This is a revised paper containing information not found in the original. Areas of revision include the statistical analysis as well as new information gleaned from published scientific and medical papers including Dr. Johnson's book reported here. What has not changed are the inferences and implications arrived at in the original paper. The genesis of and inspiration for the original and this revision stem from data found in Johnson's book.

Lead Poisoning and Stuttering

Anyone born before 1950 can remember a time when stuttering was common. Many people knew a child or adult who stuttered, sometimes severely. Today the sounds of stuttering have virtually disappeared. "*To one who has worked in the field of stuttering for many years,"* wrote a leading speech pathologist in 1982, "*it appears that the incidence of stuttering has been declining in the last 30 years … when the author of this text began to practice in 1934 the high schools seemed full of stutterers…this does not seem to be true today*." [1] Five years later that view was echoed in A Handbook on Stuttering [2] in 1987, "*… there is a widespread impression among American clinical workers of long experience that the prevalence of stuttering is considerably less than it was some decades ago* ".[i] Neither writer offered a cogent view as to why that was the case.

However buried in a collection of studies published 50 years ago by the University of Iowa on the origins of stuttering in children, are data that suggest that at least some of those studied had lead poisoning. Although lead has long been known to cause motor speech and language disorders in children, and although there is at least one published report of stuttering in an adult following acute poisoning, no study has ever been published that looked for a connection between lead poisoning and stuttering and then presented data supporting the conclusions.[ii, iii, 3, 4, 5, 6]

But the purpose here is not to prove that lead poisoned even one child. Proof requires physical evidence of lead in the body, evidence that was never collected by the Iowa investigators. Rather the purpose is to build an argument based on data newly viewed in the light of more than 50 years of lead poisoning research. An argument that poisoning could have been present and likely was.

The Iowa experience began in the early 1930s with the first of three consecutive studies. The last study ended in the late 1950s. Using only the tools of the social scientist - in this case a series of questions of parents of children who stuttered (Experimental Group) and parents of children who did not (Control Group) - investigators set out to explore why children stuttered. The questions (addressing parents, children, or both) dealt with education, upbringing, occupation, social and economic status, behavior and intelligence. Answers were compared and differences tested for statistical significance.[7, 8] The studies were made all the more powerful by the fact that each was concurrently controlled by a group of children who had never stuttered. In Study II for example, *"…each of the fifty families in the Experimental Group was matched with a family having a child of like age and sex who did not stutter",* wrote Dr. Frederic Darley, the lead investigator, *"…a third basis was used for matching, namely, socioeconomic status of the child's family….all mothers and fathers were interviewed separately…*".[iv] Similar procedures were followed in Study III. A brief description of demographics and control procedures for each of the three studies can be found in Table 1.

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[i] A Handbook of Stuttering, p 123.

[ii] See also, http://www.lead.org.au/bellsystemleadpoisoning/images/an%20investigation%20of%20circumstances.pdf , footnote # 10.

[iii] A search of the National Library of Medicine's "PubMed" failed to find any publication using "lead poisoning" and "stuttering" as search terms. However reference in the literature has been made at least as far back as 1942 to speech and language problems in children with lead poisoning.

[iv] The Onset of Stuttering, pgs 12, 19.

In the 50 plus years since publication of the Iowa studies, scientists have learned that lead poisoning can lead to Attention Deficit Hyperactivity Disorder (ADHD) with its attendant daydreaming and distractibility; [9, 10, 11] lowered intelligence; [12] juvenile delinquency; [13, 14] and behavioral changes.[15] Today there is more than enough information available to draw a picture of a typical child with lead poisoning living in the middle of the last century. Compared to a lead-free child such an individual would more likely have been raised in a working class home (and therefore potentially exposed to lead dust brought home from work),[16, 17] been slow as a toddler to acquire speech, [18, 3, 29, 19] had trouble focusing on the task at hand (that is, to be attention deficient), day-dreamed excessively, been considered not as mentally sharp as his or her peers, been a discipline problem (and therefore more at risk for juvenile delinquency), engaged in thumb and finger sucking (and therefore more likely to have ingested lead), [20, 21] suffered from sleep disturbance,[22] and repeated school years. As it happens, this is remarkably close to, if not exactly the same as, the description given by the Iowa researchers of the children who stuttered.

The figures on the following pages summarize the results of a supplemental analysis of the Iowa data. The analysis was done to look for a link between lead poisoning and stuttering. Data supporting the figures (data originally published in the book The Onset of Stuttering: research findings and implications [23] in 1959) can be found in Table 2. In the preamble to the appendix, the book's lead author Dr. Wendell Johnson wrote, "*the main purpose of making the findings* [of Studies II and III] *available in this detailed fashion are to allow essential reference to them in the body of the report and to encourage further evaluation of them and continued development of their implications, not only by students of the stuttering problem but also by…medical investigators and others…".* [v]

Table 1

A brief description of research carried out at the University of Iowa comparing children who had a stuttering speech dysfluency with children who did not; 1934 to 1957

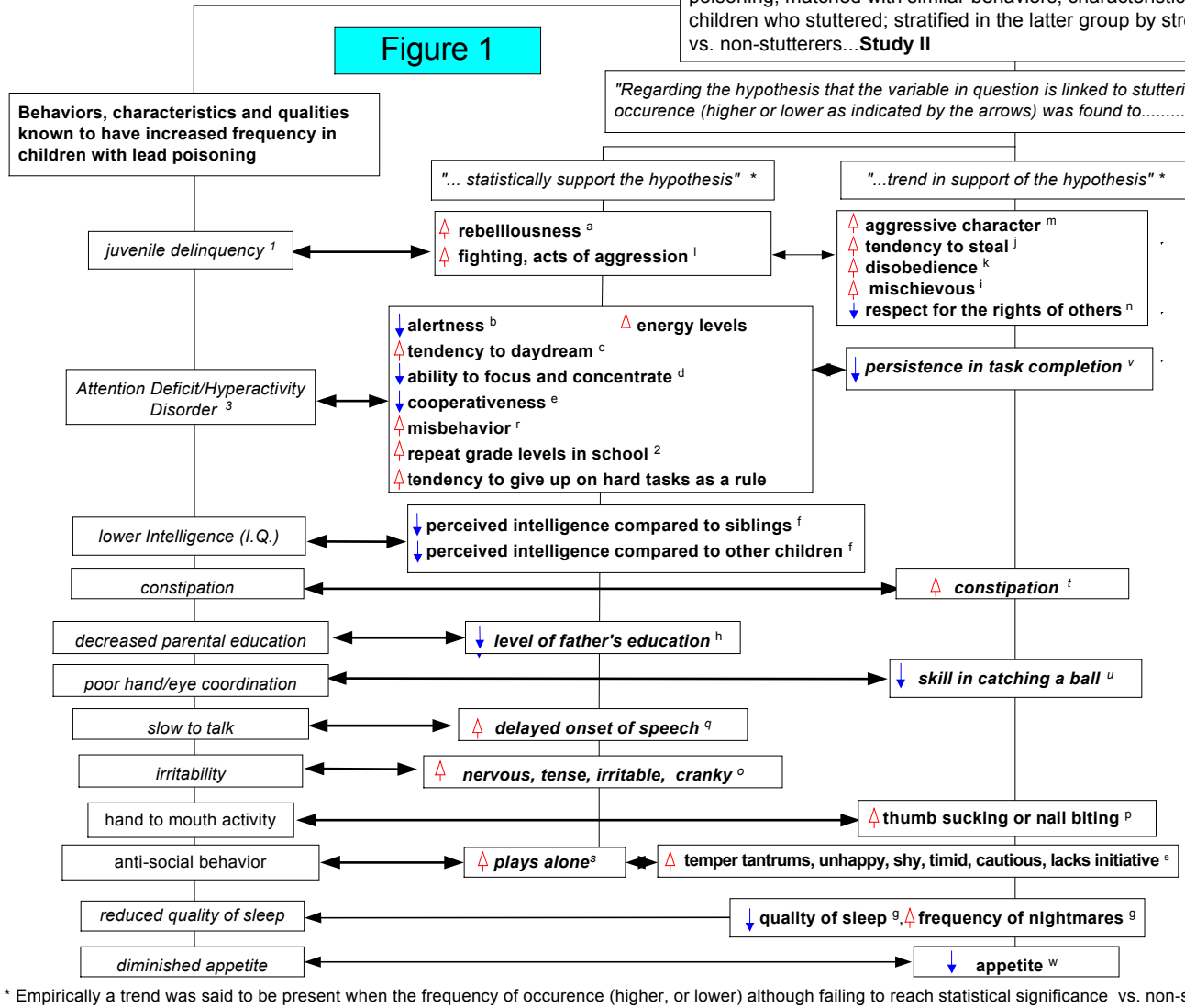
	Study I [24]	Study II [25]	Study III
Dates conducted	1934-'40	1948-'52	1952-'57
Subjects enrolled;			
• Stutterers (Experimental Group)	32 boys 14 girls	39 boys 11 girls	107 boys 43 girls
• Non-stutterers (Control Group)	33 boys 13 girls	39 boys 11 girls	107 boys 43 girls
Ages of subjects;			
• Stutterers (range)	27 mos - 9 yrs, 3 mos (median 4 yrs, 2 mos)	28 mos - 14 yrs, 4 mos (mean 8 yrs, 8 mos)	27 mos - 8yrs (mean 5 yrs)
• Non-stutterers (range)	27 mos – 9 yrs, 10 mos (median 4 yrs, 5 mos)	24 mos – 14 yrs (mean 9 yrs)	28 mos – 8 yrs, 7 mos (mean 5 yrs)
Non-stutterers matched with stutterers on variables	"Sex, age, intelligence level"	"Sex, age (± 6 mos) and socioeconomic status"[vi]	"sex, age, socioeconomic status"
Definition of stuttering	As defined by a parent, other family member, or teacher	As defined by both parents, school health official, or state health nurse	As defined by one or both parents

[v] The Onset of Stuttering; *explanatory notes to the summary table*, Appendix A.

[vi] Use was made by Johnson and his colleagues of the classification system described in Social Class in America: a manual of procedure for the measurement of social status; W.L.Warner, M. Meeker, K. Eells. Peter Smith (pub); Glouster, MA. 1957.

Figure 1

Selected behaviors, characteristics, and qualities of children with lead poisoning, matched with similar behaviors, characteristics and qualities in children who stuttered; stratified in the latter group by strength of findings vs. non-stutterers...**Study II**



Variables keyed to questions asked of parents by the Iowa investigators. The numbered questions can be found in Table 2

Footnote lettered	Variable	Question number(s)
a	"rebelliousness"	6
b	"alertness"	2
c	"tendency to daydream"	3
d	"ability to focus and concentrate"	8
e	"cooperativeness"	18
f	"intelligence"	4, 17,16
g	"sleep/nightmares "	15,20, 39
h	"level of parental education"	1
i	"mischievous"	5
j	"tendency to steal"	10
k	"disobedience"	11
l	"acts of aggression"	12,13
m	"aggressive character"	19
n	"respecting the rights of others"	23
o	"irritable, tense, nervous, etc.	22, 14
p	"thumb sucking, nail biting"	9
q	"delayed onset of speech"	25,24
r	"well behaved"	7
s	"anti-social behavior"	38,28,29,27,26,30
t	"constipation"	31
u	"decreased athletic ability"	32,33
v	"persistence in task completion"	37
w	"diminished appetite"	35

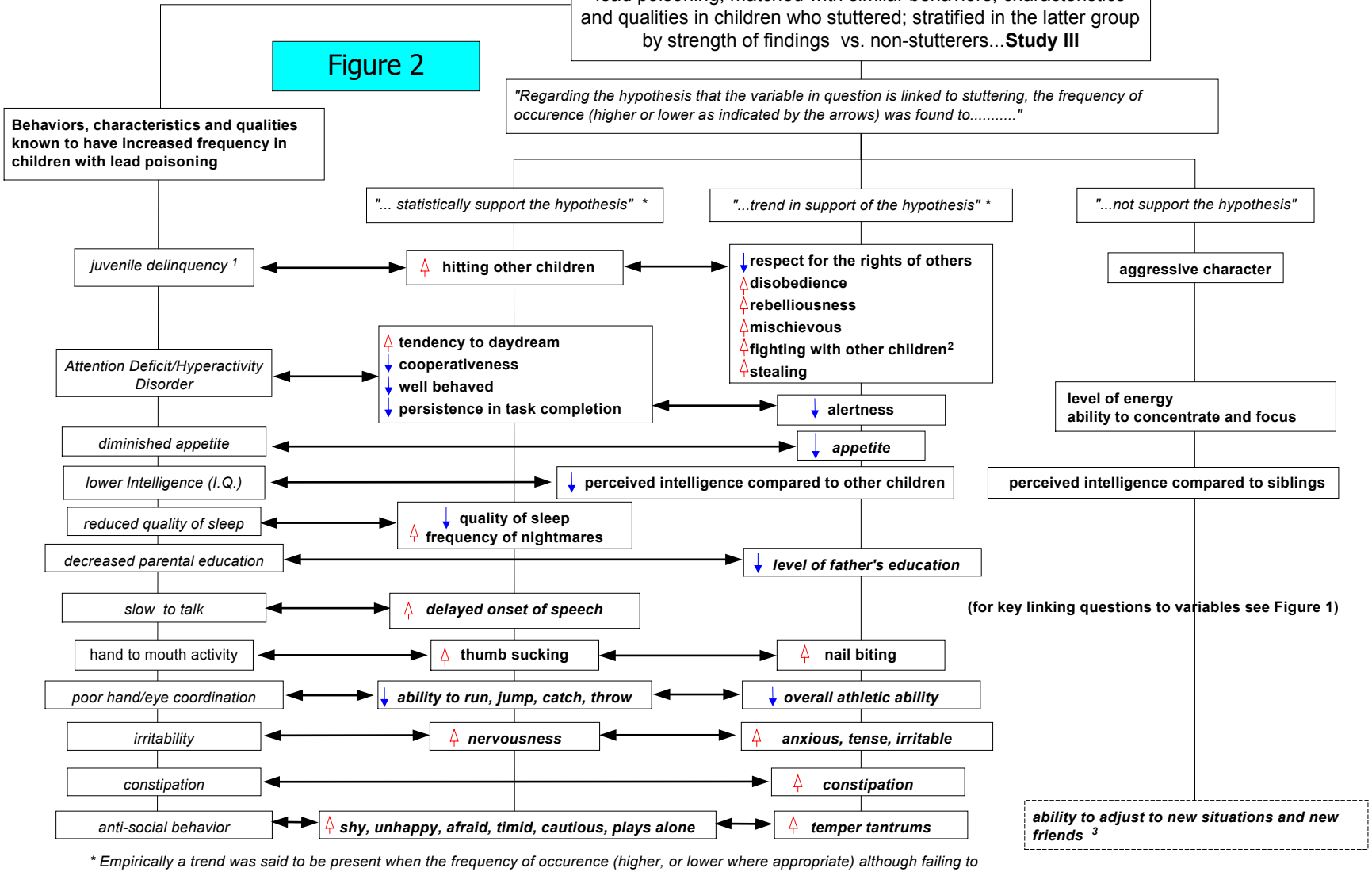
* Empirically a trend was said to be present when the frequency of occurence (higher, or lower) although failing to reach statistical significance vs. non-stutterers never-the-less favored the hypothesis by a small but measureable amount. For further information on the analysis and reporting of trends see discussion on the Exhibits page. For this paper the reporting of statistical significance follows convention, that is, for any variable the difference between groups was said to be statistically significant if there was only a small chance - less than or equal to one in twenty - that the difference could be explained as a random event.

[1] Although children in the Experimental Group in Study II were reported as being significantly more likely to hit and fight with other children (questions # 12, 13; in Study III only to fight not to hit), they were also reported as being either no (Study III) or only slightly more (Study II) aggressive than children in the Control Groups (question # 19). Darley administered the Rogers Test of Personality Adjustment (see endnotes 25 and 31) to 28 stutterers and 18 non-stutterers in Study II. Nine stutterers (32%) and 5 non-stutterers (28%) rated "high" on the Family Maladjustment score (ref 25, p 133), while 18 stutterers (64%) and 8 non-stutterers (44%) rated "high" on the Social Maladjustment score (ref 25, p 132).

[2] "*repeated grade levels in school* " (From: Chap 4; "Parental Attitudes and Adjustments" in Stuttering in Children and Adults: Thirty Years of Research at the University of Iowa. p 91. U. of Minn Press, 1955)

Selected behaviors, characteristics, and qualities of children with lead poisoning, matched with similar behaviors, characteristics and qualities in children who stuttered; stratified in the latter group by strength of findings vs. non-stutterers...**Study III**

Figure 2



** Empirically a trend was said to be present when the frequency of occurence (higher, or lower where appropriate) although failing to reach statistical significance vs. non-stutterers never-the-less favored the hypothesis by a small but measureable amount. For any variable the difference between groups was said to be statistically significant if there was less than one chance in twenty that the difference could be explained as a random event (i.e. p < .05).*

[1] *see footnote Figure 1*

[2] *In Figure 1 combined under the heading 'acts of aggression'*

[3] Although it may seem antithetical that a child demonstrating anti-social behavior could at the same time show superior social adjustment skills, Lord and Byers hint at just this in their famous 1943 paper stating that; "*lead poisoned children...with sensorimotor defects...and the inability to read or write, or deal with numbers in arithmetic...were frequently socially responsive especially in their preschool years*." (see ref # 29, page 480)

It is clear from the figures that results from the two studies are not the same. In both studies all case material (that is, children who stuttered) came from referrals. This usually meant that "…*the fact that his family had been concerned enough about his nonfluencies to label them and to seek professional help was sufficient warrant for use of the case* [in one of the two studies] " [vii]. In Study II, "family" meant that both parents agreed that the child stuttered, in Study III it meant one or both parents. In an effort to avoid selection bias it was only after enrollment that an evaluation was made of the child's stuttering. As a result, 47 of the 150 children (31%) enrolled in the Experimental Group in Study III, and 7 of the 50 children (14%) enrolled in the same group in Study II were found not to be "clinical" stutterers.[viii, ix] In addition, while there were a total of three interviewers in Study II, in Study III there were seven, injecting a greater (albeit unavoidable) degree of variability into the interviewing process. As a consequence, and contrary to any expectation that a larger study would lead to better results, the data from Study III exhibited a greater degree of distortion than data from Study II.[x] All of this makes the results of Study III more difficult to interpret and any interpretation more prone to error.

There were other important differences between Studies II and III. Children in Study II were, on average, three and a half years older than children in Study III. While 81% of Study II children had entered first grade, only 21% of Study III children had done so (ref 23, Appendix A, p 186). Because of this more parents in Study II would have had the opportunity to witness their child's academic performance than would have parents in Study III. This might help explain the difference in perceived intelligence between the two groups of children. Also, children enrolled in Study II would have on average reached toddler age (an age at which children put things in their mouths, things contaminated with lead dust brought home from work on clothing) in 1942. Children enrolled in Study III would have reached the same age in 1949, again on average. Throughout the 1940s but especially during the war years there was intense use of lead in American industry, use that was largely unregulated. Together these factors made the '40s the most dangerous decade of the last century for occupational lead exposure.

Within a 100-mile radius of Iowa City, encompassing an area from which most referrals would have originated, there was heavy war-related manufacturing, first because of World War II and then the Korean War. A prime example of this is the Iowa Army Ammunition Plant near Burlington, Iowa, less than 70 miles from Iowa City where most of the research on stuttering took place. The plant, one of the largest production facilities of its kind in the world, and even today employing thousands of workers, was undoubtedly a major consumer of lead.[xi, 26] According to Wikipedia [xii] the plant had a period of peak production between 1941 and 1945 when production stopped. Production then ramped up again sharply beginning in 1950. It would have again slowed or stopped in 1953 with the Korean Armistice. Another example would have been the Collins Radio Company located in Cedar Rapids, just

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[vii] The Onset of Stuttering, p 12.

[viii] Data from all enrolled children were included in the analysis of results.

[ix] The Onset of Stuttering, Appendix A, question # 614, p.194.

[x] One measure of distortion is skewness. In Study II (that is, Study II data in Table 2) skewness of the father's responses ranged from .95 to 1.26, while the mother's ranged from .91 to 1.12. In Study III (that is, Study III data in Table 2) the same measures ranged from 1.30 to 1.38 for the fathers and 1.27 to 1.35 for the mothers. In all cases the fathers' responses demonstrated greater skewness than the mothers'.

[xi] See "Exhibits" page

[xii] http://en.wikipedia.org/wiki/Iowa_Army_Ammunition_Plant

30 miles from Iowa City. The largest supplier of aviation communication equipment during WWII, Collins would have been a major consumer of lead wire solder for many of the years in question. All of this points toward children enrolled in Study II as having had more opportunities to be exposed to higher levels of lead for longer periods of time than children in Study III.

There are other clues in the Iowa data that support the occurrence of lead poisoning in children who stuttered. In Study III information was gathered on the birth order of study subjects (similar information was not obtained in Study II). Compared to the Control Group, children who stuttered were more often the oldest child in the family. The difference between groups was statistically significant. This meant that the child who stuttered was more likely to have reached toddler age earlier in the 1940s – a time of rampant and uncontrolled occupational lead exposure – than children who did not stutter. Also Darley stated that stutterers showed a significantly greater tendency than non-stutterers to be held back in school (ref 25, p 91).[xiii] Academic failure, including having to repeat a school year, has also been reported for children with lead poisoning. [27, 28, 29] Finally, in both studies the severity of stuttering was rated by experienced observers [(see # 36, Table 2)]. Stuttering was on average more severe for children enrolled in Study II then for those enrolled in Study III (one-tailed t-test for difference between paired samples, p=0.09). This is entirely consistent with and supportive of the argument that children enrolled in Study II were exposed to higher levels of lead for a longer period of time then children enrolled in Study III.

Admittedly it can be argued that there could be reasons other than lead poisoning for some of the observations. For example the stuttering child's acts of aggression might have been solely in response to playground taunts given because of the stuttering. Or perhaps the stuttering itself caused the child to be nervous, tense, and rebellious. On the other hand there are observations that cannot be explained by the stuttering, such as delayed onset of speech, behavior suggestive of an attention deficit, an inability to focus, level of parental education, and perceived intelligence. These and other findings would have to be accounted for in any alternate explanation.

Taken as a whole the data are remarkably consistent and paint a picture of a life under stress for a child who stuttered. That picture in all its particulars except stuttering is interchangeable in whole or in part with any number of published descriptions of children with lead poisoning.[xiv] Furthermore, if Dr. Charles Van Riper's belief, that by 1982 stuttering had been in decline for 30 years, can be taken literally, then turning the calendar back 30 years one arrives at 1952. And in 1952 there was a seminal event in the history of occupational lead exposure. For in that year the American lead industry publicly acknowledged for the first time that unprotected occupational lead exposure was dangerous, and that steps were being taken to curb the worst abuses.[30] Thus the incidence of stuttering

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[xiii] Darley stated that almost four times as many stutterers as non-stutterers were held back in school (ref 25, p 91). Intelligence tests were administered to the 15 stutterers forced to repeat all or part of a school year. Five of the 15 were found to have below normal I.Qs. (p. 95). The remaining 10 fell into the range of "average" or above. No intelligence tests were administered to non-stutterers.

[xiv] Since human physiology continues to develop and mature throughout childhood, the detrimental effect of lead in a child is a function not only of the dose (or doses) of lead, but also the age of the child - down to the month – at which the dose is absorbed, whether the child is fed or fasting at the time of lead ingestion, and the cumulative amount of lead in the child's body. As a result children in seemingly identical circumstances can have very different experiences following exposure to lead.

as well as that of lead poisoning following occupational exposure began their slow declines hand-in-hand.

It has long been accepted that neurological dysfunction is one cause of stuttering. In the middle of the last century surely one reason for that dysfunction was lead poisoning.

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Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
1. Level of education [of parents]? (only father's response) [xvi, 31]	≥ 1 yr of postgraduate work	7	15	17	36	X				X	
	graduate of 4yr college or equivalent	6	9	22	25						
	college ≤ 2 yrs	5	6	25	14						
	h.s. grad only	19	9	60	58						
	attended h.s. did not graduate	4	4	15	14						
	completed 3rd to 8th grade only	9	7	9	3						
	"Uncertain;don't know;can't say"	0	0	0	0						
(#13, p.2)	*(missing responses)*	0	0	2	0						
2. As compared to other children, how alert is your child?	Much > than average	5	13	44	40	X				X	
	Somewhat > than average	34	48	113	126						
	About average	53	32	134	132						
	Somewhat < average	8	6	9	2						
	Much < average	0	1	0	0						
(#377, p. 128)	"Uncertain;don't know;can't say"	0	0	0	0						

[xv] U = *"unknown" or "unsure"*

[xvi] That is, when compared to the fathers of control subjects, are the father's of stutterers less educated on the whole? The difference in education between control and experimental Study II mothers was not significant, while the difference between control and experimental Study III mothers was significant at p=.03 (chi-square). Men were often granted deferment from the military draft if they were employed in a critical defense industry.

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	(missing responses)	0	0	0	0						
3. As compared to other children, how much does your child daydream? [32]	Much > than average	7	3	4	2	X			X		
	Somewhat > than average	20	15	29	25						
	About average	45	41	189	147						
	Somewhat < average	15	39	56	78						
	Much < average	3	2	8	24						
	"Uncertain;don't know;can't say"	9	0	14	23						
(#399, p.133)	*(missing responses)*	1	0	0	1						
4. How do you think your child compares in intelligence with neighborhood children?	Much > than average	7	11	24	22	X				X	
	Somewhat > than average	27	42	104	111						
	About average	59	41	160	160						
	Somewhat < average	6	1	8	2						
	Much < average	0	2	0	0						
	"Uncertain;don't know;can't say"	1	0	3	4						
(#597, p. 188)	*(missing responses)*	0	3	1	1						
5. As compared with other children, how mischievous is your child?	Much > than average	2	2	12	9		X			X	
	Somewhat > than average	19	10	47	58						
	About average	52	48	175	161						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	Somewhat < average	22	31	53	53						
	Much < average	5	9	13	18						
	"Uncertain;don't know;can't say"	0	0	0	1						
(#373, p.127)	*(missing responses)*	0	0	0	1						
6. As compared with other children, how rebellious is your child?	Much > than average	2	0	13	13	X				X	
	Somewhat > average	22	11	65	49						
	About average	60	56	189	192						
	Somewhat < average	12	30	24	36						
	Much < average	4	3	7	10						
	"Uncertain;don't know;can't say"	0	0	2	0						
(#382, p. 129)	(*missing responses*)	0	0	0	0						
7. As compared with other children, how well behaved do you think your child is?	Much > than average	6	15	8	11	X			X		
	Somewhat > average	21	32	72	71						
	About average	64	49	191	209						
	Somewhat < average	8	1	27	8						
	Much < average	1	0	1	1						
	"Uncertain;don't know;can't say"	0	0	0	0						
(#535, p. 177)	(*missing responses*)	0	3	1	0						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
8. As compared with other children, how able is your child to concentrate?	Much > than average	3	8	25	16	X				X	
	Somewhat > average	14	27	61	58						
	About average	59	52	178	199						
	Somewhat < average	21	12	30	18						
	Much < average	1	1	1	0						
	"Uncertain;don't know;can't say"	0	0	5	9						
(#384, p. 130)	(*missing responses*)	2	0	0	0						
How often is the following behavior occurring:											
9. Thumb sucking or nail biting? (*this combines what was originally two separate questions, thumb sucking and nail biting. For that reason 'n' is doubled*)	Very often	NA	NA	43	30		X		X		
	Quite often	NA	NA	50	23						
	Occasionally	NA	NA	60	51						
	Never	67	76	406	458						
	Often	25	16	NA	NA						
	Seldom	8	8	NA	NA						
(#s 438,444; pgs 144, 145)	"Uncertain;don't know;can't say"	2	0	1	0						
(*Note: change in 'n' for this question.*)	(*missing responses*)	0	0	0	0						
	n	100	100	300	300						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
10. Stealing? (in Study II asked only of the mothers)	Quite often	NA	NA	1	1		X			X	
	Occasionally	NA	NA	21	16						
	Never	45	46	276	273						
	Seldom	5	4	NA	NA						
	"Uncertain;don't know;can't say"	0	0	0	0						
(#456, p. 148)	(*missing responses*)	0	0	0	0						
11. Disobedience?	Very often	NA	NA	10	6		X			X	
	Quite often	NA	NA	43	37						
	Occasionally	NA	NA	221	216						
	Never	2	4	26	28						
	Often	13	14	NA	NA						
	Seldom	35	32	NA	NA						
	"Uncertain;don't know;can't say"	0	0	0	1						
(#462, p. 150)	(*missing responses*)	0	0	0	0						
12. Hitting other children [presently or in the past]?	Very often	NA	NA	6	5	X			X		
	Quite often	NA	NA	39	29						
(responses indicating that the child hit other children in the past but	Occasionally	NA	NA	179	196						
	Never	4	23	70	44						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
not now, are not shown)	"Uncertain;don't know;can't say"	0	0	0	2						
(#426, p. 140)	Often	7	4	NA	NA						
	Seldom	39	23	NA	NA						
	(missing responses)	0	0	0	0						
13. Fighting [presently or in the past]?	Very often	NA	NA	7	8	X				X	
	Quite often	NA	NA	38	27						
(responses indicating that the child fought other children in the past, but not now, are not shown)	Occasionally	NA	NA	198	171						
	Never	5	19	57	72						
	"Uncertain;don't know;can't say"	0	0	0	2						
	Often	9	8	NA	NA						
	Seldom	36	23	NA	NA						
(#428, p. 141)	*(missing responses)*	0	0	0	0						
14. Nervousness?	Very often	NA	NA	28	6	X			X		
(in Study II question asked only of the mother)	Quite often	NA	NA	68	21						
	Occasionally	NA	NA	133	98						
	Never	5	17	66	149						
	"Uncertain;don't know;can't say"	0	0	2	1						
	Often	32	15	NA	NA						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	Seldom	13	17	NA	NA						
(#406, p. 135)	*(missing responses)*	0	1	0	0						
15. Nightmares [presently or in the past]?		NA	NA	2	1		X		X		
	Very often										
(in Study II question asked only of the mother)	Quite often	NA	NA	3	0						
	Occasionally	NA	NA	113	58						
	Never	22	27	144	165						
(responses indicating that the child had nightmares in the past but not now, are not shown)	"Uncertain;don't know;can't say"	0	0	0	3						
	Often	1	3	NA	NA						
	Seldom	27	20	NA	NA						
(#410, p.136)	*(missing responses)*	0	0	0	0						
16. Which of your children do you consider the brightest?	Present case	11	14	60	39						
	Other than present case	37	21	67	97	X				X	
	No difference	22	48	90	99						
	(no response, only child)	22	10	50	30						
	"Uncertain;don't know;can't say"	8	7	33	35						
(#606, p. 191)	*(missing responses)*	0	0	0	0						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
17. Which of your children do you consider the slowest (dullest)?	Present case	28	12	50	51						
	Other than present case	20	15	69	72	X				X	
	No difference	21	47	90	100						
	(no response, only child)	22	10	50	30						
	"Uncertain;don't know;can't say"	9	16	41	47						
(#607, p. 191)	(*missing responses*)	0	0	0	0						
18. As compared with other children, how cooperative is your child?	Much > than average	5	15	16	12	X			X		
	Somewhat > average	25	29	68	86						
	About average	50	44	167	175						
	Somewhat < average	16	11	46	24						
	Much < average	4	1	1	2						
	"Uncertain;don't know;can't say"	0	0	2	1						
(#379, p. 128)	(*missing responses*)	0	0	0	0						
19. As compared with other children how aggressive is your child?	Much > than average	6	4	24	18		X			X	
	Somewhat > average	18	18	68	85						
	About average	46	45	156	141						
	Somewhat < average	22	29	46	49						
	Much < average	7	4	4	2						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	"Uncertain;don't know;can't say"	1	0	2	5						
(#385, p. 130)	(*missing responses*)	0	0	0	0						
20. How well does the child sleep?	Very well	35	41	173	244		X		X		
	Average,fair	11	9	97	47						
(in Study II asked only of the mother)	Poorly	4	0	24	6						
	Variable	NA	NA	6	3						
(#170, p. 48)	*(missing responses)*	0	0	0	0						
21. Birth order of child being studied	Oldest	NA	NA	56	41	-	-	-	X		
	Youngest	NA	NA	45	53						
(#726, p. 219)	Second	NA	NA	16	27						
22. What is the usual mood of the child? *(parents would sometime describe the child using more than one category. For that reason responses are expressed here as percent of total # of responses for that category.) (#176, p.50)*	Usually happy, affectionate, good-natured, jolly, pleasant, cheerful, contented, easygoing….	37%	55%	81%	81%			X			X
	Cranky, sensitive, impatient, moody, quick-tempered, teasing, devilish, irritable, etc.	17%	7%	10%	8%						
	Very excitable, nervous, tense, energetic,	34%	8%	3%	2%						
	Neutral, even-keel, quiet, reserved, daydreamy, serious	12%	31%	7%	8%						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
23. As compared with other children, how much does your child respect the rights of others?	Much > than average	4	4	7	8	X				X	
	Somewhat > average	14	26	32	39						
	About average	62	52	212	211						
	Somewhat < average	16	7	43	37						
	Much < average	2	0	1	2						
	"Uncertain;don't know;can't say"	0	1	4	3						
(#401, p. 134)	(*missing responses*)	2	10	1	0						
24. Do you consider the child to have been slow in beginning to talk in comparison with other children?	Much faster than average	2	4	34	25	X			X		
	Somewhat faster than average	14	25	50	69						
	About average	46	52	139	150						
	Somewhat slower than average	24	14	46	49						
	Much slower than average	12	5	30	5						
	"Uncertain;don't know;can't say"	2	0	1	2						
(#182, p. 51)	*(missing responses)*	0	0	0	0						
25. When did the child speak his first words (in months)?	Minimum	6	6	4	5	-	-	-	-	-	-
	Maximum	18	24	30	30						
	Mean	10.9	9.9	10.9	10.8						
	Median	11	-	11.4	10.7						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
When did the child begin to use sentences? (in months)? *(#s180,181; p. 51)*	90th percentile	-	-	17.1	16.7	The 'n' given in Appendix A for question #180 in Study II was '3' for Control and '5' for Experimental. For question #181 the numbers were '5' and '9'. Nowhere in the text of either Johnson's book or in chapter 4 of the 1955 book that contains a detailed discussion of Study II is there any hint that anything other an n of 50 could be expected. For that reason the above numbers are considered typographical errors.					
	n	?	?	137	131						
	Minimum	14	12	8	8						
	Maximum	72	48	44	48						
	Mean	26.7	24.6	21.8	21.0						
	Median	?	?	21.7	21.1						
	90th percentile	?	?	30.4	30.0						
	n	?	?	136	131						
26. Compared with other children, how happy is your child? *(#489, p. 157)*	Much > than average	6	7	17	22		X		X		
	Somewhat > average	34	47	84	107						
	About average	54	42	179	165						
	Somewhat < average	6	3	19	5						
	Much < average	0	0	0	1						
	"Uncertain;don't know;can't say"	0	0	1	0						
	(missing responses)	0	1	0	0						
27. As compared with other children how shy is your child? *(question not asked in Study II)*	Much > than average	-	-	9	4	-	-	-	X		
	Somewhat > average	-	-	54	36						
	About average	-	-	155	155						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

Orange color-coding identifies data analyzed as primary response variables. See endnote # 7 for an explanation and discussion of analysis procedures. *In some instances responses were not coded identically in both studies. Where this occurred "NA" appears for the non-applicable study.*		Study II For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Study III For each category parent's responses are summed except when noted. When summed, cell frequencies reflect [n x 2]		Regarding the hypothesis that stuttering and the variable are linked, do the response frequencies support the hypothesis in a way that is statistically significant?					
Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	Somewhat < average	-	-	63	80						
	Much < average	-	-	18	24						
	"Uncertain;don't know;can't say"	-	-	1	1						
(#387, p. 130)	*(missing responses)*	-	-	0	0						
28. As compared to other children how cautious is your child about undertaking new things, going into different situations? (Study II: "how cautious is your child?")	Much > than average	11	6	16	6		X		X		
	Somewhat > average	30	40	69	46						
	About average	43	34	145	154						
	Somewhat < average	13	20	59	70						
	Much < average	3	0	9	22						
	"Uncertain;don't know;can't say"	0	0	2	2						
(#388, p. 130)	*(missing responses)*	0	0	0	0						
29. As compared with other children, how much does your child play alone?	Much > than average	8	4	21	6	X			X		
	Somewhat > average	29	29	65	52						
	About average	40	26	157	144						
	Somewhat < average	14	39	43	70						
	Much < average	9	2	10	25						
	"Uncertain;don't know;can't say"	0	0	4	3						
(#402, p. 134)	*(missing responses)*	0	0	0	0						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

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Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
30. As compared with other children, how much initiative does your child show?	Much > than average	4	4	13	16		X			X	
	Somewhat > average	18	31	79	75						
	About average	53	46	192	181						
	Somewhat < average	22	15	12	25						
	Much < average	2	2	3	2						
	"Uncertain;don't know;can't say"	0	0	0	1						
(#404, p. 134)	*(missing responses)*	1	2	1	0						
31. How often has the following behavior occurred?											
Constipation?	Very often	-	-	8	1		X		X		
(responses indicating that the child suffered in the past but not now, are not shown)	Quite often	-	-	8	10						
	Occasionally	-	-	65	45						
	Never	24	32	205	211						
	Often	7	3	-	-						
(in Study II question asked only of mother)	Seldom	19	13	-	-						
	"Uncertain;don't know;can't say"	-	-	2	2						
(#442, p. 145)	*(missing responses)*	0	2	0	0						
32. Compared with other children of his age, how good an	Much > than average	4	3	9	15		X			X	
	Somewhat > average	13	19	45	50						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

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Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
athlete do you think your child is? *(question asked in reference to boys only. # of boys in Study II = 39; # of boys in Study III = 107)* *(#476, p. 154)*	About average	39	51	126	128						
	Somewhat < average	19	14	27	15						
	Much < average	1	1	2	3						
	"Uncertain;don't know;can't say"	0	0	4	2						
	(missing responses)	1	0	0	0						
33. How good an athlete does your wife (husband) think he is? *(#477, p. 154)*	Much > than average	4	3	9	14		X			X	
	Somewhat > average	17	18	43	45						
	About average	31	56	121	121						
	Somewhat < average	19	10	28	19						
	Much < average	1	1	1	1						
	"Uncertain;don't know;can't say"	4	0	11	13						
	(missing responses)	1	0	0	0						
34. In each of the following activities rate your child's coordination (at present and as you have watched him developing, provided he engages in the activity.) Throwing?							X		X		
	Superior	15	14	68	87						
	Inferior	9	11	17	6						
	Average	76	75	211	206						
	"Uncertain;don't know;can't say"	0	0	3	1						

Table 2

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Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	(missing responses)	0	0	1	0						
Catching?	Superior	8	12	33	38		X		X		
	Inferior	16	14	50	27						
	Average	72	73	204	226						
	"Uncertain;don't know;can't say"	0	0	6	6						
	(missing responses)	0	1	2	2						
Running and Jumping?	Superior	39	37	194	251		X		X		
(*this combines what was originally two separate questions, running and jumping. For that reason 'n' is doubled*)	Inferior	12	14	29	18						
	Average	147	149	369	330						
	"Uncertain;don't know;can't say"	2	0	7	1						
	(missing responses)	0	0	1	0						
(#s 81, 82, 85, 87; pp19,20)	-	-	-	-	-	-	-	-	-	-	-
35. How is the child's appetite now?	Good	32	38	168	188		X			X	
	Fair	14	9	72	68						
(in Study II asked only of mothers)	Poor	2	2	39	20						
	Variable	2	1	21	24						
(#169, p 48)	*(missing responses)*	0	0	0	0						
36. Interviewer's rating of stuttering severity	none	7	50	47	148	-	-	-	-	-	-

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Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

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Question (# *and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
	very mild	11	0	39	0						
	mild	14	0	30	0						
	average	10	0	11	0						
	moderately severe	6	0	14	0						
	severe	2	0	1	0						
	very severe	0	0	1	0						
	unrated	0	0	7	2						
(# 614, p 194)	*(missing responses)*	0	0	0	0						
37. As compared with other children, how persistent (in getting a job done) is your child?	Much > than average	11	11	27	15		X			X	
	Somewhat > average	24	26	62	68						
	About average	44	45	150	180						
	Somewhat < average	19	16	55	33						
	Much < average	2	2	2	3						
	"Uncertain;don't know;can't say"	0	0	4	1						
(#381, p. 129)	*(missing responses)*	0	0	0	0						
<u>How often is the following behavior occurring:</u>		-	-	-	-		X			X	
38. Temper tantrums	Very often	NA	NA	3	0						
	Quite often	NA	NA	18	18						

Table 2

Two case-controlled studies, of children 14 years of age or younger who allegedly stuttered, conducted by the University of Iowa Department of Speech Pathology, 1948-1957; frequency of response to selected questions of parents

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Question *(# and location of source question, appendix A, ref 23)*	Response recorded as…	Stutterers (n=50)	Non-Stutterers (Control) (n=50)	Stutterers (n=150)	Non-Stutterers (Control) (n=150)	Study II			Study III		
						Yes	No	U [xv]	Yes	No	U
(responses indicating that the child had tantrums in the past but not now, are not shown)	Occasionally	NA	NA	123	127						
	Never	24	35	119	113						
	Often	5	2	NA	NA						
	Seldom	21	13	NA	NA						
	"Uncertain;don't know;can't say"	0	0	1	0						
(# 450; pg. 146)	*(missing reponses)*	0	0	0	0						
39. How often has the following behavior occurred?											
Sleeplessness [presently or in the past]?	Very often	NA	NA	10	5		X		X		
	Quite often	NA	NA	19	5						
(responses indicating that the child had sleeplessness in the past but not now, are not shown)	Occasionally	NA	NA	83	49						
	Never	29	25	179	203						
	Often	7	3	NA	NA						
	Seldom	14	22	NA	NA						
	"Uncertain;don't know;can't say"	0	0	0	1						
#408, p. 135)	*(missing responses)*	0	0	0	0						

Exhibits

Lead paper weight embossed with the logo of Mason and Hanger, Inc. and offered for sale on an Internet auction site. Seller stated that the weight was from the Iowa Army Ammunition Plant. Mason and Hanger, an engineering, architectural and planning firm, operates the Plant for the US Army as it has since the 1940s. Lead azide is (or was) a component of explosive ordinance and is itself explosive. What looks like a potted plant embossed to the left of the logo is actually a stylistic representation of an early bomb.

Detection and Analysis of Statistically Non-significant Trends

A strategy was devised to detect the presence and direction of observed statistically non-significant trends by assigning a value to each response in both the **Control** and **Experimental** groups. Values were determined by judging whether on the face of it the response supported the hypothesis - that children who stuttered suffered from lead poisoning - or not. A datum was then multiplied by a value to arrive at a score for each response (see example). Across responses scores were summed to arrive at a total for that question.

The example below concerns one finding in Attention Deficit Hyperactivity Disorder (ADHD), namely the difficulty a affected child has focusing his or her attention on a given task. The disorder has been linked to lead poisoning. Although a child suffering from ADHD could be expect to have difficulties concentrating on a task, the disorder may not become fully manifest until after a child has entered school. Since a child's ability to concentrate would be expected to be diminished in ADHD, the values assigned to the responses reflect this, with greater weight (that is, a higher value) given to responses indicating the presence of below average abilities.

In this example Control has the higher score (-71) because that group claimed more responses showing below average abilities. On average then parents of children in the Study III Experimental Group believed that their children were better able to concentrate on a task than did parents of children in the Control Group. Although the direction of difference is noted, no weight is given to the magnitude of the difference between scores. Taking this information and incorporating it into Figure 2, the "ability to concentrate" can be found under the banner heading *"…not support the hypothesis".*

Question	Standardized responses	Value (V)	Data, Study III (D)		Score (V x D)	
			Control (C)	Experimental (E)	C	E
"*As compared to other children, how able is your child to concentrate? (question #384, p. 130)*	Much > than average	-2	16	25	-32	-50
	Somewhat > average	-1	58	61	-58	-61
	About average	0	199	178	0	0
	Somewhat < average	1	19	1	19	1
	Much < average	2	0	5	0	10
				SUM =	-71	-100

[1] Charles Van Riper, The Nature of Stuttering, 2nd ed., p 49; Waveland Press, Prospect Heights, Illinois, 1982.
[2] Oliver Bloodstein, A Handbook on Stuttering, National Easter Seal Society, 1987.
[3] S. Mayfield, "Language and speech behaviors of children with undue lead absorption: a review of the literature". Journal of Speech and Hearing Research, 26; pp 362-368, 1983.
[4] C. D. Jenkins, "Lead poisoning in children: a study of forty five cases", AMA Archives of Neurology and Psychiatry, 77 (1), pp 70-78, 1957.
[5] R.B. Mellins, C.D. Jenkins, Epidemiological and psychological study of lead poisoning in children". Journal of the American Medical Association, 158(1); pp. 15-20; 1955.
[6] "Epidemiologic Notes and Reports Lead Poisoning Among Sandblasting Workers -- Galveston, Texas, March 1994". Morbidity and Mortality Weekly Report, 44(3); pp 44-45, January, 1995.
[7] According to the authors, data from Studies II and III were entered into contingency tables and tested for statistical significance using Chi-square (ref. # 23, p.26). The supplemental analysis reported here used similar procedures. In both cases Chi-square (or Fischer's Exact, see below) was chosen because the analysis compares two independent variables.

For this report data were first entered into contingency tables. Any table containing an expected cell populated with fewer than five observations was analyzed using Fischer's Exact test (VassarStats.com, or http://www.physics.csbsju.edu/stats/ for tables larger than 2 x 2) if the number of such cells in the table exceeded 20% of the total number of expected cells (see ref # 8, p. 20). Otherwise analysis was by Chi-square (VassarStats.com). In some cases where Fisher's Exact test was called for the total population of a table exceeded the software program's ability to calculate the test. In that case sparsely populated cells were merged with adjacent cells in the direction of the table's central tendency until the requirements for Chi-square were met.

There has been criticism leveled toward the merging of cells in a contingency table for any purpose (see ref # 8, p. 11). The criticism is along the lines that merging can lead to spurious associations where in fact none exist. Intuitively it seems logical that merging could lead to a loss of information, although in this instance it would seem to work against rejecting the null hypothesis (that is, the hypothesis that stutterers and non-stutterers come from the same population) and instead increase the likelihood that the hypothesis would be falsely accepted. For that reason merging would seem to be conservative rather than radical. The ordering of response, from "*much greater than average*" to "*much less than average*" for example, could be viewed as a tool designed to coax a response from a reticent parent rather than as a functional scale. For example if a parent were to be asked whether they thought their child's intelligence was either "*average or greater*" or "*less than average*" they might be hesitant to respond at all if they thought their child's intelligence was clearly better than average. The researcher's interests however might lie in exactly such a dichotomous response, knowing that it would be more difficult to define, quantify, or explain the difference between "*much less than average*" and "*somewhat less than average*", for example, than a simpler scale. Never-the-less in the interest of parsimony merging of cells in this study was done only to meet the operational requirements of either Chi-square or Fischer's Exact test and for no other reason. Darley gave much this same reason for merging cells in his original analysis (ref 25, p.85).

Both Fischer's Exact and Chi-square are of course nondirectional tests. Data entered into a contingency table and analyzed by either will have the same result whether the matched data are ordered or not. In the event that either test rejects the null hypothesis a direction must be established. This is accomplished through the use of percentage. For example, in question # 8, Chi-square does not tell us if children who stutter are able to concentrate better or worse than children who do not. All that is known is that the two groups do not concentrate the same. However 35% of non-stutterers are able to concentrate better than average compared with only 17% of stutterers. This procedure was followed throughout the report for all variables.

[8] For this report extensive reference was made to: H.T. Reynolds, Analysis of Nominal Data, quantitative applications in the social sciences, 2nd ed. Sage Publications, 1984.
[9] J. Biederman, "Attention deficit/hyperactivity disorder: a selective overview", Journal of Biological Psychiatry 2005; 57, p. 1215-1220.
[10] D.M. Fergusson, et. al, "A longitudinal study of dentine lead levels, intelligence, school performance and behavior: part III, dentine lead levels and attention/activity", Journal of Child Psychology and Psychiatry 1988; 29 (6), pp 811-824.
[11] J.M. Braun, et.al., "Exposure to environmental toxicants and Attention Deficit Hyperactivity Disorder in U.S. children", Environmental Health Perspectives 2006; 114 (12), pp 1904-1909.
[12] S. Pocock, "Environmental lead and children's intelligence: a systematic review of the epidemiological evidence", British Medical Journal 1994; 309, 5 November, pp.
[13] H. Needleman, "Bone lead levels and delinquent behavior", Journal of the American Medical Association (JAMA), 1996; 275(5), pp 363-369.
[14] K.N Dietrich et.al., "Early exposure to lead and juvenile delinquency", Neurotoxicology and Teratology, 2001; 23, pp 511-518.
[15] D.C. Rice, "Behavioral effects of lead: commonalities between experimental and epidemiological data". Environmental Health Perspectives", 104, suppl. 2; 1996.
[16] W.I. Manton, et.al., "Acquisition and retention of lead by young children", Environmental Research; 82 (section A), pp 60-80, 2000.
[17] D.P.H. Laxen et.al., "Children's blood lead and exposure to lead in household dust and water – a basis for an environmental standard for lead in dust"; The Science of the Total Environment, 66 (1987), pp 235-244.

[18] J. Schwartz, D. Otto, "Blood lead, hearing thresholds, and neurobehavioral development in children and youth", Archives of Environmental Health 42(2); 153-160, 1987.

[19] In Studies II and III two questions, # 23 and # 24, seek the same information about speech development. This was part of a stated attempt by the authors to validate information through the use of interlocking questions. In question # 23 in both studies the impression of both parents in the Experimental Group was that the child was slow to acquire speech compared to control. All parents in both studies answered question # 23. In question # 24 however in both studies many data are missing. In Study II this is to such an extent as to make any conclusion based on question # 24 meaningless. In Study III most of the data are present and in support of delayed speech in stutterers.

[20] M. Galvez M.D. et.al. "Childhood Lead Poisoning from Commercially Manufactured French Ceramic Dinnerware: New York City, 2003". Mobidity and Mortality Weekly Report; 53(26); pp 584-585, July 9, 2004.

[21] P.A. Baghurst et.al., "Determinants of blood lead concentrations to age 5 years in a birth cohort study of children living in the lead smelting city of Port Pirie and surrounding areas", Archives of Environmental Health: 47(3); pp 203-210, 1992.

[22] http://www.mgh.harvard.edu/children/adolescenthealth/articles/aa_lead_poisoning.aspx

[23] Wendell Johnson and Associates, The Onset of Stuttering: research findings and implications, University of Minnesota Press, Minneapolis, 1959.

[24] Data from Study I have not been provided in sufficient detail for comment with one exception. The exception is scores from standardized I.Q. tests administered to stutterers and non-stutterers, the only one of the three studies to conduct I.Q. tests in both groups. Despite the fact that researchers sought to empirically match the groups for intelligence, the results showed a lower I.Q. in children who stuttered (median 114; range 80 to 159) than in children who did not (median 116; range 95 to 158). The disparity in perceived intelligence between the groups can also be found in Study II (see comments on perceived intelligence in Study III, paragraph 2, page 5 of this report) in that it was the impression of parents that their children were not as intelligent as their peers or siblings. It is also consistent with Stuart Pocock's review of the results of I.Q. tests administered to over 2000 lead poisoned children in 7 different published cross-sectional epidemiological studies (British Med. Journal, 309; pp 1189-97; 5 Nov 1994). Although Pocock found a mean deficit of 1 to 2 I.Q. points for roughly every 10ug/dL of blood lead, in some of the studies the deficit ranged much higher, as it did for some of the affected children in Study I.

[25] A full description of Study II has been published as Chapter 4 in Stuttering in Children and Adults: thirty years of research at the University of Iowa, Wendell Johnson, (ed.) University of Minnesota Press, 1955.

[26] While it is not known if blood lead levels were ever determined on workers at the Iowa Army Ammunition Plant, levels were measured on several workers at other army ammunition plants, in Indiana, Kansas, and Illinois, at the request of the plant physician. By today's standards the levels were uniformly all elevated. At one plant abnormal lead levels, some of them alarmingly high even by the standards of the 1940s and early '50s when they were measured, were found in dozens of workers. Over time average blood lead levels at this plant fell, presumably with institution of more effective safeguards (correspondence between plant physicians and Dr. Kehoe dated 1942; 1954, in file boxes 79, 36, 43 at The Robert A. Kehoe archive, Henry R. Winkler Center for the History of the Health Professions, University of Cincinnati Libraries, Cincinnati, Ohio.

[27] H.L. Needleman et.al., "Bone lead levels and delinquent behavior". Journal of the American Medical Association: 275(5); pp 363-369;1996.

[28] D.C. Bellinger, et.al. "Low-level lead exposure, intelligence, and academic achievement: a long-term followup study". Pediatrics, 90(6); pp. 855-861; 1992.

[29] R. Byers, et. al. "Late effects of lead poisoning on mental development". American Journal of Diseases of Children, 66 (5); pp 471-494; 1943.

[30] "Lead in Modern Industry: manufacturer, applications and properties of lead, lead alloys, and lead compounds", chapter 25, Lead Industries Association, NY, NY 1952.

[31] In the scheme put forth in Social Class in America, the book's authors wrote that at first in order to assign social class the "*amount of income and education were used in addition to the four factors already discussed* [that is, occupation, source of income, house type, and dwelling area]. *In the revision…these factors proved unnecessary..and, as this information was more difficult to obtain, they were eliminated*." (chap 2, p. 44) In The Onset of Stuttering, the authors made use of this classification system and wrote that "*the two groups of families* [that is, the Control and Experimental Groups in Studies II and III,] *were matched in socioeconomic status* [using the classification system found in Social Class in America]". The system uses a weighted average of the four factors mentioned with no attempt to match occupations directly. Given that the Iowa researchers failed to achieve balance between the two groups for educational achievement, it suggests that in any social class where members of the class do manual labor, those at an educational disadvantage are more likely to wind up with the dirty dangerous jobs. In the middle part of the last century that meant working with lead more often than not. Further, a lack of education made these workers unprepared to protect themselves (and their families) from hazards arising from occupational lead exposure.

[32] Darley administered standardized social, behavioral, and intelligence tests to some stutterers and non-stutterers in Study II. The tests (see C.R. Rodgers, A Test of Personality Adjustment; Manual of Directions. New York, Association Press, 1931.) included a measure of a child's fantasy life (the 'Daydreaming score'). 25% of tested stutterers and 5% of tested non-stutterers scored "high" on the test (ref 25, p.133). Excessive daydreaming is frequently found in ADHD children. ADHD is a known outcome of lead poisoning.