HAIGAZIAN UNIVERSITY

MERCURY VAPOR EXPOSURE FROM DENTAL AMALGAMS, AND ITS RELATIONSHIP TO SEVERAL PSYCHOLOGICAL, MOTOR AND COGNITIVE VARIABLES

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To my family

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Abstract

The present study investigated the relationship of dental amalgams to a set of psychological, cognitive and motor measures. The study comprised two parts, a survey-based research and an experimental part. The survey part involved three samples, a university sample and two different internet samples. It examined hypotheses concerning the relationship of amalgam with depression, social phobia, smoking and habit. Results showed that participants who had amalgam tended to score higher than participants who had no amalgams on measures of depression. Further, participants who had very high amalgam tended to score higher also in social phobia and smoking frequency. Gender differences were also noted. The results differed among the three samples. These differences were explained in terms of sample characteristics such as age and gender. The experimental part of the study, which was based on a university sample, tested hypotheses concerning the relationship of dental amalgams to simple reaction time, memory span and finger tapping. Results indicated that subjects with high amalgam scores tended to do poorer in reaction-time, finger tapping and digit span forward. Gender differences were also obtained. It was concluded that dental amalgams should be considered as a possible contributor in the etiology of depression and social phobia and possibly to motor and cognitive deficits. It was also concluded that the present research is important in alerting clinical psychologists, all health professionals and the general public to the potential adverse effects of dental amalgam, on psychological functions in particular.

CHAPTER ONE
INTRODUCTION AND BACKGROUND

The goal of the present study is to investigate the relationship of dental amalgams to measures of psychological, cognitive, and motor functions. The study is composed of three parts. The division of the study into three parts was predicated by the fact that three independent samples were used where the same or different hypotheses were tested. The first part deals with the relationship of dental amalgams with several psychological functions in university students. The second part aims at verifying the relevance of the results of the first part to a population of more diverse backgrounds and a broader age range: a sample of Internet mailing list members. The third part is an experimental study dealing with the relationship of dental amalgam to a number of selected cognitive and motor functions in university students.

Dental amalgam fillings, which are the most widely used substance for dental restorations comprise 50% mercury (Bauer & First, 1982, as cited in Siblerud, 1992), which is one of the most toxic substances known to man. There is no threshold of a level of mercury below which it has no toxic effects (Friberg, 1994). There are two types of toxicity from mercury. One is acute mercury poisoning, the other is chronic mercury poisoning. Chronic mercury poisoning results from exposure to small amounts of mercury on a long-term basis. Mercury from amalgams has been shown to escape as vapor (Gay, Cox & Reinhardt, 1979). When inhaled, this vapor passes from the lungs into the bloodstream (Hursh, Clarkson, Cherian, Vostall & Millie, 1976, as cited in Siblerud, Motl & Kienholz, 1994). From the bloodstream it passes the blood-brain barrier into the brain where it is ionized (Clarkson, 1972). Ionized mercury accumulates in the brain (Eggleston

and Nylander, 1987) and kidneys (WHO, 1991). Eggleston and Nylander (1987) found a direct correlation between number of amalgams and amount of mercury in the brain in a post-mortem analysis. Mercury has many toxic effects. Dental amalgam mercury has been connected with multiple sclerosis (Craelius, 1978; Huggins & Levy, 1998). Mercury vapor concentrations equal to those in people with large numbers of amalgam fillings have been found to cause Alzheimer-like changes in the brains of rats (Lorscheider, Vimy, Pendergrass & Haley, 1995). In fact, increased blood mercury levels have been found in patients with Alzheimer's disease (Hock et al, 1998). Many countries including Sweden, Denmark, Austria, Germany, England and Canada, have advised dentists to seek alternatives to mercury fillings, especially for pregnant and breast-feeding women and in some instances children and those with kidney problems (Pyle, 1999).

As can be seen from the above, the physiological effects of mercury are numerous and well documented. The present study however, is not directly concerned with these kinds of effects but with the behavioral concomitants of the problem of amalgam mercury exposure. It is essentially concerned with some of the behavioral effects associated with mercury exposure. The physiological effects are discussed only insofar as they contribute to the understanding of these behavioral effects.

Studies on mercury exposure from dental amalgams have mostly used amalgam number as an index of the degree of mercury exposure. As regards the present study, this index of exposure seems inadequate. This is because there are other factors, other than simply the number of amalgams, determining the degree of mercury exposure. These 'other' factors are the size of amalgams, the age of amalgams, frequency of chewing and brushing, etc. The present study utilizes a new scale constructed by the author: Dental Amalgam Effect Scale (DAES). This scale, which is fully self-administered, takes into consideration, in addition to amalgam number, the other factors determining the degree of mercury

exposure, thus arriving at a better approximation of the degree of mercury exposure. However, before discussing the scale in any detail, an introduction to the psychological effects of mercury -the scientific background to the present study- seems in order. The three parts of the study will come later.

Psychological Effects of Mercury

Among its many toxic effects mercury has been found to have psychological effects. These can be divided into two groups, a) Those which are seen in occupationally exposed workers, for example, felt hat workers, dentists, thermometer-makers, chlorine-alkali workers, fluorescent lamp makers, etc. and b) Those which have been identified in people whose exposure to mercury is attributable solely to their amalgams. The first group of psychological symptoms, includes irritability, loss of self-confidence, shyness, loss of memory, depression, difficulty sleeping, nightmare, fatigue, loss of ability to concentrate, nervousness (Rosneman, Valciukas, Glickman, Meyers & Cinotti, 1986), disturbances of personality (such as erethism), psychosomatic complaints (Fagala & Wigg, 1992) deficits in memory span (Echeverria et al., 1998), and poor performance in finger tapping and simple reaction time (Kishi et al., 1994) . The second group of symptoms, includes the symptoms of depression, excessive anger, and anxiety (Siblerud et al., 1994). Depression is common to both groups. There is no reason why the other psychological effects in group (a) should not also be present, to a lower extent and perhaps at a subclinical level, in group (b). The present study seeks to find some of the symptoms identified in group (a), namely depression, erethism (a mercury symptom similar to social phobia as discussed later), memory span, finger tapping and simple reaction time in a group (b) sample.

1.The Dental Amalgam Effect Scale (DAES)

The Dental Amalgam Effect Scale (Appendix III) is a scale developed by the author. It consists of questions regarding the number, size, and age of amalgams. It also includes questions concerning amalgam breakage, removal or replacement of amalgams, use of chewing gum, frequency of brushing teeth, frequency of exercise, and the time of the last visit to the dentist. The validity and reliability of the questionnaire have not been investigated. However, despite its self-administered nature and the uncertain validity which that could imply, it is a beginning towards subsequent more empirically based scales measuring dental amalgam load. It also has the advantage, when compared to interviewer- or dentist-administered scales, of being suitable for distribution on a larger scale and over the Internet (as will be seen later). The following is a ranking of the factors dealt with in the above questions. The ranking is based on the strength of literature supporting each factor's contribution to the release of mercury from amalgams. The ranking presented here aims at showing the importance each factor was accorded in the scale (by the position it occupies in the ranking) and at presenting the literature support it has received.

a. Number of amalgams: This is the most obvious measure of mercury exposure from amalgams. Many studies have used this as their only measure of mercury exposure from amalgams. For example, Nylander, Griberg & Lind (1987) correlated number of tooth surfaces containing amalgam with mercury concentration in the occipital lobe cortex. They found a statistically significant regression.

b. Size of amalgams: This obviously influences the amount of mercury in one's mouth, since smaller amalgams would contain less mercury than larger amalgams. Saxe et al. (1995) used surface area measurements in square millimeters as measure of amalgam. Aposhian et al. (1992) likewise scored each amalgam surface according to its diameter in

millimeters.

c. Age of amalgams: The more the time amalgam is in one's mouth, the more the exposure to mercury would be, since mercury accumulates in the brain (Eggleston & Nylander, 1987).

d. Amalgam replacement or removal, and breakage: Studies have shown that after removal of amalgam there is an increase of mercury in plasma, erythrocytes, and urine (Molin, Bergman, Marklund, Schutz & Skerfving, 1990) and there are previously absent significant deposits of mercury in the lungs, Kidneys, endocrine glands, liver and heart (Omura, Shimotsuura, Fukuoka, Fukuoka and Nomoto, 1996)

e. Chewing gum: Gay, Cox & Reinhardt (1979) found that in participants with dental amalgam, mercury in expired air increased 4-fold after 15 minutes of chewing. Siblerud et al. (1994) also found that in participants with amalgam there was a 350% increase in mercury vapor in oral cavity after chewing, whereas in participants without amalgam there was only a 55% increase. There is also another type of evidence that gum chewing increases mercury release from dental amalgam. Gebel & Dunkelberg (1996) found that in people with similar amalgam status those who chewed gum had significantly higher mean urinary mercury content.

f. Brushing teeth: Brushing teeth with commercial toothpaste stimulates the release of mercury vapor from amalgam surfaces (Patterson, Weissberg & Dennison, 1985; as cited in Hahn, Kloiber, Vimy, Takahashi & Lorscheider, 1989). According to Aposhian et al. (1992) the release of mercury vapor from amalgams when brushing is by now an accepted fact.

g. Exercise Frequency: Sihimojo and Arai (1994) found that mercury concentrations in the heart, whole blood, red blood cells and brain were significantly higher in exercise-trained mice (as compared to non-exercise-trained mice) 24 hours and 48 hours after exposure to

Hg vapor for 1 hour. This finding, however, needs to be replicated in humans.

h. Recent amalgam installation: Gay, Cox, & Reinhardt (1979) in a study of 5 amalgam patients and two controls, reported much higher mercury vapor levels in the expired breaths of the 3 amalgam patients who had had their amalgams placed 1 week, 2 weeks and seven months ago respectively, compared to the other 2 amalgam patients who had had their amalgams placed 1 year and 2 years ago.

The following is the questionnaire with each possible response on each item preceded by the ratio by which it will add to the DAES score.

1. How many of your teeth are filled with metal (amalgam tooth fillings, also called 'rsas' in Arabic or 'gabar' in Armenian)? Please check your teeth with a mirror and count the teeth which are filled with metal. Write the number here ____. (You may have to use two mirrors, a strong lamp, and may have to lift your head up in front of the mirror to be able to count the amalgams clearly) If you don't have any, jump to question number 4.

Number of amalgams (multiplied by) x two

2. How large are the metals in your teeth?

x 2 a) Most of them are large (covering most of the surface area of the tooth).

x 1.5 b) Most of them are medium (covering about half the surface area of the tooth).

x 1 c) Most of them are small (covering a small part of the surface area of the tooth).

3. For how long have you had metals in your teeth?

x 2 a) 10 years or more.

x 1.75 b) 7-9 years.

x 1.50 c) 4-6 years.

x 1.25 d) 2-3 years.

x 1 e) 0-1 year

4. Have you had broken amalgams, or has your dentist removed/drilled out old amalgam (in order to replace them or to drill cavities from under them)?

x 1 a) No.

x 1.25 b) Yes, 1-4 times.

x 1.5 c) Yes, 5-9 times.

x 1.75 d) Yes, 10 times or more.

5. How often do you chew gum?

x 1.5 a) Very often.

x 1.25 b) Often.

x 1.1 c) Occasionally.

x 1 d) Never.

6. How many times a day do you brush your teeth?

x 1.2 a) 3 times or more.

x 1.15 b) 2 times.

x 1.1 c) Once.

x 1.05 d) I don't brush my teeth regularly.

7. How often do you exercise?

x 1 a) Once or twice a month.

x 1.05 b) Once a week.

x 1.10 c) Twice a week.

x 1.15 d) Three times a week or more.

8. Have you gone to the dentist for the past 7 months to have a tooth filled with amalgam?

_____

x 1.1 for yes

x 1 for no

2. Scoring Rationale of the DAES

The responses of participants to each question will be weighted according to the above ranking. Questions which are higher in the ranking, will have a greater contribution to total DAES score. The maximum score for each question decreases in the order of the above ranking, since number and size of amalgam are more important determiners of mercury exposure than brushing teeth or exercising. Within each item the different response-options' coefficients will increase from least contributing to amalgam effect to most contributing by equal increments in general. The value accorded to each response will be multiplicatively (proportionately) related to the responses to each of the other questions to yield a total DAES score. The score on the second question will be multiplied by the score on the first question (the scores will vary from 1 to 2 according to the response and the question's ranking) and the result will in turn be multiplied by the score on the next question and so on, each successive question's score being multiplied by the product of the scores of the previous questions. Somebody who has 20 amalgams will probably get more increase from chewing than somebody who has only one amalgam. This method of ranked multiplication between question scores will permit such finer differences to be accounted for.

The minimum score in the questionnaire will be 0: those who have no amalgams. The maximum score will be 100. This will be achieved by dividing each score by the highest possible score of the test (637 assuming the highest number of amalgams to be 20) and multiplying the result by 100. In the real questionnaire (see Appendix III) the second question had pictures of amalgam filled teeth accompanying each option of response in order to aid the participants in their decision.

CHAPTER TWO

PART 1

Part one is concerned with the relationship of dental amalgams to psychological functions in university students. It investigates the association of dental amalgam with the variables of depression, social phobia, smoking and habit. The following sections will deal with each of these variables as related to mercury exposure. They will also present the hypotheses regarding each variable. The presentation of the study will follow next.

Dental Amalgams and Depression

One of the symptom of chronic mercury poisoning is depression (Rosenman, Valciukas, Glickman, Meyers & Cinotti, 1986). There is also evidence of a significantly higher score in depression in amalgam bearing participants as compared to participants with no amalgams. Siblerud et al. (1994) compared 25 amalgam bearing women with mean age of 35.3 years with 23 women without amalgams with mean age of 34.6 years. For the amalgam bearing group only women with 10 or more amalgams were included. The average number of amalgams was 13. They found that in participants with amalgams the mean total score on the Beck Depression Iventory (BDI) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) was significantly higher than for participants without amalgams. They also found that the amalgam group scored significantly higher in 9 of the 21 questions in the BDI. These questions concerned pessimism, guilt, punishment, self-accusation, body-image change, difficulty of work, insomnia, fatigability and somatic preoccupation. As the authors themselves suggest, this study being the first of its kind needs further replication by other studies using other psychometric instruments and larger samples (Sibelrud et al., 1994). The present study uses two measures of depression and a sample exceeding a

hundred participants. Thus one of the hypotheses in the present study is: people with dental amalgams will score higher, than people with no dental amalgams, on the Beck (Beck et al., 1961) and Costello-Comrey (Costello & Comrey, 1967) depression scales.

Dental Amalgams and Social Phobia

A frequently occurring classic personality disturbance from chronic mercury poisoning is erethism. The main features of erethism are nervousness, timidity and shyness, blushing readily, embarrassment in social situations, objection to being watched and seeking to avoid people, irritability and quarrelsomeness, and marked mood lability (O'carroll, Masterton, Dougall, Ebmeier, and Goodwin, 1995). However, when these symptoms of erethism are compared with the diagnostic criteria for social phobia many similarities will be detected. For one thing, the primary criterion for a diagnosis of social phobia as stated by the Diagnostic and Statistical Manual of psychiatric disorders (DSM-IV) (American Psychiatric Association, 1994):

> A marked and persistent fear of one or more social or performance situations in which the person is exposed to unfamiliar people or to possible scrutiny by others. The individual fears that he or she will act in a way (or show anxiety symptoms) that will be humiliating or embarrassing. (p. 205).

This description is echoed in the following features of erethism: embarrassment in social situations, shyness, blushing readily, objection to being watched (O'carroll et al., 1995). The second criterion for social phobia: "exposure to the feared social situation almost invariably provokes anxiety..." (American Psychiatric Association, 1994) is reflected in the "nervousness" of erethism (O'carroll et al., 1995). Another criterion of social phobia: "the feared social or performance situations are avoided, or else endured with intense anxiety or distress", is echoed in the following features of erethism: objection

to being watched, seeking to avoid people, and irritability and quarrelsomeness (O'carroll et al., 1995). Such similarities or overlaps between erethism and social phobia have led the author to consider the possibility that mercury from dental amalgams may be a contributor in the etiology of social phobia, especially since, unlike occupational mercury poisoning, mercury from dental amalgams is not clinically recognized as a possible contributor to psychological disorders. Hence, the second hypothesis of this study is: people with dental amalgams will score higher than people with no dental amalgams on a two-part measure of social phobia, the Social Avoidance and Distress and the Fear of Negative Evaluation Scales (Watson and Fiend, 1969).

As discussed in Chapter One, mercury has many physiological effects. Of these, one which is of basic importance to this study, and which is of major importance to its psychological effects, is mercury's accumulation in the brain (Eggleston & Nylander, 1987). It is known that mercury affects the neurotransmitter (Cooper & Manalis, 1983; Oudar, Caillard & Fillion 1989; Rajana, Hobson, Harris, Ware & Chatty, 1990) and immune systems (Dantas and Queiroz, 1997; Eedy, Burrows, Clifford and Fay, 1990; Hultman, Lindh, and Horstel-Bindslev, 1998; Moszczynski & Moszczynski, 1995). It can be argued that the physiological mechanisms through which mercury could cause depression and social phobia could well be its effects on the neurotransmitter and immune systems, changes in both of which are implicated in depression (Herbert and Cohen, 1993; Peterfy, Pinter, and Pattee, 1976; Quetsch, Achor, Litin, and Faucett, 1959, as cited in Stockmeier, 1997) and in anxiety disorders (Castilla-Cortazar, Castilla, Gurpegui, 1998; Kaplan, Sadock and Grebb, 1994; Rapaport, 1998). For a review of studies on depression and immunity see Herbert & Cohen (1993).

Dental Amalgams and Smoking

Several studies have associated amalgams and smoking (e.g. Siblerud, Kienholz, & Motl, 1993; Michel, Norback and Edling, 1989). Siblerud et. al. (1993) compared the smoking habits of 119 participants with amalgams to those of 119 participants without amalgams. They found that the amalgam group had significantly more (2.5 times) smokers than the non-amalgam group. The present study will try to replicate those findings. Thus the present study's third hypothesis is: people with dental amalgams smoke more than people who have no amalgams.

Dental Amalgams and Habit Formation ("addiction")

Smoking is an addiction or a habit difficult to discontinue once established. It has been found that people who have dental amalgams tend to smoke more than people who don't have dental amalgams (Siblerud et al., 1993). It may be speculated that mercury from amalgams renders people more likely to form strong habits or increases people's tendency to be "addicted" (or even renders them weak so that they are incapable or unwilling to discontinue habits once they are 'addicted' to them), whether to smoking or any other thing like watching television, playing computer games, using the Internet, drugs, gambling etc. If this is the case, people bearing amalgams would not only have more smokers among themselves, but more people 'addicted' to television, computers, Internet, gambling etc. Thus the final hypothesis in this study is: On a measure of strength of tendency to form habits, the scores of people with dental amalgams will differ from those of people with no amalgams.

To sum up, the four hypotheses tested in this part of the study are:

1) People with dental amalgams will score higher, than people with no dental amalgams, on the Beck (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) and Costello-Comrey (Costello & Comrey, 1967) depression scales.

2) People with dental amalgams will score higher than people with no dental amalgams on a two-part measure of social phobia, the Social Avoidance and Distress and the Fear of Negative Evaluation Scales (Watson and Fiend, 1969).

3) People with dental amalgams smoke more than people who have no amalgams.

4) On a measure of strength of tendency to form habits, the scores of people with dental amalgams will differ from those of people with no amalgams.

METHOD

Participants

The participants were university students (all from Haigazian University). They were mostly sophomores and of different majors. There were 141 participants: 60 males and 80 females (one participant had not indicated gender). Their average age was 20.78 years with a range between 17 to 44 years and a median of 20 years.

Material

The following tests were used: the Beck Depression Inventory (BDI) (Beck et al., 1961), the Costello-Comrey Depression Scale (CCDS) (Costello & Comrey, 1967), the Social Avoidance and Distress scale (SAD), the Fear of Negative Evaluation (FNE) scale (Watson and Fiend, 1969), and the Dental Amalgam Effect Scale (DAES) (see Chapter 1 and Appendix III) assessing the number of amalgams and other related factors detailed in

chapter 1. There were also two separate questions constructed by the author. One of these assessed smoking frequency (Appendix I). The other assessed the strength of the tendency to form habits (See Appendix II). Altogether there were 103 items to answer.

Procedure

Having agreed with the teachers and taken their consent, the experimenter distributed the questionnaires during regular class hours. The experimenter explained what the students had to do. The students were requested to fill the questionnaires later and return them to their teacher in their next class. Nearly 290 questionnaires were distributed. 141 were returned.

Results

Data and Sample Characteristics

Of the 141 people who responded, 112 had amalgams (79.4%). For these, the mean DAES score was 7.98, and mean amalgam number was 5.17. Of the 60 males who responded, 41 had amalgam (68.33%). For these, the mean DAES score was 7.79, and mean amalgam number was 4.90. Of the 80 females who responded, 70 had amalgam (87.5%). For these, the mean DAES score was 8.02, and mean amalgam number was 5.29. In order to compare a group with high amalgam with a group with no amalgam, participants with a DAES score of 8 or more were chosen for this and the third part of the present research. The minimum score of 8 was chosen because it represented a rather high score and was just above the mean DAES score for those who had amalgams.

In line with the hypothesis and as shown in Table 1 a one-tailed t-test showed that students who had amalgams scored significantly higher than those who had no amalgams on the two depression scales, the Beck Depression Inventory and the Costello-Comrey Depression Questionnaire. On the other hand, there were no statistically

significant differences for the SAD and FNE scales nor for the smoking and habit questions. Pearson product-moment correlations were also calculated between DAES score and each of the scales (for those who had amalgams). There was a small but statistically significant correlation between the DAES and the SAD ($r = .16$, $N = 141$, $p = .046$). There was another small but statistically significant correlation between the DAES and smoking frequency ($r = .159$, $N = 112$, $p = .047$). The rest of the correlations were not significant.

Table 1

Differences between amalgam bearing and no amalgam participants

Questionnaire	Means (SDs) Amalgam N = 112	No Amalgam N = 29	t	df	Sig.
BDI	11.04 (7.13)	8.07 (5.99)	2.06*	139	.021 †
CCDS	50.91 (16.99)	43.48 (16.15)	2.12*	139	.018 †
SAD	9.76 (5.88)	8.28 (5.27)	1.24	139	.109 †
FNE	14.54 (6.97)	14.69 (7.09)	0.11	139	.458 †
Smoking	0.22 (0.64)	0.31 (0.85)	0.61	139	.272 †
Habit	6.05 (2.50)	5.90 (2.86)	0.29	138	.770

* significant at $p < .05$, † one-tailed significance test

Note: The Bonferroni correction for p .05 for multiple comparisons is $p = .008$, and for p .10 is $p = .017$

t-tests comparing students with a DAES score of 8 or more to those with a DAES score of zero, showed no statistically significant differences between students with amalgam and those without on any of the six measures. The differences in the BDI were close to

significance ($t = 1.337$, $df = 69$, $p = .093$). It was reasoned that there could be differences between students with even higher DAES scores and those with no amalgam. Therefore, it was decided to check for various different thresholds defining high DAES scoring groups, in order to check for differences that may be apparent only beyond a certain DAES score. It was decided to increase the threshold of the DAES score by increments of 8. Consequently, in addition to students with high DAES scores of 8 and above, students with high DAES scores of 16 and above, and of 24 and above were compared to students who had no amalgam. t-tests comparing students with DAES scores of 16 and above to students with no amalgam disclosed no statistically significant differences between the two groups in any of the measures. Only for the Social Avoidance and Distress scale (SAD) did the differences between high DAES and no amalgam approach statistical significance ($t = 1.393$, $df = 40$, $p = .086$). Because the participants were young students who were not very likely to have large numbers of amalgams, the sample was not an extreme one in terms of amalgam load. The number of students with DAES scores above 24 was only five. t-tests (one-tailed) comparing these students (with DAES scores of 24 and above) to students with no amalgam showed statistically significant differences in the BDI, the Costello-Comrey Depression Scale, and the SAD (see Table 2). Also, differences in two of the other scales were very close to conventional statistical significance: the FNE, and smoking frequency (see Table 2).

Although the present study had no hypotheses for gender differences in the association of the various scales with amalgam, examination of the literature disclosed that most of the research on mercury exposure was done on mercury mine workers who are males. At the same time it was noted that the study by Sibelrud, Motl, & Kienholz, (1994) dealing with the associations of amalgam and depression as well as anxiety and excessive anger had only female participants. Animal studies have found gender differences in mercury

distribution and urinary excretion in mice (e.g. Hirayama and Yasutake, 1986; Inouye, Kajiwara, and Hirayama, 1986; Yasutake and Hirayama, 1988).

Table 2

Differences between high amalgam (DAES score of 24 or above) and no amalgam participants

Questionnaire	Means (SDs) Amalgam N = 5	No Amalgam N = 29	t	df	Sig.
BDI	16.80 (8.58)	8.07 (5.98)	2.83**	32	.004 †
CCDS	62.80 (21.30)	43.48 (16.15)	2.36*	32	.012 †
SAD	16.20 (6.69)	8.28 (5.27)	2.99**	32	.003 †
FNE	20.00 (5.61)	14.69 (7.09)	1.59	32	.062 †
Smoking	1.00 (1.22)	0.31 (0.85)	1.57	32	.063 †
Habit	6.20 (2.68)	5.90 (2.86)	0.22	31	.827

* significant at p< .05, ** significant at p< .01, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p .10 is p = .017

One of these studies (Hirayama & Yasutake, 1986) attributed higher urinary excretion rates (of mercury) in male mice to sex hormones. Studies on humans, on the other hand, have found higher urinary excretion of mercury in females (Lie, Gundersen, & Korsgaard, 1982; Zander, Ewers, Jermann, Westerweller, & Brockhaus, 1990) and higher concentrations of mercury in red blood cells for males (Sakamoto, Nakano, Akagi, Kitano, & Futatsuka, 1993). There are also well-known gender differences in depression and social phobia (Kaplan, Sadock and Grebb, 1994). It was therefore found proper to analyse the results of males and females separately. It could be that sex differences in the effects of mercury on psychological variables exist but are as yet unexplored.

Gender Differences

A t-test between males and females (see Table 3) showed that males had significantly higher mean scores in the Beck Depression Inventory, the Costello-Comrey Depression Scales, the Social Avoidance and Distress Scale and Smoking, and a marginally significantly higher mean score in the Fear of Negative Evaluation Scale and in Habit, whereas females had a marginally significantly higher mean number of amalgams. These results justified separate analyses of the results of males and females.

Table 3

Gender Differences

Questionnaire	Means (SDs) Males N = 60	Females N = 80	t	df	Sig.
BDI	12.58 (7.29)	8.91 (6.34)	3.18**	138	.002
CCDS	52.95 (17.22)	46.77 (16.56)	2.14*	138	.034
SAD	11.03 (5.63)	8.34 (5.64)	2.80**	138	.006
FNE	15.77 (6.6)	13.65 (7.18)	1.79	138	.076
Smoking	0.40 (0.85)	0.13 (0.51)	2.38*	138	.019
Habit	6.46 (2.53)	5.70 (2.58)	1.73	137	.087
DAES	5.32 (8.68)	7.02 (6.45)	1.32	138	.188
Amalgam N	3.35 (4.16)	4.63 (3.58)	1.94	138	.054

* significant at p< .05, ** significant at p< .01,
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .006, and for p .10 is p = .0125

Results for Males

A t-test for males alone between those who had amalgam and those who did not, showed that males with amalgam had a statistically significant higher score in the Costello-Comrey Depression Scale as well as a marginally significant higher score in the

BDI (see Table 4). Analyses were also done comparing those who had DAES scores of 8 or higher with those who had DAES scores of 0 (i.e. no amalgam). This was undertaken with the logic that whatever differences were hypothesised to be present in those who had amalgam would be more pronounced the higher their amalgam (i.e. degree of amalgam exposure). t-tests for males comparing those with a DAES score of 8 or more to those with a DAES score of zero (see table 5) showed statistically significant higher scores for males with DAES scores of 8 or more (as compared with those with no amalgam) in the BDI, the CCDS and the SAD. Correlational analyses (see Table 6) showed statistically significant correlations between DAES score (for those who had amalgam) and the Costello-Comrey Depression scale, and between DAES score and the SAD and a marginally significant correlation between DAES score and the BDI.

Table 4

Differences between amalgam-bearing and no amalgam males

Questionnaire	Means (SDs)		t	df	Sig.
	Amalgam N = 41	No Amalgam N = 19			
BDI	13.61 (7.65)	10.37 (6.04)	1.63	58	.055†
CCDS	55.88 (17.35)	46.63 (15.10)	2.00*	58	.026†
SAD	11.61 (6.28)	9.79 (3.71)	1.17	58	.124†
FNE	15.37 (6.52)	16.63 (6.86)	0.69	58	.247†
Smoking	0.44 (0.87)	0.32 (0.82)	0.52	58	.303†
Habit	6.58 (2.42)	6.21 (2.80)	0.51	57	.609

* significant at p< .05, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p = .10 is p = .017

Table 5

Differences between high amalgam (score of 8 or more) and no amalgam males

Questionnaire	Means (SDs) High Amalgam N = 10	No Amalgam N = 19	t	df	Sig.
BDI	15.8 (7.63)	10.37 (6.04)	2.10*	27	.023†
CCDS	62.3 (19.25)	46.63 (15.10)	2.42*	27	.012†
SAD	15.5 (7.95)	9.79 (3.71)	2.66**	27	.007†
FNE	15.1 (6.01)	16.63 (6.86)	0.60	27	.279†
Smoking	0.40 (0.52)	0.32 (0.82)	0.29	27	.386†
Habit	6.40 (2.84)	6.2 (2.80)	0.17	27	.864

* significant at p< .05, ** significant at p< .01, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p .10 is p = .017

Table 6

Pearson correlations between DAES score (for those who have amalgam) and the first part of the experiment (the questionnaires) for males alone. N = 41 (N = 40 for Habit).

		BDI	CCDS	SAD	FNE	Smoking	Habit
DAES	r	.256	.293*	.456**	.153	.021	.036
	p	.053†	.032†	.001†	.170†	.447†	.824

* significant at p< .05, ** significant at p< .01, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p .10 is p = .017

Results for Females

A t-test for females alone (see Table 7) showed that females with amalgam had a significantly higher score than females without amalgam on the BDI and statistically significant higher scores in the Costello-Comrey Depression Scale and in the SAD. t-tests between those with a DAES score of 8 or more and those with a DAES score of zero were done (see Table 8). The results showed significantly higher scores in the BDI for females with a DAES score of 8 or more (as compared with females with a DAES score of 0, i.e. no amalgam). There was a statistically significant correlation between DAES score and smoking frequency (see Table 9). There were no positive correlations between DAES score and the rest of the scales, but on the contrary a statistically significant negative correlation between DAES score and the Costello-Comrey Depression scale.

Table 7

Differences between amalgam-bearing and no amalgam females

Questionnaire	Means		t	df	Sig.
	Amalgam N = 70	No Amalgam N = 10			
BDI	9.66 (6.39)	3.7 (2.45)	2.91**	78	.003†
CCDS	48.1 (16.34)	37.5 (17.17)	1.91*	78	.030†
SAD	8.76 (5.24)	5.4 (6.70)	1.79*	78	.039†
FNE	14.03 (7.26)	11 (6.25)	1.25	78	.107†
Smoking	0.10 (0.42)	0.30 (0.95)	1.16	78	.126†
Habit	5.76 (5.30)	5.3 (5.30)	0.52	78	.604

* significant at p< .05, ** significant at p< .01, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p = .10 is p = .017

Analyses of Variance

Two-way analyses of variance with the factors of amalgam (have or don't have) and gender (male or female) was desired, but because the data did not satisfy the assumptions for an analysis of variance, they were not carried out. Specifically, the variances for the DAES scores of males and females differed greatly, which constituted a severe violation of the assumption of homogeneity of variance (McCall, & Kagan, 1994). Also, the cell sizes were different (the number of males with amalgam was 40, while that of females was 68; and number of males without amalgam was 19, while that of females was 10).

Table 8

Differences between high amalgam (DAES score of 8 or more) and no amalgam females

Questionnaire	Means (SDs) High Amalgam N = 31	No Amalgam N = 10	T	df	Sig.
BDI	8.65 (5.77)	3.70 (2.45)	2.62*	39	.007†
CCDS	43.81 (15.43)	37.50 (17.17)	1.09	39	.141†
SAD	8.10 (5.91)	5.40 (6.70)	1.22	39	.116†
FNE	14.77 (7.44)	11.00 (6.25)	1.44	39	.157†
Smoking	0.16 (0.58)	0.30 (0.95)	0.56	39	.281†
Habit	5.71 (2.69)	5.3 (3.02)	0.41	39	.686

* significant at p< .05, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p .10 is p = .017

Subsidiary Findings

The findings reported here were not hypothesized for. However, they are reported because other studies in the literature have obtained similar results. The fact that the

present study replicated those findings, indirectly reinforces the validity and the reliability of the present sample. It was found that there was a statistically significant positive correlation between smoking and the two depression scales: the BDI ($r = .33$, $df = 139$, $p = .000$), and the CCDS ($r = .20$, $df = 139$, $p = .019$). This finding corroborates other similar findings (Covey, Glassman, Stetner, 1998; Anda et al., 1990). Anda et. al. (1990) found that the "prevalence of current smokers increased as the Center for Epidemiologic Studies Depression Scale score increased" (p.1541). Covey et. al. (1998) in their review of the literature concluded that people who had major depression were more likely to smoke as well as to have difficulty when they tried to stop. Other findings were small but statistically significant correlations between the tendency to form difficult-to-break habits ('addictions') and scores in the Costello-Comrey Depression scale ($r = .22$, $df = 138$, $p = .02$) and between the tendency to form difficult-to-break habits ('addictions') and the Social Avoidance and Distress scales ($r = .27$, $df = 138$, $p = .001$). These findings suggest that the higher one's depression score, the more likely is one to form difficult to break habits. They also suggest that the more socially avoidant and distressed one is, the more likely is one to form difficult to break habits.

Table 9

Pearson correlations between DAES score (for those who have amalgam) and the first part of the experiment (the questionnaires) for females alone with N = 70

		BDI	CCDS	SAD	FNE	Smoking	Habit
DAES	r	-.172	-.224*	-.107	-.038	.442***	-.043
	p	.077†	.031†	.190†	.376†	.000†	.363

* significant at $p < .05$, *** significant at $p < .001$, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is $p = .008$, and for $p = .10$ is $p = .017$

Discussion

This part of the study tested four different hypotheses. The first hypothesis: people who have amalgam will score higher in two measures of depression, was supported. There were statistically significant differences between amalgam bearers and no-amalgam participants in scores on both measures of depression. However there was no correlation between scores on the two variables. This result for the first hypothesis shows that university students who have amalgams tend to score higher on measures of depression than university students who don't. This result has several implications for mental health and psychotherapy. It points to the need of considering dental amalgam as a possible contributor to depression. It also alerts psychotherapists to the possible contribution of dental amalgam mercury to some of their patients' depression. Especially in cases not responsive to psychotherapy, it could be that the underlying physiological cause is a patient's mercury exposure due to numerous dental amalgams.

The second hypothesis: people with dental amalgams will score higher than people with no dental amalgams on a two-part measure of social phobia, was partly supported. There was a statistically significant small correlation between scores on the Social Avoidance and Distress scale (SAD) and scores on the DAES (for those who had amalgam). However there were no statistically significant differences between amalgam bearing and no-amalgam participants. This result for the second hypothesis suggests that one of the two constituent factors of social phobia (the one measured by the Social avoidance and Distress scale) is related to dental amalgams or the DAES scale. It may be that the second factor (the Fear of Negative Evaluation scale) may show a relationship only for higher scorers on the DAES. This possibility receives support from the finding that there were differences (very close to conventional statistical significance) between very high DAES

scorers (score of 24 and above) and no amalgam participants in the FNE. Differences between these two groups were statistically significant in the SAD. The third hypothesis: people with dental amalgams smoke more than people who have no amalgams, was supported. There was a statistically significant small correlation between smoking frequency and scores on the DAES. However there were no statistically significant differences between amalgam bearing and no-amalgam participants in smoking frequency. Yet, as in the second hypothesis, there were differences (very close to statistical significance) between very high DAES scorers and no amalgam participants in smoking frequency. The fourth hypothesis was not supported.

When data pertaining to males' and females' were analyzed separately, several gender differences in the hypothesized relationships were observed.

Gender Differences

Males were found to have significantly higher mean scores in the two depression scales, the Social Avoidance and Distress Scale and Smoking. The finding that males scored significantly more in the two depression measures may at first be thought unusual as the literature on depression has consistently found higher rates of depression in women (e.g. Bebbington, 1988, 1990,1996; Weissman & Klerman, 1977). However, sociodemographic and marital status as well as age affect this gender difference (Bebbington et al., 1998). One study found that single and divorced women had a lower prevalence of minor affective disorder than their male counterparts, whereas married women had five time the prevalence of husbands (Bebbington, Hurry & Tennant, 1981, as cited in Bebbington et al., 1998). In the present study the vast majority of the participants were unmarried. Therefore the finding that males were statistically significantly more depressed than females does not contradict the literature.

Gender Differences in the Correlations of DAES Score with Depression and Social Anxiety

When males' scores were analyzed separately, there were statistically significant correlations between the DAES and the Costello-Comrey Depression scale (Table 6) and between the DAES and the Social Avoidance and Distress scale (SAD). There was also a very close to statistical significance correlation between the DAES and the BDI. When females' scores were analyzed separately (see Table 9), a statistically significant negative correlation was found between the DAES and the Costello-Comrey Depression scale. Also, a close to statistical significance negative correlation was found between the DAES and the BDI. These two correlations were against the hypothesized relationships as well as in contrast to the results of male participants. Also in contrast to the results of male participants, there were no correlations between the DAES and the SAD, and there was a correlation between the DAES and smoking frequency (supporting the third hypothesis). These gender differences may partially be explained by referring to the literature. As was discussed earlier, in the results section, most of the research on mercury exposure has been done on mercury mine workers who are males. Similarly, the study by Sibelrud et al. (1994) dealing with the associations of amalgam and depression as well as anxiety and excessive anger had only female participants. Therefore in most studies on mercury exposure a comparison of the data of males with the data of females was probably not possible and therefore gender differences in the effects of mercury exposure were not investigated. There are also well-known gender differences in depression and social phobia (Kaplan et al., 1994) which, together with the gender differences in the relationships of dental amalgam to depression and to social phobia (that were found in the present study), may be the result of an underlying physiological cause, as will be explained shortly. As was discussed earlier, studies have found gender differences in mercury distribution and

more urinary excretion in females (e.g. Lie et al., 1982; Zander et al., 1990) as well as higher concentrations of mercury in red blood cells for males (Sakamoto et al, 1993). Also, there are inherent gender differences in the brain (Kimura, 1999). For example, the hypothalamus of male rats is visibly larger than that of female rats (Kimura, 1999). In humans also, gender differences have been found in a clump of nerve cells in the brain - part of the interstitial nucleus of the anterior hypothalamus - which is larger in males (Kimura, 1999). Marked gender-related differences are also observable in the regulation of the limbic-hypothalamic-pituitary-adrenal (LHPA) activity (Patchev and Almeida, 1998) in basal and stress-related conditions. Studies have clearly demonstrated that the organizational effects of gonadal steroids during early brain development are the source of these differences. Gonadal steroids continue to exert their "gender-specific activational effects on the LHPA axis through adulthood" (page 63). In fact Patchev and Almeida (1998) speculate that "the importance of these modulatory effects of gonadal steroids may be reflected in gender differences in the incidence of psychopathologies that are accompanied by symptoms of LHPA dysregulation" (page 63). One such psychopathology is depression (Plotsky, Owens, & Nemeroff , 1998). It may therefore be speculated whether gender differences in the prevalence of depression and social phobia as well as gender differences in dental amalgam mercury-associated increases in depression and social phobia are not both due to the gender-related differences in LHPA activity regulation.

In addition to the above explanations of findings that may be the cause of this gender-specific relationship of dental amalgam to depression and social anxiety, to answer the question of why or how dental amalgam mercury (as measured by the DAES) is correlated with depression and social anxiety (as measured by the SAD) only in males, it might be noted that males in the present sample were found to have a higher mean score in the SAD,

whereas in the literature the female to male ratio for Social Phobia has been found to be in the range of 2.5 to 1 (Rosenbaum, 1994). There may also be gender differences in the distribution of mercury in the body, including the brain, as suggested by the animal studies discussed above (Hirayama and Yasutake, 1986; Inouye et al., 1986; Yasutake and Hirayama, 1988). If indeed there are gender differences in brain distribution of mercury in humans, it may be that one gender accumulates more mercury than the other, or that mercury accumulates in different areas in the brain, or in different proportions in the same area, thus influencing behaviour in different ways in each gender.

Yet, the negative correlations between the DAES and the Costello-Comrey Depression scale, and between the DAES and the BDI that were found in females demand further elucidation. First, it should be mentioned that they do not constitute a complete rejection of the first hypothesis for females. This is because, in contrast to the negative correlations, there were statistically significant differences (in the direction hypothesized) between amalgam-bearing and no amalgam female participants in both scales (Table 7) as well as in the SAD. These negative correlations suggest some kind of relative, perhaps gradual adaptation to the effects of mercury that is specific to females. This possibility gains support from the literature findings of better urinary excretion of mercury in females (Lie et al., 1982; Zander et al., 1990) and of lower concentrations of mercury in the red blood cells of females (Sakamoto et al, 1993).

Gender Differences in the Correlations of the DAES with Smoking Frequency

There was a statistically significant correlation between amalgam and smoking for females but not for males. It can be speculated that this difference could be due to males' and females' different reasons for smoking. Sarason, Mankowski, Peterson, and Dinh (1992) studied adolescents' reasons for smoking. They found out that more females than males

gave pleasure and/or reduction of negative affect (e.g. "it's relaxing") as a reason for current smoking. Siblerud et al. (1994) suggest that there may be a biochemical basis for the correlation between amalgam and smoking. They report that studies have found that nicotine increases levels of dopamine (Wesftall & Watts, 1963), serotonin (Goodman & Weiss, 1973), acetylcholine (Armitage, Hall & Sellers, 1969) epinephrine (Wesftall & Watts, 1963), and norepinephrine (Ahtee & Mattila, 1966) whereas mercury has the opposite effect on neurotransmitters (Cooper & Manalis, 1983; Oudar, Caillard & Fillion 1989; Rajana, et.al., 1990). Thus Siblerud et. al. (1994) postulate that people with amalgams may be smoking more (than controls) to relieve their anxious feelings which are brought on by decrease or inhibition of the binding of various neurotransmitters in the brain because of amalgam mercury. Their study on smoking and amalgam was done on females only (Siblerud et al., 1993). The present study found that the DAES is correlated with smoking for females but not for males. One may thus speculate whether this "smoking-more-to-relieve-anxious-feelings-brought-on-by-amalgam-mercury" postulate holds for females but not for males, at least not for university age males. The above finding (Sarason, et. al. 1992) that females are more likely to experience pleasure from smoking may be one indication of such a relief of anxious feelings upon smoking occurring more in females than males. A possible explanation of why the above postulate should hold for females but not for males could be found in the gender differences in the distribution of mercury, if indeed such differences exist in humans as they do in animals (see above). Thus the reason of the postulate holding for females exclusively (and thus the reason for a correlation between the DAES and smoking exclusive to females) could be the result of mercury interfering with nicotine receptors in the brains of females but not of males.

CHAPTER THREE

PART 2

In order for the results to be more generalizable, it was decided to extend the first part of the present study to a sample from another, non-student and older population. Since such a sample was not readily available, it was decided to use participants from the internet (see next section). For this sample, as in the university sample, the DAES, the Costello-Comrey Depression scale (Costello & Comrey, 1967), and the SAD and the FNE (Watson and Fiend, 1969) were used. The BDI (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) was excluded for several reasons. First, it was highly correlated with the Costello-Comrey Depression Scale (CCDS) (Costello & Comrey, 1967) (see Table 1) so that there was little point in including two highly correlated depression scales. Second, the BDI was also much longer than the CCDS. It was feared that length would make the questionnaire less likely to be completed by an internet sample. The questionnaires were set up on the author's site on the Internet[1]. A previous internet search had uncovered two internet mailing lists, groups of people discussing specific subjects via e-mail. These two internet mailing lists: the AMALGAM mailing list[2], a mailing list devoted to poisonous effects of dental amalgam, and the Fatfree mailing list[3] which discusses issues of fat free diets, were requested to participate by e-mail announcements. Seventeen people responded from the first group and thirty-nine from the second. The two Internet studies will be treated in separate sections.

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[1] http://www.geocities.com/HotSprings/Villa/9731/New.html

[2] http://www.listserv.gmd.de/archives/amalgam.html

[3] http://www.fatfree.com

Reliability and Validity of Internet Studies

Literature on studies using Internet participants has had promising findings regarding the validity and reliability of Internet studies. Senior, Phillips, Barnes and David (1999) replicated, on the internet, a study on the perception of schematic faces (Keating, Mazur, & Segall, 1977). They concluded that experimental work carried out on the internet is not necessarily biased by the medium. Buchanan and Smith (1999) compared an Internet-administered version of the revised Self Monirtoring Scale (Snyder, 1974) to a paper and pencil administered version. Despite the obvious absence of standardized conditions of testing, they found that the psychometric properties of the Internet administered version compared favorably with its conventional equivalent. In fact, they found that the reliability of the Internet version was slightly higher than the reliability of the comparison group or of any of the reliabilities reported in the literature. They attributed the better psychometric properties of the Internet version to two factors the first of which has frequently been reported in the literature. These two factors are: First, the increased levels of honesty and self-revelation (Levine, Ancill & Roberts, 1988; Locke & Gilbert, 1995, as cited in Buchanan and Smith, 1999), and second, the increased heterogeneity of the sample. Levine Ancill and Roberts (1988) found that a computer administered suicide scale predicted suicide better than a psychiatrist's diagnosis.

First Internet Study

Participants

As mentioned in the opening section of the present chapter, the participants were from the AMALGAM mailing list. There were 17 participants: 8 males and 7 females (2

participants had not indicated their gender). Their mean age was 41.2 years and the median was 42 years with a range between 17 and 63 (2 participants had not indicated their age).

Results

Data and Sample Characteristics

Of the 17 people who responded, 8 had amalgam (47.1 %). For these, the mean DAES score was 27.78, and mean amalgam number was 11.88. Of the 8 males who responded, 2 had amalgam (25 %). For these, the mean DAES score was 42.33, and mean amalgam number was 19. Of the 7 females who responded, 5 had amalgam (71.4 %). For these, the mean DAES score was 26.91, and mean amalgam number was 10.8.

The results indicated that there was a statistically significant correlation (for those who had amalgams) between the DAES and the SAD ($r = .676$, $p = .033$) and a marginally significant correlation (for those who had amalgams) between the DAES and the Costello-Comrey Depression Scale ($r = .555$, $N = 8$, $p = .077$). There were no significant correlations between the DAES and the FNE ($r = .323$, $p = .217$) and between the DAES and smoking frequency ($r = .206$, $p = .312$). t-tests between amalgam bearing and no amalgam participants found significant differences in the FNE and marginally significant differences in the Costello-Comrey Depression Scale, the SAD, and smoking (see Table 10). t-tests comparing participants with DAES scores of 8 or more (all had scores of 34 and above, $N = 5$) with no-amalgam participants showed statistically significant differences in the hypothesized direction in all of the measures except habit (see Table 11).

Table 10

t-tests for whole sample between amalgam bearing and no amalgam participants for first internet sample

Questionnaire	Means (SDs) Amalgam N = 8	No Amalgam N = 9	T	df	Sig.
CCDS	54.88 (38.16)	33.33 (15.39)	1.56	15	0.070 †
SAD	12.50 (12.20)	4.89 (7.93)	1.54	15	0.072 †
FNE	13.88 (10.91)	5.75 (5.52)	1.88*	14	0.041 †
Smoking	0.88 (1.36)	0.11 (0.33)	1.64	15	0.061 †
Habit	5.88 (3.60)	6.33 (3.08)	0.28	15	0.781

* significant at $p < .05$, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .01, and for p .10 is p = .02

As in the first study and for the same reasons (because earlier studies used one-gender samples, and because of the gender differences in depression and social phobia), an attempt was made to analyze males' and females' scores separately. However it was found that it was impossible to compare amalgam bearing and no amalgam participants in either gender, for in males there were only two amalgam-bearing participants and in females only two no amalgam participants. Correlational analysis were not possible for males as there were only two amalgam-bearing participants. For females (N = 5), correlational analyses revealed no statistically significant correlations between DAES score and the various scales of depression, social phobia, smoking and tendency to form habits.

Table 11

t-tests between high amalgam (DAES score of 34 or above) and no amalgam participants for first internet sample

Questionnaire	Means (SDs) High Amalgam N = 5	No Amalgam N = 9	T	df	Sig.
CCDS	69.20 (42.03)	33.33 (15.39)	2.35*	12	.019 †
SAD	18.60 (11.46)	4.89 (7.93)	2.66*	12	.011 †
FNE	17.40 (10.97)	5.75 (5.52)	2.57*	11	.013 †
Smoking	1.20 (1.64)	0.11 (0.33)	1.98*	12	.036 †
Habit	5.88 (3.60)	6.33 (3.08)	0.296	12	.386

* significant at $p < .05$, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .01, and for p .10 is p = .02

Discussion

The data in general support all hypotheses except habit, particularly when high amalgam participants are compared with no amalgam participants. These supportive results establish the generalizability of the hypotheses for participants older than university students, thus fulfilling the original purpose of the present internet study.

Comparison of the Results of the Present Internet Sample with those of the Sample of the First Study

First, it is important to mention that the two samples are hardly comparable in terms of number of participants. In the university sample there were statistically significant differences between amalgam bearing participants and no amalgam participants in the two depression scales as well as statistically significant or marginally significant differences

between very high DAES scorers (a score of 24 or above) in all of the measures except habit. In the present sample, in contrast, there were statistically significant or marginally significant differences (between amalgam-bearing and no-amalgam participants) in the hypothesised direction in all of the variables measured except in the habit. Also, for high amalgam participants (compared with no amalgam participants) there were statistically significant differences in the hypothesized directions in all of the variables except that of habit. This comparison suggests that the internet sample, being an extreme sample in terms of amalgam load, compares better (in terms of similar results) with the very high DAES scorers in the university sample than with amalgam-bearing university participants in general (see Table 12). In the university sample there were only small correlations between DAES score and the SAD, and the DAES and smoking frequency. In the present sample there were correlations between the DAES and CCDS and between the DAES and the SAD. The rest of the correlations (except for that between DAES score and habit) were in the expected direction but did not reach significance. This comparison also suggests that in less extreme samples (such as university students), the correlations between the DAES and the various variables, if they exist at all, are smaller than the correlations in extreme samples such as the internet sample who are both older and have much higher mean amalgam scores. Another possibility of why older age (independent of amalgam status) may affect the relationship between amalgams and the various variables, may be that age differences in depression and social phobia contributed to differences in the results in ways which will be discussed later (see second internet study).

Table 12

Comparison of Haigazian and first Internet samples in differences between high amalgam (DAES score of 24 or above) and no amalgam participants

Questionnaire	Means (SDs) Amalgam $N_{Haig.} = 5$, $N_{Int.} = 5$	No Amalgam $N_{Haig.} = 29$, $N_{Int.} = 9$	t	df	Sig.
CCDS (Haigazian)	62.80 (21.30)	43.48 (16.15)	2.36*	32	.012 †
(Internet)	69.20 (42.03)	33.33 (15.39)	2.35*	12	.019 †
SAD (Haigazian)	16.20 (6.69)	8.28 (5.27)	2.99**	32	.003 †
(Internet)	18.60 (11.46)	4.89 (7.93)	2.66*	12	.011 †
FNE (Haigazian)	20.00 (5.61)	14.69 (7.09)	1.59	32	.062 †
(Internet)	17.40 (10.97)	5.75 (5.52)	2.57*	12	.013 †
Smoking (Haigazian)	1.00 (1.22)	0.31 (0.85)	1.57	32	.063 †
(Internet)	1.20 (1.64)	0.11 (0.33)	1.98*	12	.036 †
Habit (Haigazian)	6.20 (2.68)	5.90 (2.86)	0.22	31	.827
(Internet)	5.88 (3.60)	6.33 (3.08)	0.30	12	.386

* significant at $p < .05$, ** significant at $p < .01$, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .008, and for p .10 is p = .017

Second Internet Study

Participants

As mentioned in the opening section of the present chapter, the participants were from the Fatfree Mailing List. There were thirty-nine participants: 3 males and 34 females (2 participants had not indicated their gender). Their average age was 38.35 years and the median was 38 with a range between 15 and 68 with 2 participants not indicating their age.

Results

Data and Sample Characteristics

Of the 39 people who responded, 34 had amalgam (87.2%). For these, the mean DAES score was 13.56, and mean amalgam number was 7.71. Of the 3 males who responded, all had amalgams (100 %). Their mean DAES score was 20.97, and mean amalgam number was 13.00. Of the 36 females who responded, 31 had amalgam (86.1%). For these, the mean DAES score was 12.92, and mean amalgam number was 7.21. The data of the 3 males were eliminated, and only the data of the 34 females were analyzed.

No statistically significant differences were obtained between amalgam bearing and no amalgam groups on any of the scales used. Further analysis revealed no statistically significant correlations between DAES score and any of the scales.

Because depression is negatively correlated with age (Wallace & Pfohl, 1995), and because there was a statistically significant correlation between DAES score and age in the present sample ($r = .45$, $p = .015$), it was decided to analyze higher age groups separately. This was not possible in the university sample because the overwhelming majority of the participants were in their early 20s. It was also not possible in the first internet sample because there were only three participants aged 50 and above. For the present, second internet sample, it was found that for the age group of 51-64 there was a statistically significant correlation between DAES scores (for those who had amalgams) and the Costello-Comrey depression scale, and a marginally significant correlation between DAES scores and the Fear of Negative Evaluation scale. There were no significant correlations between DAES score and the other scales, but the correlation between DAES scores and the SAD were in the expected direction (see Table 13).

Table 13

Pearson Correlations between DAES score (DAES) and the questionnaires for the second internet sample for ages of 51-64. N = 6 . All are nonsmokers.

		CCDS	SAD	FNE	Habit
DAES	r	.888*	.547	.677	-.031
	p	.009†	.131†	.070†	.954

* significant at p< .05, † one-tailed significance test
Note: The Bonferroni correction for p .05 for multiple comparisons is p = .0125, and for p .10 is p = .025

Discussion

As we review the results it will be seen that there is a significant correlation as well as a marginally significant one for participants in the age range of 51 to 64 whereas there are no correlations for the full age range of 15 to 68. Event though these correlations are based on so few subjects, the importance of the role of age in accentuating the effect of amalgam that is inferred from these correlations should not be underestimated. It is therefore clear that age is one of the most important factors contributing to the psychological effects of dental amalgam.

The Significance of Age

It should be mentioned at the outset that the following arguments are of a speculative nature as there has been no research on the role of age in the relationship between depression (or social phobia) and dental amalgams.

Depression and Social phobia (or Social Anxiety) are psychological variables which are prone to changing with age. Amalgam load (number, size etc. of amalgams) is prone to increasing with age, as teeth decay and deteriorate. There are studies showing that depression is more frequent and severe in adolescents and young adults. For example, Wallace & Pfohl (1995), working on participants admitted to a psychiatric hospital, found that the scores for males on the Beck Depression Inventory were negatively associated with age. They also found that important depressive symptoms like low self-esteem, guilt, sense of failure, self-accusations, and thoughts of suicide showed significant negative correlations with age for both males and females. Grassler (1989) reports on the frequency of depressive psychoses in various age groups during an 8 year period in a German district of 70,000 inhabitants. Eighty-nine women and 64 men, aged between 31-50 who suffered from depressive episode had been treated during that period. Based on these data, Grassler (1989) has observed a growing tendency to suffer from depressive psychosis up to the age group 41-45 with the female proportion increasing. On the other hand, in the age group 46-50 Grassler (1989) reports a declining tendency. In an attempt to uncover factors contributing to these trends, the patients were also questioned about particular aspects of their so-called midlife crisis. This questioning disclosed the biological, sociological, and psychological background in this syndrome.

Based on the research reviewed above, a possible explanation of the relationship of dental amalgams to depression with reference to the factor of age may be formulated. Thus, if the severity of depression tends to decrease with age, and amalgam load to increase, then if there is indeed a correlation between amalgam and depression it would probably appear in a weak form in adolescents and middle-aged adults, since depression is already prominent during those ages, and amalgam load's effect may be minor compared to the stronger effects of adolescence and middle age. But for people in their early fifties up

to their sixties and beyond, whose lives have stabilized and for whom the vulnerabilities of adolescence and of middle age have passed, amalgam load may come to play a greater role (in depression or social phobia), since it would be a factor among a possibly smaller group of factors (as the factors of adolescence and of middle age with their respective crises has ceased to exist). There are also other possible reasons why a correlation between depression (or social phobia) and amalgam load would be stronger in older people. It may be that as time goes on the body's defences against mercury will be more heavily taxed as the body burden of mercury increases. Thus the person's nervous system will more easily and frequently be affected by mercury. Another reason may be the body's natural aging process which will render the body more sensitive to external poisonous agents like mercury. Regarding age and mercury, an autopsy study by Schiele, Freitag, Schaller et.al. (1981) found a positive correlation between age and mercury content in the cerebellum and reasoned that this could reflect an accumulation over life. The Dental Amalgam Effect Scale (DAES) that was used in the present study included an item about the number of years amalgam was present in the participants' teeth. This obviously took account of the accumulative effect of amalgam, but did not take account of age-related increases of mercury effects.

Regarding social phobia (or social anxiety) there have again been studies finding a negative correlation between social phobia and age. For example, Abe and Suzuki (1986) found that "fear of blushing and fear of being looked at showed a maximum in the mid-teens and a subsequent gradual decrease both in males and females. They were more common in females at most ages." (Medline abstract). They also found that anxiety symptoms peaked in the mid-teens. Thus the above argument regarding depression and amalgam load is valid for the relationship between social phobia and amalgam load also. Specifically, older people would be less likely to suffer from social phobia, yet at the same

time they would, due to the natural aging process of the body, be more sensitive to the poisonous effects of mercury. Thus, in their case, social phobia would be less likely to occur due to causes other than mercury poisoning, and mercury poisoning would at the same time be more likely to produce it. This is first, because they have accumulated much more mercury from amalgams than would younger persons (through years of exposure) and second, their bodies have, due to the natural effects of aging and to the years of mercury exposure, become much more poisoned and susceptible to the effects of ongoing poisoning.

To substantiate the above arguments, future studies focusing on the role of age in the relationship between depression (or social phobia) and dental amalgam are needed.

CHAPTER FOUR

PART 3

This part of the research, unlike the previous two, is an experimental study dealing with the relationship of dental amalgam with cognitive and motor functions in university students. The hypotheses of the study concern some motor and cognitive functions which have repeatedly been found to be adversely affected by mercury poisoning. These motor and cognitive functions are short-term memory as measured by the WAIS Digit Span Forward test (Kishi et. al., 1994; Camerino, Cassitto, Desideri, and Angotzi, 1981; Ngim, Foo, Boey, & Jeyaratnam, 1992), finger tapping (Kishi et al., 1994; Ngim et. al., 1992) and simple reaction time, (Kishi et. al., 1994). These functions in relation to mercury poisoning will be discussed further in the following section.

Dental Amalgams (Mercury Poisoning) and Motor and Cognitive Functioning

In their study on ex-mercury miners, Kishi et al., (1994) examined the neurobehavioral functioning of 76 ex-mercury miners about 18 years after they had ceased working. Their motor coordination, cognitive and psychomotor function were compared with those of 76 controls (matched for age, sex and education) selected from 154 residents in the neighbourhood of the mercury mine. Results showed that the motor (psychomotor and sensorimotor) functions which were adversely affected by mercury poisoning included grip strength, simple reaction time, finger tapping performance, finger dexterity, hand-eye coordination, and speed of colour card reading. Other studies have found that mercury affects block design (e. g. Kishi et. al., 1994; Ngim et. al., 1992), mental arithmetic, two-digit search, switching attention, visual choice reaction time (Liang, Sun, Sun, Chen & Li, 1993) and digit symbol (Ngim et. al., 1992).

Mercury Exposure and Short-term Memory

Numerous studies have found that mercury exposure impairs short-term memory (e. g. Camerino et al.,1981; Echeverria et al., 1998; Hua, Huang, & Yang, 1996; Ngim et al.,1992; Smith, Langolf, & Goldberg, 1983). To take one example, Camerino et. al. (1981) compared 52 workers in a plant transforming mercury mineral with 29 controls living in the same area on three short-term memory tests. These tests were the Benton Visual Retention Test which "investigates short-term memory and reproduction of visually presented nonverbal stimuli" (p.1302), the Digit Span subtest of the WAIS which involves "short-term mechanical memory and concentration" (p.1302), and Rey P. M. R. which measures short and delayed free recall, and visual-verbal recall of progressively schematized and ambiguos initial figures. They found statistically significant differences in all three memory tests. Kishi et. al. (1994) in the same study discussed above, found that ex-mercury miners had significantly poorer (compared with matched controls) short-term memory as measured by the digit span forward subcomponent of the WAIS but not the digit span backward subcomponent. Thus in the present study, the backward subcomponent was not measured.

Kishi et. al. (1994) also found that the ex-mercury miners tapped significantly less for 30-second and 60-second durations as compared with matched controls. In the reaction time test, where they were required to hold a falling steel pole as quickly as they could upon a visual cue from the pole, the ex-miners were significantly slower than the controls. Clearly, the adverse effects of mercury on these motor and cognitive functions have been found in occupationally exposed people. The present study is concerned with a much less exposed group. Because of this, only participants in the two extremes of amalgam load (those with too many and those with none) were used for this part of the study to check for differences between amalgam bearing and no amalgam participants in the various

cognitive and motor functions. The next section will consider the physiological explanation of how mercury can affect motor and psychomotor functions

Physiological Mechanisms through which Mercury can influence Motor and Psychomotor Function

There is evidence that mercury enters and harms motor neurons in the spinal cord. Pamphlett and Waley (1998), found mercury in the spinal motor neurons of 36% of normal adults. They concluded that many humans, by the time they become adults, appear to accumulate mercury in their spinal motor neurons from industrial pollution or dental amalgam exposure. In another study, Pamphlett and Png (1998) injected 1 or 2 micrograms/gram mercuric chloride intraperitoneally into mice and perfused again one or thirty weeks later. Examining the cellular distribution of mercury in the spinal cord, they found that it was present throughout the cytoplasm of motor neuron cell bodies after one week, and in paranuclear aggregations after 30 weeks. Their investigation allowed the conclusion that inorganic mercury, behaving as a slow-acting neurotoxin, shrinks motor axons in the anterior and to a lesser extent the posterior spinal root. In yet another study , Pamphlett, Slatter and Thomas (1998), found that mercury exposed mice suffered oxidative damage to their motor neuron DNA. They concluded that mercury can enter and damage motor neurons. Damage to motor neurons would explain mercury induced deterioration in motor functions such as finger tapping and simple reaction time.

The hypotheses tested in the present study were: Compared to people with no amalgam load, people with high amalgam load will:

1) Score less in the digit span (forward) subscale of the WAIS (Wechsler, 1981).

2) Score less in finger tapping speed.

3) Have a longer simple reaction time.

METHOD

Participants

The participants for this part were selected from the initial 141 in the first study on university participants. The selection was based on their scores on the DAES. Only those with a score of 8 or more and those with a score of zero were selected. They were contacted by phone (their phone numbers were available on the questionnaire forms). There were 51 participants: 25 males and 26 females. Their mean age was 21.06 years ranging between 18 and 28.

Material

The testing was done on the computer. Three types of tests were used. Two of these tests were located on the Internet (see Stevenson, Francis, & Kim, 1999; www.psych.purdue.edu/~coglab/demos.html). One of them was a test of simple reaction time. The other was a test of memory span in which the participants had to identify in order a list of items presented earlier. It tested five different types of memory span: digits, letters that sound different, letters that sound the same, short words and long words. It relied on recognition, since the participant had to select the words (or letters or digits) from a list recognizing the order in which they appeared. The third test was the test of finger tapping.

Procedure

The experiment was conducted in a computer room designated for research purposes. Upon arrival the participant was received by the experimenter and seated at a chair in front of the computer. The experimenter then explained the nature of the experiment. The participant was told that there were 3 experiments dealing with finger tapping, reaction

time and memory span. For the memory span experiment the participant's task was to memorise the list of words (or letters or digits) appearing successively on the computer screen and to recognize them from among a set of items in the same order in which they were originally presented. Once they could identify a list of 5 items of a certain type (e.g. digits or letters etc.), the next presentation of the same type of list would be longer by one item. If they couldn't identify the initial list of five items the next presentation of the same type of list would be shorter by one item. There were 25 trials, 5 for each type of item. For the simple reaction time test, the participants were instructed to click the space bar on the computer keyboard as soon as a large green square appeared. There were ten trials. The experimenter recorded their reaction time in each trial. For the finger tapping test, the participants were instructed to tap the 'Enter' key with their index finger as fast as they could for the duration of 30 seconds. After they finished tapping, they were asked to tap with their other hand. After each tapping period, the experimenter checked the number of taps from the 'Word count' in the 'Tools' menu. To prevent any carryover effects between the finger tapping and simple reaction-time tasks (since they both involved pressing buttons on the keyboard), the memory span test was always given second in order. Later each student was thanked and given a token gift (a pen) in appreciation for their participation.

Results

Data and Sample Characteristics

There were 51 participants. All the participants who had amalgam, had a DAES score of 8 or above. Twenty-eight of the participants had amalgam (54.9 %). For these, the mean DAES score was 16.70, and mean amalgam number was 9.04. Of the 25 males in the sample, 9 had amalgam (36 %). For these, the mean DAES score was 20.59, and mean

amalgam number was 10.89. Of the 26 females in the sample, 19 had amalgam (73.1 %). For these, the mean DAES score was 14.85, and mean amalgam number was 8.16.

There were statistically significant differences between high amalgam participants (DAES score of 8 and above) and no amalgam participants in the digit span (forward) subscale of the memory span test ($p = .058$), the dominant ($p = .025$) and non-dominant hand finger tapping ($p = .046$) and simple reaction time average ($p = .009$) (see Table 14) supporting all the hypotheses (numbers 1, 2 and 3).

Gender Differences

The present study had no hypothesis for gender differences concerning the association of the cognitive and motor functions with amalgam. However, examination of the literature revealed that there are gender differences in finger tapping and reaction time (Kauranen & Vanharanta, 1996). In order to check for gender differences in the present sample, t-tests were done between males and females (both with and without amalgams) on all the cognitive and motor functions measured. It was found that males had a higher mean for finger tapping of the dominant hand ($p = .001$), the non-dominant hand ($p = .002$), and simple reaction time average for 10 trials ($p = .021$) (see Table 15).

Results for Males

A t-test for males alone between high amalgam (DAES score of 8 and above) and no amalgam participants showed no significant differences in any of the measures. The differences for simple reaction time, dominant-hand finger tapping, and non-dominant hand finger tapping were in the expected direction.

Table 14

t-tests between high amalgam (DAES score of 8 or more) and no amalgam participants in cognitive and motor functions. First four significance tests are one-tailed

Cognitive or motor function	Means (SDs) Amalgam N = 28	No Amalgam N = 23	t	df	Sig.
RT Average	263.07 (30.56)	244.30 (22.7)	2.45**	49	.009††
Tapping DH†	185.82 (21.36)	198.87 (24.95)	2.01*	49	.025††
Tapping NDH†	166.25 (22.78)	176.91 (21.03)	1.72*	49	.046††
MS Digits†	6.36 (0.95)	6.87 (1.32)	1.61	49	.058††
MS Letters Diff.	5.57 (1.14)	5.39 (1.41)	0.51	49	.308
MS Letters Same	5.21 (1.26)	5.65 (1.30)	1.22	49	.115
MS Words Short	5.00 (1.02)	5.22 (1.00)	0.77	49	.224
MS Words Long	4.43 (1.00)	4.35 (0.98)	0.29	49	.387
MS Average	5.31 (0.66)	5.50 (0.76)	0.91	49	.184

† DH = Dominant Hand, NDH = Non-Dominant Hand, MS = Memory Span

†† one-tailed significance test, * significant at $p < .05$, ** significant at $p < .01$

Note: The Bonferroni correction for p .05 for multiple comparisons is p = .006, and for p .10 is p = .011

Table 15

t-tests between male and female participants in third part of the study

Cognitive or motor function	Means (SDs) Males N = 25	Females N = 26	t	df	Sig.
RT Average	245.60 (25.07)	263.27 (29.54)	2.30*	49	.026
Tapping DH†	202.60 (23.48)	181.23 (19.08)	3.57***	49	.001
Tapping NDH†	180.76 (20.52)	161.73 (20.45)	3.32**	4998	.002
MS Digits†	6.64 (1.25)	6.54 (1.10)	0.31	49	.757
MS Letters Diff.	5.44 (1.47)	5.54 (1.03)	0.28	49	.783
MS Letters Same	5.44 (1.23)	5.38 (1.36)	0.15	49	.879
MS Words Short	5.28 (0.98)	4.92 (1.02)	1.28	49	.208
MS Words Long	4.32(1.11)	4.46 (0.86)	0.51	49	.612
MS Average	5.42 (0.77)	5.37 (0.66)	0.27	49	.786
DAES score	7.41 (12.67)	10.85 (8.64)	1.14	49	.261

† DH = Dominant Hand, NDH = Non-Dominant Hand, MS = Memory Span

* significant at p< .05, ** significant at p< .01, *** significant at p< .001

Note: The Bonferroni correction for p .05 for multiple comparisons is p = .005, and for p .10 is p = .01

Results for Females

A t-test for females between high amalgam (DAES score of 8 and above) and no amalgam participants revealed a significant difference for letters that sound the same ($p = .037$, $t = 2.206$, $df = 24$).

Discussion

The results for the third part of this research (cognitive and motor tests) show that all three hypotheses were supported in that there were significant differences between high amalgam participants (DAES score of 8 and above) and no amalgam participants in digit span forward, dominant and non-dominant hand finger tapping and simple reaction time average. These results support the basic premise central to all the hypotheses in the present study (in all its three parts) that mercury from dental amalgams evaporates and enters the body and its organs to cause chronic mercury exposure with all the characteristic syptoms (at least the ones that have been measured in this study) that it entails and which have been found in occupationally exposed individuals. These results also raise the question whether these differences in cognitive and motor function in high DAES scoring individuals do not reflect the possibility of eventual more serious motor or cognitive diseases in a proportion of them.

Studies have found that males are significantly better than females in finger tapping and reaction time (e.g. Kauranen & Vanharanta, 1996). Because of this males' and females' scores were analyzed separately. No statistically significant differences were found between males with amalgam and males with no amalgam in any of the functions tested, however differences for simple reaction time, dominant-hand and non-dominant-hand finger tapping were in the expected direction. One reason why the differences did not

reach significance may be that the samples were not as extreme (with regard to DAES score) as other samples with higher age means would be.

Females with a high DAES score (8 and above) were found to score significantly less compared to females with no amalgams in letters that sound the same. A possible explanation for this result may lie in the literature on gender differences in the human brain, which show that a part of the hypothalamus is larger in males (Kimura, 1999; Patchev and Almeida, 1998). Another explanation may lie in the higher urinary excretion of mercury in females (Lie et al., 1982; Zander et al., 1990).

CHAPTER FIVE
OVERVIEW AND RECAPITULATION

The present research sought to investigate the relationship of dental amalgams to depression, social phobia, smoking, simple reaction time, finger tapping and memory span. It sought to determine whether the psychological effects of occupational mercury exposure were apparent, in a milder form, in participants who had dental amalgams.

The present research contributed a new scale, the DAES, which sought to better approximate the amount of mercury exposure from dental amalgams, taking into account, in addition to the usual amalgam number, such factors as amalgam size, amalgam age, gum chewing frequency, etc. This scale made it possible to correlate the depression and social phobia scales with an amalgam measure better than simple number of amalgam. It is believed that this scale contributes toward a more methodical and systematic measurement of amalgam load. The same logic underlying this scale could form the basis for the development of more empirically derived scales. Research on the contribution of each factor to mercury exposure from dental amalgams could lead to changes in the weights given to each factor, thus leading to a clearer picture of mercury exposure. The scale could be modified to accommodate new factors contributing to mercury release from amalgams.

The present study answered some questions and pointed to new directions for future research. The results as a whole support the hypotheses. For some of the variables, the relationship with dental amalgams was not as simple as previously expected. For example, the relationship between the DAES score and the SAD is complex, being affected by such factors as gender and age.

The present results should be interpreted with caution because they do not necessarily indicate a causal relationship between amalgam and depression, social phobia, frequent

smoking, poorer simple reaction time, poorer finger-tapping performance and poorer digit span forward performance. The present research does not rule out a confounding variable which could be causing both the tooth decay (usually treated with dental amalgam) and the psychological, cognitive and motor impairments. Until such possible confounding variables are ruled out it is difficult to conclude with certainty that mercury from dental amalgams is the causal factor in the poorer performance in the psychological, cognitive and motor measures. Yet the fact that the psychological, cognitive and motor functions in which dental amalgam bearing participants scored poorer are all functions associated with mercury exposure renders it more likely that mercury from dental amalgams is at least a contributing factor.

Contribution to the Literature

The findings of the present study are of importance to clinical psychologists, all health professionals, as well as the public in general who are exposed to dental amalgams without any knowledge of its adverse effects. They are of importance to clinical psychologists in particular because they should make them more aware of the sychological effects of chemicals and substances in general and the possibility that some of their patients' problems can be traced to such poisonings. More specifically the results of this study should alert clinical psychologists to consider mercury poisoning as a possible contributor or cause in the etiology of depression and social phobia. This consideration would lead them to caution patients about the toxicity and possible psychological effects in particular of dental amalgams. Already, many people are removing their amalgams all over the world out of concern for their health. The present results give some substance to their concerns. Research has already shown that most people who remove their amalgams report feeling better (Siblerud, 1990). Also, removal of dental amalgams is followed by a decrease in

plasma, erythrocyte and urinary mean levels of mercury (Molin et al., 1990; Molin, Berglund, & Mackert, 1995). There are already other dental filling materials available for dentists to use. This new trend may imply a tacit industrial awareness of the adverse effects of dental amalgams. Therefore the continued use of amalgam, especially in the light of possible adverse effects, remains at best a questionable practice.

Future Research

Based on the findings of the present study, it is suggested to design future research with gender and age differences in mind. Considering the results of each part of the study alone, various directions for further research suggest themselves. One line of future research can investigate the relationship between clinical depression and dental amalgams, and between psychotherapy-resistant depression and dental amalgams. Another line of research can investigate the relationship between clinically diagnosed social phobia and dental amalgams, and between psychotherapy-resistant social phobia and dental amalgams. Such studies can, if successful, establish dental amalgams as a risk factor for depression, social phobia and even smoking.

Considering the results of the third part, various directions for further studies can be suggested. Future research can investigate the possible relationship between dental amalgam and diseases of motor, neurological or cognitive function (e.g. Parkinson's disease, Multiple Sclerosis, Alzheimer's etc.). Such studies can lead to the establishment of dental amalgam as a risk factor for motor, neurological, and cognitive diseases or for nervous system disorders.

Finally, it is hoped that the present study will contribute to increasing awareness of the possible psychological, motor and cognitive effects of dental amalgams. It is also hoped that it will take a step towards ending the controversy about the toxicity of dental amalgams.

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Appendix I

QUESTION ASSESSING SMOKING

Do you smoke?

a) No.

b) Yes, 1-5 a day.

c) Yes, 6-10 a day.

d) Up to one packet a day or more.

Appendix II

QUESTION ASSESSING HABIT FORMATION

OR 'ADDICTION' TENDENCIES

Would you say of yourself that you are particularly a man/woman of habit and thus have difficulty breaking habits like watching television, listening to music, using computers, playing computer games, reading newspapers or journals, etc.? Where would you stand on a 10 point scale ranging from 1 (definitely false) to 10 (definitely true)? Please circle a number: 1 2 3 4 5 6 7 8 9 10

Appendix III

DENTAL AMALGAM EFFECT SCALE

1. How many of your teeth are filled with metal (silver amalgam tooth fillings, also called 'rsas' in Arabic or 'gabar' in Armenian)? Please check your teeth with a mirror (hand held) and count the teeth which are filled with metal (you may need a strong lamp). Write the number here ____ . If you don't have any, jump to question number 4.

2. How large are the metals in your teeth? (look at the picture examples to decide)

a) Most of them are large (covering most of the surface area of the tooth).

Examples: 

b) Most of them are medium (covering about half the surface area of the tooth).

Examples: 

c) Most of them are small (covering a small part of the surface area of the tooth).

Examples: 

3. For how long have you had metals in your teeth?
a) 10 years or more.
b) 7-9 years.
c) 4-6 years.
d) 2-3 years.
e) 0-1 year

4. Have you had broken amalgams (metals), or has your dentist removed/drilled out old amalgam (in order to replace them or to drill cavities from under them)?
a) No.
b) Yes, 1-4 times.
c) Yes, 5-9 times.
d) Yes, 10 times or more.

5. How often do you chew gum?
a) Very often.
b) Often.
c) Occasionally.
d) Never.

6. How many times a day do you brush your teeth?
a) 3 times or more.
b) 2 times.
c) Once.
d) I don't brush my teeth regularly.

7. How often do you exercise?
a) Once or twice a month.
b) Once a week.
c) Twice a week.
d) Three times a week or more.

8. Have you gone to the dentist for the past 7 months to have a tooth filled with amalgam (metal)?

Yes ☐ No ☐