subjects made more errors on the local task, their PPVT-R scores were high.

The non-significant correlations between the PPVT-R and the local scores for all the subjects could possibly be accounted for by the difference in subjects in the present study and in the OPPS. The subjects for the present study were first year psychology students, whereas the OPPS children were between the ages of 3 to 7 years. An alternative explanation may be based on selection bias. That is, of the students who enter university, only those who are more likely

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to overcome the effects of smoking (among the smokers and *in utero* exposed category) get accepted. These students are perhaps above average achievers.

The second findings show that when the six smoking groups were compared on their PPVT-R scores, contrary to the prediction, trend wise, the *in utero* groups (gps. 4 followed by 2) had the highest scores. A basic difference between the OPPS and present study *in utero* subjects was that, the OPPS mothers provided a self report on their smoking habit, while the subjects of the present study reported retrospectively ($\bar{x}$ age 21.9) on their parent's smoking habit. Though the validity of the parent's smoking history may be questionable for the present study, the method employed for data collection was the most practical one at the time of collection. Thus, not knowing the magnitude of *in utero* exposure in the present study makes it difficult to adequately interpret the findings (opposite to the prediction) for maternal smoking effects.

The third finding is based on the assumption that the left hemisphere functions analytically (Moscovitch, 1979), implying local analysis. The author further hypothesizes that damage in the left hemisphere will selectively impair aspects of cognition, such as language. From the above two points it appears that the left hemisphere functions for both local and verbal analysis. Thus, if smokers perform poorly on the local task, they will be expected to perform poorly on the verbal test.

Of the two current smoking groups (gps. 3 and 4) in the present study, a significant positive correlation between the local and verbal scores were noted only for group 4, who were also exposed *in utero*. These results are opposite to the prediction, as they imply that when the scores are high on the verbal test, there is a likelihood of more errors being made on the local task. For group 4, it was also noted that the heavy smokers ($n = 4$, defined earlier) within the group had the highest PPVT-R means (not significant). Ironically, as reported earlier, the heavy smokers also had the highest errors on the local task. These results are peculiar and difficult to rationalize. Group 4 finds further support for the above positive correlations (significant and/or near significant) on several left/right visual field comparisons.

For the current smoking group (gp. 3), trend wise, their PPVT-R scores were the lowest of the six smoking groups. This result was as predicted. A further line of support for the prediction is in the negative, though non-significant correlation between the errors on the local task, and the verbal test for group 3. The correlation suggests that when the subjects made the most errors on the local task, they also made the most errors on the verbal test. For the group exposed *in utero* (gp. 2), a similar negative correlation as seen in group 3 was noted. Again, why would current smoking and *in utero* effects indicate a correlation in the same direction?

In addition to the explanations offered above for lack of significance for a relationship between the local task and the verbal test, another possibility could be related to the parameters used in the basic development of the perception (global-local) task. However, this seems unlikely as Delis et al. (1986), and Delis et al. (1992) predicated their work on the observation that the right visual field presentations are processed in the left hemisphere. Furthermore, according to Sergent (1983), retinal eccentricity is essential for the stimuli to cross-over to the opposite hemisphere. In the present study, the local task was presented for 140 msec at a visual angle of approximately 6.78 degrees. As these settings are fairly consistent with most of the literature, and some of the results reported earlier suggest trends consistent with the prediction, the parameters are most likely adequate to make their initial cross-over to the opposite hemispheres. At the present time, it is difficult to interpret the high verbal scores for the two groups exposed *in utero* (gps. 2 and 4), other than the explanations offered earlier.

A final and important distinction between the two samples is that all the OPPS children were non-smokers, while the subjects for the present study compared smokers with non-smokers. A consistent finding in the present study on the perception task was that the current smokers (gps. 3) had faster reaction time scores, which did not compromise their accuracy scores. These same subjects scored the lowest of the six smoking groups on the verbal test. Perhaps, the motor responses seen for group 3 are quite

different to cognitive functions that involve verbal processing. Bearing in mind that the OPPS findings were for negative *in utero* effects on the verbal scores, the *in utero* groups (gps. 2 and 4) in the present study scored the highest on the verbal test! These odd findings are difficult to interpret.

The Raven's Progressive Matrices (RPM)

One of the hypotheses of the present study is based on the assumption that the right hemisphere functions holistically, implying global analysis (Moscovitch, 1979). Further, that damage to the right hemisphere will impair processing of whole or configural parts. Thus, it is assumed that the right hemisphere functions for both global and spatial analysis, and that poor performance on the global task will also mean poor performance on the spatial task.

The RPM is a spatial task that compares well with other traditional performance tasks, and is well suited for adults. Several neurological studies have examined the relationship between spatial tasks and the global (whole) aspect of a configural task in hemispheric lateralization comparisons. The OPPS has utilized the RPM on the smoking mothers of the children who were tested on several studies. The present study utilized the RPM as a dependent variable in an attempt to correlate it with the global task.

Results showed that there was no relationship between the RPM scores and the global scores for all the subjects. Also, statistical

significance was not reached for a comparison of the performance of the six smoking groups on the RPM test as predicted. However, consistent with the hypothesis, the following significant observations was noted for the current smokers (gp. 3). The global error scores correlated negatively with the RPM on several correlations. In other words, when the global scores were more accurate, the RPM scores were high. It may be of interest to note that the local error scores were also negatively correlated with the RPM scores. These findings might have been easier to interpret if the correlation was only with the global task. Since the current smokers showed a similar correlation for both the global and local tasks with the RPM test, it is more difficult to interpret the results.

.6 Conclusion

The objective of the present study was to examine the effects of smoking on a perception task. Two principle findings were noted: (1), the trends for *in utero* effects were consistent with the prediction of higher errors on the local task; and (2), although active smoking did not follow the prediction of the present study, the trends suggest that current smokers perform better on psychomotor performance tasks. That is, the global and local accuracy scores were higher, and the reaction time scores were faster for the current smokers than for the subjects who did not currently smoke. These findings are consistent with the existing literature on current smoking and reaction time tasks.

The *in utero* group (gp. 2) in the present study was similar to the OPPS children of active maternal smokers in their higher accuracy scores, but dissimilar in their response time. That is, in comparison to the respective smoking groups in the two studies, the OPPS children responded faster and made more errors on a timed motor type task, and the subjects of the present study also made more errors, but responded slower on the perception (local) task. While the higher errors for the two *in utero* groups may point to a possible association of *in utero* smoking to the vulnerability of processing the above tasks, the different reaction time scores may be based on the background information collected on the subjects in the two studies. In the present study, a smoking history questionnaire

provided the smoking data on the subjects, while in the OPPS study, the mothers of the children provided self-reports, and reports on their observations of their children. In addition, several tests from the OPPS neuropsychological battery were administered to the children.

From the OPPS test battery and the mother's reports, the offspring of active maternal smokers were observed to be more active, and to exhibit more behaviour problems than the passive and non-smoking offspring. When these children were administered a timed motor test, they responded the fastest of the groups, but did not have the most accurate responses. Thus, their behaviour on the motor test and the results from their OPPS battery led to the conclusion that these children were also impulsive. Additionally, because their test scores separated them from the maternal passive and non-smoking mothers, the conclusion was that maternal smoking during pregnancy was most likely a contributing factor to the children's higher active and impulsive behaviours.

The original hypothesis made with respect to the performance of subjects on the verbal and local tasks in the present study was based on the finding that *in utero* exposure resulted in impulsivity. Three findings were noted when the *in utero* group was compared to the other five smoking groups in the present study: (1), their reaction time scores on the local task were slower (except for the controls), (2), they had the highest errors on the local task, and (3), their verbal scores were second highest. From the above three

results, a likely conclusion is that the *in utero* group were not impulsive, that on certain tasks (e.g., perception), they seem to indicate vulnerability (trend wise) to *in utero* effects approximately 20 years after being exposed *in utero*, and finally, their verbal scores suggest that those who may have overcome any possible impairment on verbal processing are the ones who enter university .

The above findings suggest that the performance of the *in utero* group in the present study is only partially consistent with the prediction. Perhaps, if the present study like the OPPS had obtained additional information on the subjects prior to testing, the prediction for the *in utero* group may have more closely reflected their performance, especially on the verbal task. For instance, knowledge on the subject's family background, and perhaps a skill testing questionnaire might have shed light on whether a supportive family environment, or perhaps the subject's personal coping skills and strategies helped them overcome any possible impairment associated with *in utero* effects.

Several studies on current smoking suggest that nicotine, independent of dose, and whether inhaled in cigarette form, or chewed as nicotine gum results in enhanced performance through better concentration and focused attention on reaction time tasks. Consistent with the above findings, but contrary to the prediction of the present study, the current smokers had (trend wise) higher accuracy scores and faster reaction time scores on the local task than any of the other smoking groups. These results for enhanced

performance must be utilized with caution, because the same subjects who performed better on the perception task did poorly on the verbal test. The poor verbal scores for the current smokers may suggest that nicotine possibly functions differently on cognitive tasks that involve aspects of language. Thus, it is important to note that although nicotine may appear to raise performance in certain areas, it is just as likely that it may impair other cognitive abilities.

Several issues need to be addressed based on the above findings. First, for the enhancing properties of nicotine, it is important to consider whether smoking can justifiably be promoted to improve concentration or focused attention on certain types of tasks; also, how much, and for how long must one smoke in order to achieve and maintain high levels of psychomotor performance; and finally, for the current smoker, if success at all costs is important, is there a concern for addiction to nicotine. Second, if the poorer verbal scores for the current smokers are associated with the inhibiting characteristics of nicotine, then, what are the long-term consequences on academic performance in general. Although it may not be possible to provide answers to all of the above issues at the present time, it is important to bear in mind the implications that have been suggested. These implications are most likely for the domain of both clinical and experimental psychology, and perhaps, sensitive measures are needed to separate the issues in order to address them adequately.

The overall results from the present study although not definitive, indicate trends that were consistent, and that have found support in several studies in the existing literature. Some possible reasons for the non-significant findings of the present study may be accounted for by the following.

When examining the sample for the present study, it is worth noting that all the subjects were recruited from Carleton University. Perhaps, a wider range of subjects needs to be examined, as it is likely that those individuals who might have been affected by smoking never made it to university.

With respect to smoking groups, aspects of determining smoke exposure (*in utero*, passive) are difficult to achieve. It is extremely difficult to get a pure *in utero* group. That is, it is highly unlikely that mothers (and fathers) who smoke during pregnancy will stop smoking immediately after giving birth. This makes it difficult to separate *in utero* effects from secondhand effects of smoking. Also, for the adult, the length of time since being exposed *in utero* is most likely confounded by many extraneous variables following birth and up to adulthood that may make it difficult to separate *in utero* effects from postnatal environmental effects of smoking. Finally, although passively exposed subjects are more readily available for testing, determining the level of exposure is not always pragmatic. That is, how closely can people monitor their daily activities. Also, for the researcher, are biological measures exorbitantly expensive, and more particularly, to what extent can one's privacy be invaded.

V REFERENCES

Adams, M.M., Brogan, D.J., Kendrick, J.S., Shulman, H.B., Zahniser, S.C., Bruce, F.C. (1992). Smoking, pregnancy, and source of prenatal care: results from the pregnancy risk assessment monitoring system. Obstetrics & Gynecology, 80(5), 738-744.

Anastasi, A. (1988). Psychological Testing, 3rd edition, Macmillan and Company, New York.

Avis, H. (1993). Drugs and Life, 2nd edition, Brown & Benchmark, New York.

Bates, Pellett, Stough, & Mangan, (1994). Effects of smoking on simple and choice reaction time. Psychopharmacology, 114, 365-368.

Bayley, N. (1969). Bayley scales of infant development. New York: Psychological Corporation.

Brazelton, T. (1973). Neonatal behavioral assessment scale. London: Wm. Heinemann & Sons.

Callaway, Halliday, & Naylor, (1992). Cholinergic activity and constraints on information processing. Biological Psychology, 33, 1-22.

Chute, D.L. (1990). MacLaboratory Psychology: Software Documentation. MacLaboratory Inc., Pennsylvania.

Cohen, J. (1977). Statistical Power of Analysis for the Behavioral Sciences. London: Academic Press.

Collishaw, N.E., Kirkbride, J., & Wigle, D.T. (1984). Tobacco smoke in the workplace: An occupational health hazard. Canadian Medical Association Journal, 131, 1199-1204.

Davies, R., Butler, N., Goldstein, H. (1972). From Birth to Seven. London, Longman.

Delis, D.C., & Bihle, A. (1989). Fractionation of spatial cognition in focal and diffuse brain damage. In A. Ardila & F. Ostrosky (Eds.), Brain Organization of Language and Cognitive Processes. New York: Plenum.

Delis, D.C., Massman, P.J., Butters, N., Salmon, D.P., Shear, P.K., Demadura, T., Filoteo, J.V. (1992). Spatial cognition in alzheimer's disease: Subtypes of global-local impairment. Journal of Clinical and Experimental Neuropsychology, 14(4), 463-477.

Delis, D.C., Robertson, L.C., & Efron, R. (1986). Hemispheric specialization of memory for visual hierarchical stimuli. Neuropsychologia, 24(2), 205-214.

Dunn, L.M., & Dunn, L.M. (1981). Peabody picture vocabulary test: revised. Circle Pines, MN: American Guidance Service.

Dunn, H. G., McBurney, A.K., Ingram, S., & C.M. Hunter, C.M. (1977). Maternal cigarette smoking during pregnancy and the child's subsequent development: 2. Neurological and intellectual maturation to the age of 6 1/2 years. Canadian Journal of Public Health, 68, 43-50.

Etzel, R.A., Pattishall, E.N., Haley, N.J., Fletcher, R.H., & Henderson, F.W. (1992). Passive smoking and middle ear effusion among children in day care. Pediatrics, 90(2), 228-232.

Ferguson, G.A. (1959). Statistical Analysis in Psychology and Education. New York: McGraw Hill Book Company Inc.

Fielding, J.E., & Phenow, K.J. (1988). Health effects of involuntary smoking. New England Journal of Medicine, 319, 1452-1460.

Flavell, J.H., & Draguns, J.A. (1957). A microgenetic approach to perception and thought. Psychological Bulletin, 54, 197-217.

Forastiere, F., Corbo, G.M., Michelozzi, P., Pistelli, R., Agabiti, N., Brancato, G., Ciappi, G., & Perucci, C.A. (1992). Effects of environment and passive smoking on the respiratory health of children. International Journal of Epidemiology, 21(1), 66-73.

Fried, P.A. (1993). Prenatal exposure to tobacco and marijuana: Effects during pregnancy, infancy, and early childhood. Clinical Obstetrics and Gynecology, 36(2), 319-337.

Fried, P.A. (1992). Clinical implications of smoking: Determining long-term teratogenicity. In: I.S. Zagon, T.A. Slotkin, (Eds.). Maternal abuse and the developing nervous system. Orlando, FL: Academic Press, pp 77-96.

Fried, P.A. (1986). Marijuana and human pregnancy, in Chasnoff IJ (Ed.). Drug Use in Pregnancy: Mother and Child. MTP Press, Norwell, MA, pp. 64-74.

Fried, P.A., Barnes, R.N., & Drake, E.R. (1985). Soft drug use after pregnancy compared to use before and during pregnancy. American Journal of Obstetrics and Gynecology, 151, 787-792.

Fried, P.A., Innes, K.S., & Barnes, M.V. (1984). Soft drug use prior to and during pregnancy: A comparison of samples over a four-year period. Drug and Alcohol Dependence, 13, 161-176.

Fried, P.A., Makin, J.E. (1987). Neonatal behavioural correlates of prenatal exposure to marihuana, cigarettes and alcohol in a low risk population. Neurotoxicology and Teratology, 9 1-7.

Fried, P.A., O'Connell, C.M., Watkinson, B. (1992a). 60- and 72-month follow-up of children prenatally exposed to marijuana, cigarettes, and alcohol: Cognitive and language assessment. Developmental and Behavioral Pediatrics, 13(6), 383-391.

Fried, P.A., & Oxorn, H. (1980). Smoking for Two. New York, Free Press.

Fried, P.A., & Watkinson, B. (1990). 36- and 48-month neurobehavioral follow-up of children prenatally exposed to marijuana, cigarettes, and alcohol. Developmental and Behavioral Pediatrics, 11(2), 49-58.

Fried, P.A., & Watkinson, B. (1988). 12- and 24-month neurobehavioural follow-up of children prenatally exposed to marihuana, cigarettes and alcohol. Neurotoxicology and Teratology, 10, 305-313.

Fried, P.A., Watkinson, B., Gray, R. (1992b). A follow-up study of attentional behavior in 6-year-old children exposed prenatally to marihuana, cigarettes, and alcohol. Neurotoxicology and Teratology, 14, 299-311.

Gusella, J.L., & Fried, P.A. (1984). Effects of maternal social drinking and smoking on offspring at 13 months. Neurobehavioral Toxicology and Teratology, 6, 13-17.

Hardy, J.B., Mellits, E.D. (1972). Does maternal smoking during pregnancy have a long-term effect on the child? The Lancet, 2, 1332-1336.

Health and Welfare Canada, (1992). Smoking behaviour of Canadians. Ottawa: Health and Welfare Canada, Cat. No. H39-66/1985E.

Health and Welfare Canada, (1985). Smoking behaviour of Canadians. Ottawa: Health and Welfare Canada, Cat. No. H39-240/1992E.

Health and Welfare Canada. (1977). Smoking and Health in Canada: Ottawa: Long Range Health Planning Branch and Non-Medical Use of Drugs Directorate.

Health and Welfare Canada (1976). Smoking Habits of Canadians. Ottawa: Technical Report Series No. 1.

Hindmarch, Kerr, & Sherwood, (1990). Effects of nicotine gum on psychomotor performance in smokers and non-smokers. Psychopharmacology, 100, 535-541.

Hoffman, J.E. (1980). Interaction between global and local levels of a form. Journal of Experimental Psychology: Human Perception and Performance, 6, 222-234.

- Jacobson, S.W., Fein, G.G., Jacobson, J.L., Schwartz, P.M., & Dowler, J.K. (1984). Neonatal correlates of prenatal exposure to smoking, caffeine, and alcohol. Infant Behavior and Development, 7, 253-265.
- Karakostov, P. (1985). Passive smoking among pregnant women and its effect on the weight and height of the newborn. Akusherstvo i Ginekologija, 24(2), 29-31. Abstract translated in Smoking Bulletin Abstract, No. 31644(1985). Rockvill, MD: U.S. Office of Smoking and Health.
- Keith, R.W. (1986). SCAN-A screening test for auditory processing disorders. San Antonio, TX: The Psychological Corporation, Harcourt Brace Jovanovitch, Inc.
- Kimchi, R. (1992). Primacy of Wholistic processing and global/local paradigm: A critical review. Psychological Bulletin, 112(1), 24-38.
- Kitterle, F.L., Christman, S., & Conesa, J. (1993). Hemispheric differences in the interference among components of compound gratings. Perception and Psychophysics, 54(6), 785-793.
- Kristjansson, E.A., Fried, P.A., Watkinson, B. (1989). Maternal smoking during pregnancy affects children's vigilance performance. Drug and Alcohol Dependence, 24, 11-19.
- Lamb, M.R., & Roberison, L.C. (1988). The processing of hierarchical stimuli: Effects of retinal locus, locational uncertainty, and stimulus identify. Perception and Psychophysics, 44, 172-181.
- Longo, L.D. (1982). Some health consequences of maternal smoking: Issues without answers. Birth Defects: Original Article Series, 18, (3A), 13-31.
- Maisto, S. A., Galizio, M., Connors, G.J. Drug Use and Misuse, Holt, Rinehart and Winston, Inc., Chicago, 1991.
- Makin, J., Fried, P.A., Watkinson, B. (1991). A comparison of active and passive smoking during pregnancy: Long-term effects. Neurotoxicology and Teratology, 13, 5-12.

Martin, T.R., & Bracken, M.B. (1986). Association of low birthweight within passive smoke exposure in pregnancy. American Journal Epidemiology, 124, 633-642.

McCarthy, P. (1972). McCarthy Scales of Children's Abilities. New York: The Psychological Corporation.

McCartney, J.S., Fried, P.A., Watkinson, B. (1994). Central auditory processing in school-age children prenatally exposed to cigarette smoke. Neurotoxicology and Teratology.

Meyer, M.B., & Tonascia, J.A.. (1977). Maternal smoking, pregnancy complication, and perinatal mortality. American Journal of Obstetrics and Gynecology, 128, 494-520.

Moscovitch, M. (1979). Information processing and the cerebral hemispheres. In The Handbook of Behavioral Neurobiology. M.S. Gazzaniga (Editor). Plenum, New York.

Naeye, R.L., & Peters, E.C. (1984). Mental development of children whose mothers smoked during pregnancy. Obstetrics and Gynecology, 64(5), 601-607.

National Research Council (1986). Environmental Tobacco Smoke. Washington: National Academy Press.

Navon D. (1991). Testing a queue hypothesis for the processing of global and local information. Journal of Experimental Psychology: General, 120(2), 173-189.

Navon, D. (1981). The forest revisited: More on global precedence. Psychological Research, 43, 1-32.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. Cognitive Psychology, 9, 353-383.

From NIDA (National Institute on Drug Abuse) Notes, May/June, 1994.

Ober, B.A., Jagust, W.J., Koss, E., Delis, D.C., Friedland, R.P. (1991). Visuoconstructive performance and regional cerebral glucose metabolism in alzheimer's disease. Journal of Clinical and Experimental Neuropsychology, 13(5), 752-772.

Palmer, S.E. (1975). Visual perception and world knowledge: Notes on a model of sensory-cognitive interaction. In D.A Norman, D.E. Rumelhart, & the LNR Research Group, Explorations in Cognition. San Francisco: Freeman.

Paquet, L. (1994). Does the attentional state determine processing dominance in to-be-ignored compound stimuli? Acta Psychologica, 85, 1-15.

Paquet, L. (1992). Global and local processing in nonattended objects: A failure to induce local processing dominance. Journal of Experimental Psychology: Human Perception and Performance, 18(2), 512-529.

Paquet, L., & Merikle, P.M. (1988). Global precedence in attended and nonattended objects. Journal of Experimental Psychology: Human Perception and Performance, 14(1), 89-100.

Paquet, L., & Merikle, P.M. (1984). Global precedence: The effect of exposure duration. Canadian Journal of Psychology, 38(1), 45-53.

Picone, T.A., Allen, L.H., Schramm, M.M., & Olsen, P.N. (1982). Pregnancy outcome in North American women: Effects of diet, cigarette smoking, and psychological stress on maternal weight gain. American J. Clinical Nutrition, 36, 1205-1213.

Pritchard, W.S. (1991). Psychopharmacology, 104, 485-490.

Raven, J., Court, J., & Raven, J. (1983). Manual for Raven's progressive matrices and vocabulary scales. London: H.K. Lewis & Co.

Report of the Surgeon General (1972). The Health Consequences of Smoking. Washington: Government printing office. Publication No. [HSM] 72-7516. pp 117-135.

Revell, A.D., (1988). Smoking and performance - a puff-by-puff analysis. Psychopharmacology, 96, 563-565.

Reynell, J. (1969). Reynell developmental language scales. Windsor, Berkshire: NFER.

Robertson, L.C., & Lamb, M.R. (1991). Neuropsychological contributions to theories of part/whole organization. Cognitive Psychology, 23, 299-330.

Saxton, D. (1978). The behaviour of infants whose mothers smoke in pregnancy. Early Human Development, 2, 363-369.

Schlaadt, R.G., & Shannon, P.T. (1990). Drugs of Choice, Current Perspectives on Drug Use, 2nd edition, Prentice-Hall, New Jersey.

Sergent, J. (1982). The cerebral balance of power: Confrontation or cooperation? Journal of Experimental Psychology: Human Perception and Performance, 8(2), 253-272.

Sergent, J. (1983). The effects of sensory limitations on hemispheric processing. Canadian Journal of Psychology, 37(3), 345-366.

Shipley, W. (1975). Test review. In: O. Buros (Ed.) Intelligence tests and reviews. New Jersey: The Gryphon Press, p. 289.

Shulman, G.L., Sullivan, M.A., Gish, K., & Sakoda, W.J. (1986). The role of spatial-frequency channels in the perception of local and global structure. Perception, 15, 259-273.

Shulman, G.L., & Wilson, J. (1987). Spatial frequency and selective attention to spatial location. Perception, 16, 103-111.

Smith, N., Austen, J., & Rolles, C.J. (1982). Tertiary smoking by the fetus. Lancet, 1(8283), 1252.

Versace, R., & Tiberghien, G. (1988). Sensitivity of cerebral hemispheres to the local and global components of verbal and non-verbal stimuli. C.P.C.: Cahiers de Psychologie Cognitive. European Bulletin of Cognitive Psychology. 8(2), 125-137.

Warburton, D.M. (1988). The functional use of nicotine. In: Wald N.J., Forggatt P (Eds.) Nicotine, smoking and the low tar programme. Oxford, London, pp. 182-199.

Warburton, D.M., & Wesnes, K. (1978). Individual differences in smoking and attentional performance. In: Thornton RF (ed) Smoking behaviour. Churchill-Livingstone, Edinburgh, pp 19-43.

Wesnes, K., & Warburton, D.M. (1984). The effects of cigarettes of varying yield on rapid information processing performance. Psychopharmacology, 82, 338-342.

Wesnes, K., & Warburton, D.M. (1983). Effects of smoking on human information processing performance. Neuropsychobiology, 9, 223-229.

Wilbert, A.S. (1978). Effect of passive smoking on angina pectoris. New England Journal of Medicine, 299, 21-24.

Appendix 1: Cigarette Smoking History Questionnaire

Please answer all questions as accurately as possible. You may be contacted by phone to participate in a 1 hr. 30 min. experiment for which you will receive 2 credit hours. Please PRINT.

FullName.....Age.....Male.....Female
Telephonenumber.Home.....Work.....

- 1) Do you currently, or did you ever smoke? a) Yes..... b) No.....
- 2) Do you currently smoke on a regular basis? a) Yes..... b) No.....
- 3) Did you ever smoke on a regular basis? a) Yes..... b) No.....
- 4) While your mother was expecting you (i.e., while pregnant) did she smoke on a regular basis?
a) yes b) no c) don't know.....
- 5) While your mother was expecting you did your father (and/or close family member living at home) smoke on a regular basis in her presence?
a) yes b) no c) don't know.....
- 6) Were you exposed to cigarette smoke on a regular basis as a child or an adolescent for a minimum of 2 hours per day?
a) yes b) no c) don't know
- 7) Do you currently live or work in an environment which exposes you to smoke regularly?
a) yes b) no
- 8) Are you: Left handed..... Right handed.....
- 9) Do you have any difficulties with your vision that is not corrected with glasses?
a) Yes b) no If yes, please specify.....
- 10) Do you consider yourself fluent in the (spoken) English language
a) yes b) no

Appendix 2: Informed Consent Form

This consent form provides you with sufficient information to understand the purpose of this study, and what will be required of you. Read it carefully, and should you be willing to participate, please sign your consent at the bottom of page 2.

This study is being carried out in partial fulfillment of the requirements of the M.A. Program. Please direct any questions to the principal investigator, a graduate student in psychology, Mary Gonsalves (788-2600, ext. 2677), or to the supervisor, Dr. Peter Fried (ext. 2676). For any concerns regarding ethical issues, please contact Dr. L. Paquet (ext. 2692), Chair of the Ethics Committee, or Dr. W. Jones (ext. 2658), Chair of the Department.

This experiment is designed to look at possible differences in performance levels of smokers (three groups) and non-smokers in a perception task. You will be asked to fill out a smoking history questionnaire; do a verbal and non-verbal standard test; and to participate in a perception task that involves looking at different stimuli on a computer screen and remembering what they are. The entire participation time will be no longer than approximately 1 hour and 30 minutes, for which you will receive 2 hours of course credit. The location for testing is Tower A in the LOEB building, in Room 318, at Carleton University.

The experimental tasks are pre-designed and non-stressful, and you may find them quite interesting and enjoyable. You are free to stop at any time without academic penalty, and should you choose

to stop participating, any forms you may have filled out will be destroyed. All information you provide is held in strict confidence.

I will provide you with instructions before each experimental task. If you have any general questions relating to this study, please feel free to ask them at the end of the experiment. However, should you need clarification for any of the tests, please do not hesitate to stop and inquire.

ACKNOWLEDGMENT:

I have read the above explanation and understand the material therein. I consent to be a participant in this study on "The Effects of Cigarette Smoke On Global/Local Performance" and I agree to allow the use of my responses for research purposes. I understand that this information will be kept confidential.

Signature: _____

Subject: _____

Researcher: _____

Date: _____

A summary (not individual) of the results of this study will be available in the fall of 1995. If you would like to receive a copy of this summary, please leave your name and summer or permanent address with the researcher, Mary Gonsalves.

Appendix 3: Cigarette Smoking History Questionnaire

This questionnaire is about your history of cigarette smoking or exposure to cigarette smoke. Please answer all relevant questions as accurately as possible. Your replies are held in strict confidence.

Name..... Age Sex: M..... F.....

Are you familiar with the computer keyboard a) yes..... b) No.....

1) Do you currently smoke on a regular basis? a) Yes..... b) No.....

2) Did you ever smoke on a regular basis? a) Yes..... b) No.....

If you answer NO to questions 1 and 2, please skip to number 12

3) When was your last cigarette? Date.....
Time.....

4) What brand of cigarette do you usually smoke?.....

5) What type of cigarette do you usually smoke?

a) filter b) low tar c) light

d) regular e) king size..... f) other

(specify).....

6) Number of cigarettes you currently smoke per day:

a) 1 to 10..... b) 10 to 20..... c) 20 and over.....

7) At what age did you first start smoking?

a) under 15 years b) 15 to 18 years.....

c) over 18 years

8) For how many years did you smoke (not necessarily consecutive)?

a) less than one year b) 1 to 5 years

c) 5 to 10 years d) over 10 years

- 9) If you do not currently smoke, did you smoke cigarettes on a regular basis in:
- a) 1992 b) 1987 - 1991 inclusive
 - c) 1977 - 1986 inclusive
- 10) If you no longer smoke, how many years ago did you quit?
- a) less than 1 year b) 1 to 3 years ago
 - c) over 3 years ago
- 11) How many cigarettes did you smoke in an average day before you quit?
- a) 1 to 10 b) 10 to 20..... c) 20 and over.....
- 12) While your mother was expecting you (i.e., while pregnant) did she smoke on a regular basis?
- a) yes b) no c) don't know.....
- If yes, would you say your mother smoked:
- d) less than 1 pack a day e) more than 1 pack a day
 - f) don't know
- 13) While your mother was expecting you, did your father (and/or close family member living at home) smoke on a regular basis in her presence?
- a) yes b) no c) don't know.....
- If yes, would you say that he (and/or other family member) smoked (in total):
- d) less than 1 pack per day (pipe or cigar)
 - e) more than 1 pack per day (pipe or cigar)
 - f) don't know

- 14) Were you exposed to cigarette smoke on a regular basis as a child (age 0 to 11) for a minimum of 2 hours per day?
- a) yes b) no c) don't remember
- 15) Were you exposed to cigarette smoke on a regular basis as an adolescent (age 12 to 16) for a minimum of 2 hours per day?
- a) yes b) no
- 16) Do you currently live with someone who smokes?
- a) yes b) no
- If NO, please move to question 18.
- 17) On the average, approximately how many cigarettes a day does this person (or these persons) smoke in your presence?
- a) 1 to 10
b) 10 to 20
c) 20 and over
- 18) How many hours a day do you currently spend in the company of people (work/social) who smoke?
- a) 0 hours
b) more than 0 hours, less than one hour
c) 1 to 3 hours
d) 3 to 5 hours.....
e) 5 and over
- 19) Not including your present situation, in the PAST THREE YEARS, have you been exposed to second hand smoke on a regular, daily basis (at home or work)?
- a) Yes..... b) No.....

Appendix 4: Instruction Sheet

Thank you for your willingness to participate in this experiment. There are several tasks, which will take up to one and a half hours of your time.

Please complete the following before you begin the experimental tasks:

1. carefully read and complete the consent form;
2. print your name and other information on the receipt for your course credit. This receipt is proof of your participation, and is to be retained by you. Your name will be submitted by me to the undergraduate office to credit you for your time (2 hours).

Experimental Tasks

1. Fill out the three page smoking history questionnaire as accurately as possible.
2. (a) The Computer Letter Identification Test. Please read the instructions on page 2. We will go over them together just prior to starting the test.
(b) Fill out feedback sheet
3. Standardized non-verbal Tests
(a) you will be presented with some pictures for which you will indicate the correct response;
(b) a paper and pencil test. You will complete this test on your own after you are given the appropriate instructions for it.

An oral debriefing session will follow the completion of all the tasks. You are free to ask any questions at this time and I will do my best to answer them. You will be given a written debriefing to take away with you.

THE COMPUTER LETTER IDENTIFICATION TEST

Please place your left index finger on the W and your right index finger on the M on the computer keyboard. The cue cards marked with the M and the W will help you remember the location of the M and W on the keyboard.

When the message "press the OK key when you are ready" appears at the bottom of the screen, use your thumb to press the bar above the ball on the panel just below the keyboard. This message will appear 3 times before you begin the test. After pressing the bar, carefully tuck your thumbs under the palm of your hand in order to avoid accidentally pressing the bar; this will 'trip' the experiment, and cause it to stop.

At the beginning of the letter test, a star will appear centered on the computer screen. The star will then disappear, and, within seconds, a single letter will appear very briefly on one of the four quadrants on the screen. Please focus your eyes on the star as this will keep you focused on the task, and will help you avoid any urge to anticipate where the letter will appear which may result in missing the letter entirely. Try not to blink after the disappearance of the star, as you may miss the letter that follows. The letter will be either a large M or a large W, each of which is made up of small m's, or small w's. These sample letters will appear on the screen prior to the task, please take careful note of their configuration.

There are two conditions to the letter identification task. Under one condition you are requested to identify the OVERALL letter and press the corresponding letter key (i.e., an M or W) on the keyboard. For example, when a large W made up of small m's or w's is presented, the correct response is the large W. In the other condition you are requested to identify the COMPONENTS of the overall letter (what the large letter is made up of) and press the corresponding letter key on the keyboard. For example, when a large M made up of small m's or w's is presented, the correct response is the small letter, m or w respectively.

Your task is to respond accurately and as quickly as possible after the presentation of the letter. If you are not sure of the correct response, please make a rapid guess, and answer all the trials. For each of the two test conditions there will be a total of 16 letters presented randomly in any of the four quadrants. When you complete the first set of 16 letters, instructions will appear on the screen for the second condition. You will be informed when the test is finished with a message on the computer screen.

Following the letter identification test, you will be required to complete a feedback sheet for the test. Please be as accurate as possible in your responses.

If you generally wear glasses or contact lenses for reading, please use them for the computer test. If you have any questions, please clarify them before you begin the test.

Appendix 5: Post-Task Questionnaire (Letter identification Task)**Subject:****Task:****Date:**

1. Approximately what percentage of errors do you think you made?
2. How often (percentage) did you feel you guessed the response?
3. In general, did you respond immediately, or did you have to think about your response?

Immediately_____ Think_____

4. Letter identification in the following quadrant position was:
1) very difficult; 2) difficult; 3) easy; 4) very easy.

a) Top left_____; b) Top right_____;
c) Bottom left_____; d) Bottom right_____;
5. Please circle one of the following responses:

a) A large letter made up of the same letter (e.g., M made up of m or W made up of w), was more difficult to identify;

b) A large letter made up of a different letter (e.g., M made up of w or W made up of m) was more difficult to identify.
6. Did you focus on the star? a) Yes____; b) No_____.

Appendix 6: Debriefing

Research on the effects of cigarette smoke, both active and passive focus on health issues in adults, and on the developing fetus of smoking mothers. Extensive literature, both neurological and psychological point to the effects of cigarette smoke on cognitive and behavioral responses in children and adults.

This study examines the effects of cigarette smoke, either active, passive, or *in utero*., on a person's ability to identify fine, or detailed content of a whole perceptual visual feature. It predicts that smokers will make more errors in analyzing detailed (local) content than non-smokers, and that there will be no difference in performance for the smokers and non-smokers in identifying whole (global) features. Thus, the experimental task was to look at visually presented stimuli made up of both, small and large (identical) letters at very short durations and be able to identify them accurately.

The Smoking History Questionnaire provides information on one's life-style and habits, and the standardized verbal and spatial tests (Peabody Picture Vocabulary Test-Revised, and Raven's Progressive Matrices respectively) are performance measures against which the perception task will be statistically correlated.

These findings may be significant for educational purposes, as the analysis of detailed features is a prerequisite for attention and learning. Therefore, such a study is important as previous research points to the effects of cigarette smoke on attentional behavior, and to a small but significant relationship on the processing of auditory

information. For instance, Fried's (1992) summary on his Ottawa Prenatal Prospective Study (OPPS) points to an association between prenatal cigarette exposure and decreased auditory habituation in babies between 3 and 6 days of age, and continuing to have a significant relationship at age 2. Additionally, Fried suggests a relationship between lowered cognitive skills in childhood and maternal smoking. His findings extend to several studies that show that school age offspring of women who smoke during pregnancy demonstrate a small but significant decrement in intellectual, perceptual and academic functioning with the most vulnerable areas being in the auditory/language processing dimension. This study looks at the effects of cigarette smoking and/or exposure in young adults.

Future studies may want to explore the temporal analysis of small or large features and correlate them to the effects of smoking.

We would like to thank you for your participation in this study. Your time and efforts are greatly appreciated.

Please direct any comments or questions about this research to any of the following: the principal investigator (Mary Gonsalves, 788-2600, ext. 2677), the thesis supervisor (Dr. Peter Fried, ext. 2676), Dr. Lise Paquet (Chair of the Ethics Committee, ext. 2692), and Dr. W. Jones (Chair of the Department, ext. 2658).

Appendix 7: Receipt Form

Experiment Number 93-117

Experiment Title EFFECTS OF CIGARETTE SMOKE ON
GLOBAL/LOCAL PROCESSING

Student Name

Student I.D.

Date

Hours of Participation

Appendix 8: Global/Local Sample Stimuli

Appendix 9: Global/Local Stimuli Position in Quadrants

m m m
m m m
m m m
m m m
m m m
m m m

m m m
m m m
m m m
m m m
m m m
m m m

END

1 5-1 1-9 5

FIN