

A Validation Study of the Influence of Alcohol on Handwriting*

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ABSTRACT: The purposes of this article are to report experimental findings and to validate prior selected studies that examined handwriting comparisons and alcohol consumption. Subjects who participated in this experiment were given handwriting testing forms which were completed at assigned intervals throughout the testing period. The setting for the completion of the experiment was within a controlled environment with adult students attending the Breath Tests for Intoxication School for the use of blood alcohol concentration (BAC) instruments for law enforcement purposes. Handwriting data and pertinent information, BAC level and time, were recorded on the testing forms which were completed before, during, and after drinking. This study does not attempt to determine handwriting characteristics that can be predicted at various blood alcohol levels, but rather demonstrate, as noted in prior studies, if handwriting trends develop during or after the consumption of alcohol. The results of the handwriting comparisons, between and among test subjects, are discussed and applied to prior findings.

KEYWORDS: forensic science, questioned documents, handwriting, alcohol, validation

The effects of alcohol on handwriting have been well documented in scientific journals and unpublished technical papers (1). Continued examinations of abnormal writings, their causes, and their documented results are of importance to document examiners when presented with questioned documents (2-4). Establishing and reinforcing scientific cause and effect relationships are fundamental to the process of handwriting comparison and the results derived therefrom (2). The purposes of this study are to test documented results of alcohol on handwriting and report those findings observed through the direct comparison of samples obtained within the experiment.

Alcohol, many times, can cause observable effects upon a person's handwriting. Intoxicants and their effects upon individuals will vary to the degree that each person is affected at different blood alcohol concentrations according to varying physical conditions (4-6). Individual handwriting characteristics, specifically those acquired over years of practice and repetition, are also the effect of unique physical ability and neuromuscular composition, among other causes which are not discussed in this paper (7). This study is not an attempt to establish at what level alcohol will produce predictable and consistent results, rather this study was

conducted to determine if the previously reported effects of alcohol on handwriting are valid observations that can be generally applied to the established methods of handwriting comparison. This study involved drinking participants who were tested under a controlled environment, and monitored for approximately 3½ h during the Breath Tests for Intoxication School. The following is the reported activity and results, the conclusions, and the statements obtained from practical observation and testing, which validate prior research studies.

Materials and Methods

Participation from the drinking subjects tested was solicited from attendees of the Indiana University, Department of Pharmacology and Toxicology, Breath Tests for Intoxication School.² The study was conducted at the Indiana Law Enforcement Academy (ILEA) facility in Plainfield, Indiana, with the laboratory and classroom portions limited to the participation of law enforcement officers. The 28 initial participants, all male, ranged in age from 22 to 43 years old. After the testing session had begun, two (2) control numbers were not utilized during the experiment; the participating group was then limited to 26 members for statistical purposes. (The participant identified as "Control No. 9" did not remain at either the laboratory or the classroom during the testing period and did not complete the required quantity of handwriting testing forms. The "Control No. 13" packet was not selected by the participants.) The following percentages designate the composite ages for the population of the group:

22 to 29 years	20/26	or	77% (0.7692)
30 to 36 years	4/26	or	15% (0.1538)
43 years	2/26	or	8% (0.0769)

A portion of the curriculum assigned for the 40 h course contains a voluntary participation segment in which students are served test dosages of the ethyl alcohol of their choice, limited to vodka, rum, or bourbon. The test dosages are composed, theoretically, to get the subject to test between 0.08% and 0.10% BAC if fully consumed within the allotted time period. "In most states in the United States a person is presumed to be intoxicated and unable to drive safely or otherwise function normally, when he or she exhibits blood alcohol concentration of from 0.10 to 0.15% BAC and over," (6). Instructions are given to the students that immediately following a lunch period, at 1:00 p.m., they are to begin consuming their assigned alcoholic beverages. Prior to the drinking exercise, each student designated if he would be participating as a drinker, his body weight in pounds, and the type of alcoholic beverage he would prefer to consume for the testing period (limited to those

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brands made available for the exercise). This information was taken to the Toxicology Laboratory and technicians prepared alcoholic beverages for each of the participants. The alcoholic beverages were based upon the volume of alcohol that would be necessary to bring an individual of a designated body weight to a level of 0.10% BAC intoxication while consuming a predetermined selection of alcohol (8). In order to attain 0.10% BAC, the entire alcoholic beverage was to be consumed within the allotted time frame, 1 h (9). The solutions consisting of vodka (Smirnoff®) or bourbon (J. W. Dant®) were equated on a 1 mL:1 lb of body weight ratio due to the percent alcohol by volume contained in these liquors (100 proof). Rum (Bacardi®) solutions consisted of higher ratios of milliliters of alcohol to pounds of body weight due to the lower percentage of alcohol by volume (80 proof). Specific ratios are listed (Table 1) for each participant.

Each test subject was instructed that drinking would commence at 1:00 p.m., after the lunch period, and cease at 2:00 p.m. Within this 1 h time frame, the entire alcoholic beverage was to be consumed with or without any quantity of "mixing" beverage that was made available within the classroom; Coke®, Sprite®, and orange juice were provided.

Subjects were provided with a Participant Questionnaire Form, Fig. 1, at the start which requested general information and was utilized for the purposes of assigning a control number to each individual who was taking part in the exercise. After this questionnaire was completed, students completed the first of seven Handwriting Test Forms, Fig. 2, that would be administered throughout the afternoon. For purposes of consistency, each person was provided with a Bic®, medium point, black ball point pen. The first test form was important in establishing general features of each participant's handwriting in the absence of alcohol. The handwriting contained on this form does not purport to be an all-inclusive

exhibit of each writer's range of natural variation, but a representative range was acquired (5). For the purposes of this paper, the effects of alcohol on handwriting were able to be observed and documented in most cases. Instructions were also given to the students that each consecutive test form should be completed each time while seated at a desk. Variation in writing position, as far as sitting or standing, was discouraged (8,9).

If alcohol produces an effect or effects upon an individual's handwriting, to what degree are these effects observable? Assuming a base level of consumption, but not attempting to predict effects based upon blood alcohol concentration, can probability be introduced on an individual basis regarding alcohol and handwriting? If observable and reliable results are obtained as a function of alcohol consumption, the effects observed upon an individual's handwriting must not be equated with the quantity consumed (2).

An example of this condition would be to observe the handwriting of no less than two individuals who each consumed the same quantity of alcohol, yet differed in body weight by 100 lb. (The 100 lb difference in body weight is an indiscriminate value. Other differing weight ratios could be substituted.) Having consumed the exact same quantity and concentrations of alcohol, one would not expect these two individuals to be affected in the same manner or to the same degree due to the body weight difference. Conversely, if no, or only slight, changes are observed, this does not imply that an individual only consumed a small quantity of liquor (2). "People differ from one another in their susceptibility to the effects of alcohol on motor performance, especially at blood alcohol levels of less than 0.10% and below," (sic)(4).

Various factors outside the control of the boundaries of this experiment could have affected the tolerance each individual has when consuming alcohol. Possible factors that may affect the occurrence of handwriting deviations could include one or more

TABLE 1—Participant data.

Control No.	Age (Years)	Height (In.)	Weight (lb)	Alcohol (Type)*	Dosage (mL)	1:00 BAC A	2:00 BAC B	2:30 BAC C	3:00 BAC D	3:30 BAC E	4:00 BAC F	4:30 BAC G
1	30	69	200	B	200	0.000	0.070	0.089	0.095	0.083	0.073	0.044
2	25	72	210	B	210	0.000	0.036	0.052	0.050	0.044	0.035	0.028
3	36	72	233	R	290	0.000	0.080	0.060	0.062	0.050	0.049	0.039
4	24	72	210	R	265	0.000	0.060	0.070	0.060	0.059	0.060	0.046
5	25	77	175	R	220	0.000	0.088	0.087	0.091	0.080	0.075	0.064
6	23	69	150	R	190	0.000	0.078	0.087	0.070	0.065	0.046	0.046
7	24	72	205	V	205	0.000	0.070	0.080	0.081	0.082	0.073	0.065
8	24	70	195	R	245	0.000	0.079	0.067	0.059	0.041	0.043	0.038
9	24	72	190	R	240	0.000	0.073	NA	NA	NA	NA	NA
10	25	68	155	NA	NA	0.000	0.070	0.093	0.090	0.093	0.088	0.086
11	28	77	238	R	310	0.000	0.022	0.017	0.007	0.000	0.000	0.000
12	43	67	180	R	225	0.000	0.070	0.035	0.034	0.027	0.024	0.020
13	NA	NA	NA	NA	NA	0.000	NA	NA	NA	NA	NA	NA
14	24	73	170	V	170	0.000	0.020	0.028	0.031	0.024	0.016	0.015
15	25	70	160	V	160	0.000	0.061	0.077	0.078	0.070	0.065	0.062
16	28	66	210	R	265	0.000	0.090	0.080	0.080	0.080	0.080	0.065
17	26	73	200	V	195	0.000	0.021	0.040	0.052	0.051	0.050	0.039
18	29	70	160	V	150	0.000	0.040	0.045	0.046	0.047	0.034	0.025
19	22	72	185	R	225	0.000	0.050	0.053	0.062	0.046	0.050	0.039
20	25	75	240	V	235	0.000	0.077	0.061	0.061	0.056	0.049	0.045
21	28	76	215	V	215	0.000	0.026	0.035	0.032	0.029	0.021	0.016
22	24	70	170	R	220	0.000	0.042	0.030	0.032	0.024	0.018	0.012
23	35	74	210	B	210	0.000	0.053	0.055	0.051	0.044	0.041	0.031
24	24	71	200	R	250	0.000	0.075	0.080	0.079	0.062	0.056	0.051
25	25	73	197	B	197	0.000	0.080	0.070	0.075	0.070	0.063	0.051
26	25	67	185	V	185	0.000	0.036	0.041	0.046	0.045	0.038	0.030
27	33	71	190	R	245	0.000	0.063	0.062	0.062	0.063	0.061	0.056
28	43	75	235	V	235	0.000	0.040	0.056	0.067	0.075	0.068	0.064

*B (bourbon), R (rum) and V (vodka).

THE EFFECTS OF ALCOHOL ON HANDWRITING

Control Number

Participant Questionnaire

The following information is requested to verify your participation in a handwriting study. The purpose of the study is to document and draw conclusions about the effects of alcohol on a person's handwriting at various levels of consumption under a controlled environment. The information requested on this page is solely for the purpose of control number assignment and participant statistics. Once you have been designated with a control number, your name as a drinker will not appear on any other forms.

Complete the following questions as directed:

(PLEASE PRINT!)

1. Name _____
2. City of residence _____
3. Birthdate _____
4. Sex () Male or () Female
5. Age _____
6. Height _____
7. Weight _____

If you should have any questions throughout the testing, please do not hesitate to ask.

Thank you for your participation!

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FIG. 1—The Participant Questionnaire form allowed the author to collect the necessary information required to document a research project as well inform each participant that his or her anonymity would be protected. The utilization of a control number to track individual results was emphasized to each participant to try to diminish inhibitions and promote natural handwriting behaviors.

of the following: The actual quantity of alcohol consumed within the allotted hour, the amount of food consumed prior to the testing period (the effects of alcohol are minimized by "a full stomach"), the amount of "mixing" beverage consumed during the exercise, and the individual's tolerance to liquor prior to engaging in the exercise (8). Notably, not all participant's consumed the entire quantity of their solution within the hour. Instructors advised the students that if the solution was not consumed by 2:00 p.m., the remainder would be poured out. (No records were kept as to which students fully consumed their assigned alcoholic beverages, or to which students relinquished some quantity of the alcohol.) After the drinking hour ceased, each person was allowed to drink water if necessary for the remainder of the testing period, but only water and no carbonated beverages or juices.

At approximately 2:00 p.m., each participant walked from the classroom to the laboratory to be tested by a non-drinking partner. BAC levels and the signatures of the tester were recorded on the handwriting testing forms during each test throughout the exercise. BAC levels were calculated by either a DataMaster™ (National Patent, Analytical Systems, Incorporated) or by an Intoxilyzer

Handwriting Test Form

Control Number

EXERCISE I.

Word List:	Write the word here:	Print the word here:
1. Indianapolis	_____	_____
2. certification	_____	_____
3. policeman	_____	_____
4. handwriting	_____	_____
5. alcohol	_____	_____
6. intoxication	_____	_____
7. hospital	_____	_____
8. alphabet	_____	_____
9. Toxicology	_____	_____
10. jeopardy	_____	_____
11. advise	_____	_____
12. question	_____	_____
13. kick	_____	_____
14. stabilize	_____	_____
15. Study	_____	_____

EXERCISE II.

Write the following sentence in cursive hand in the box provided:

The speeding car was driving off the road and down the hill.

Signature of the TESTER	BAC Level	Time

FIG. 2—Each letter of the alphabet was incorporated among the 15 words to be handwritten and handprinted on the Handwriting Test form. Individual words were selected on the basis of familiarity that police participants would have with the terms. Words that would not necessarily be associated with a police officer, or are frequently misspelled, were avoided to try to diminish a false positive, or inflated result, for the increase in errors, corrections, and omissions category.

5000™ (CMI, Incorporated; Subsidiary of Federal Signal Corporation) throughout the testing period, as both instruments were available for use within the laboratory. Acknowledgment is given that instrument or human error may have occurred due to the operator skill with the instruments, the nature of the exercise utilizing student trainees, or to the nature of the instruction given by the tester to the drinker on how to provide a good breath sample. The results or conclusions concerning alcohol and its effect(s) upon handwriting are not based upon any of the numerical data, especially blood alcohol concentrations, provided on the test forms. The BAC level information that was documented was done so to record increasing and/or decreasing levels of intoxication. Therefore it follows that the conclusions contained herein are justifiable based upon the documentation of the subjects' consumption of a basic quantity of alcohol within structured parameters.

Upon returning to the classroom shortly after 2:00 p.m., the students were instructed to complete the second test form provided to them. Each student completed this process throughout the testing period, five additional times. The last test forms were completed at approximately 4:30 p.m., and the entire exercise ceased at 5:00 p.m.

Evaluation of the handwriting test forms was made using some of the criteria of prior studies of other document examiners. The

The Probability of a Handwriting Characteristic (PHC), for a group, is demonstrated by the number of times the occurrence was observed within the participant group, A, divided by the total number of trials, T (10). Each Control Number listed, 1 through 26, was considered a trial, even though each subject completed seven handwriting testing forms. PHC was determined by control number as either an occurrence or a nonoccurrence for each handwriting characteristic.

The purpose of this study was not to determine at what BAC level would predict particular handwriting characteristics, but rather to establish the predictability of observing specific effects of alcohol on the handwriting of individuals within a group. No attempt is made to draw a direct relationship from the BAC data presented in Table 1 to the PHC values designated in Table 2. It cannot be stated that if one attains a BAC level of 0.080, for example, he or she will experience increased size and spacing within handwriting and a decrease in baseline tendency. The quantity of alcohol consumed and the resultant BAC level figure is not a reliable indicator of the probability of observing the handwriting characteristics described in this study (6). Rather, *with the introduction of an intoxicant, specifically alcohol*, the particular handwriting characteristics may be observed as a dependent variable. The characteristics are dependent due to the nature of how each individual metabolizes or is tolerant to the effects of the depressant (8). Generally, the PHC values indicated are stable data across the group, for this experiment. The total number of trials T considered for this study was 26. (The preceding calculations were performed within a MicroSoft® Excel™ spreadsheet environment.)

Results

The conclusions that can be drawn from the direct observations of this study and which validate the conclusions drawn from the previous studies consist of the following statements. When an individual is under the influence of alcohol, certain handwriting abnormalities may be observed when multiple samples of that individual's handwriting are compared with each other. Depending upon the effect the alcohol may have upon an individual, the appearance of these tendencies, or deviations from normal handwriting, may appear quite visibly. Two characteristics of handwriting that will generally *not* indicate the effects of alcohol are the instrument effect and the speed of the writing. The data compiled in this study strongly confirms Ordway Hilton's prior findings that no apparent change in either of these categories was observable between the before, during, or after drinking samples (11). Alcohol did affect other characteristics, though. At least 42% of the participants' samples demonstrated an increase in size and spacing of the writing and a decline in legibility, or increase in carelessness (9,11,12). Other tendencies, as designated in the previous studies did occur, but not with the frequency of the previous categories. Specifically, only 7 of the 26 participants' samples demonstrated a decrease in baseline tendency or alignment (9,11,12). Only four samples contained an increase in errors, corrections, and omissions (9,12). Additionally, only 8% of the samples showed a decrease in the uniformity of slant and an increase in mixing upper and lower case letters (9).

The consensus arrived at within the previous studies and validated by this study is that BAC levels are not proper indicators of the effects alcohol will have upon an individual's handwriting. It follows that the tendency increases for the occurrence of some abnormal handwriting characteristics during or after the consumption of alcohol. Time frames for when abnormal handwriting characteristics may be observable will vary between individuals, if observed at all. It is not possible to state decidedly, though, which specific effects may be observed or what level of intoxication is necessary to bring about those abnormalities.

Discussion

On the surface, occurrences for each of the listed handwriting characteristics observed within the previous studies occurred during this study as well. There is agreement that the introduction of alcohol has effects upon individuals' writings, limited to the degree that the individuals are impaired by the intoxicant. In establishing agreement or validation between the results of this study and the previous studies, difficulty is encountered in quantifying the conclusions. Descriptive terms such as "few" or "increased" were used to describe the results on a general level. Phrases such as "appeared more" or "did not appear to have an effect" were also used. One statistic within the Nanette G. Galbraith study that was specific, though, was the reported 51% occurrence for errors, corrections, or omissions (12). This result was based upon a 51% rate of difference between pre-drinking error-free samples and post-drinking samples which contained these elements. This study did not achieve the above reported occurrence for this category; only 15% of this study's group experienced this trend. This trend may be attributable to the amount of writing that is requested during the experiment. Possibly participants within the Galbraith study were instructed to write at greater length while intoxicated, therefore increasing the possibility for errors, corrections, or omissions.

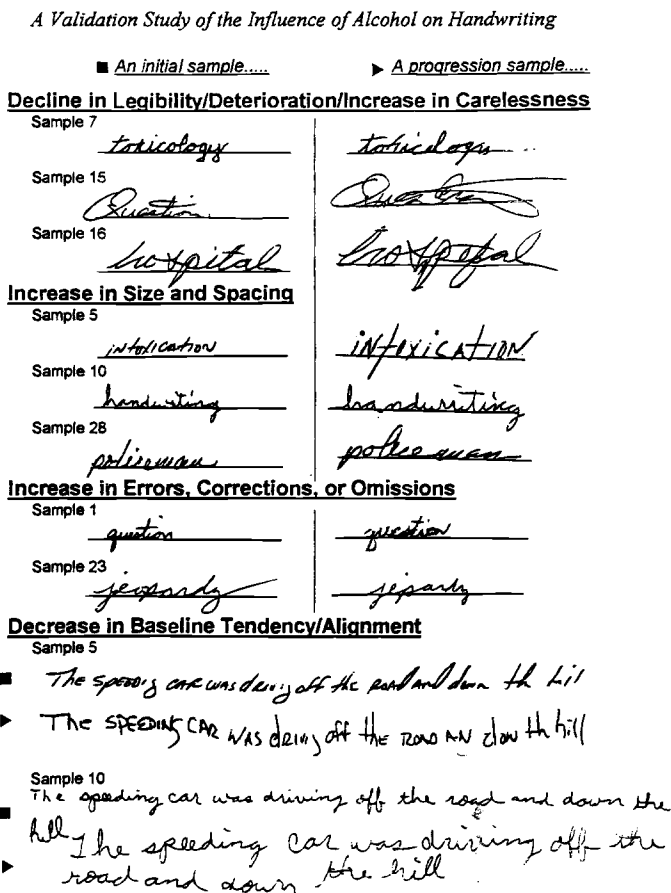


FIG. 3—Examples of initial (predrinking) and progression (during or postdrinking) samples.

An additional limitation to this study was the absence of a control group. All participants were selected based upon their voluntary participation as a drinker during the certification exercise. Participation from non-drinking attendees of the school was available, but was not solicited due to the nature of the effects sought. It is difficult to speculate the effect that non-drinking participant data might have on the outcome of the results. Logically, one would not expect the non-drinker's data to bear any statistical resemblance with the present study due to the lack of alcohol as a catalyst. The use of a control group in this circumstance could be beneficial as a "blinding" tool.

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