

Handwriting changes under the effect of alcohol

Faruk AŞICIOĞLU^{a,*}, Nurten Turan^b

^aThe Council of Forensic Medicine, Adli Tıp Kurumu Başkanlığı, Esekapı, İstanbul, Turkey

^bDepartment of Biostatistics, Faculty of Medicine, University of İstanbul, Çapa, İstanbul, Turkey

Received 9 October 2002; received in revised form 6 January 2003; accepted 15 January 2003

Abstract

Document examiners are often faced with difficulties in evaluating handwriting by persons under the influence of alcohol. Although numerous articles are available on the subject of alcohol influence on handwriting quality, most of them were based on empirical data such as “few” or “increased”, without any statistical evaluation. The aim of this research is to determine whether previous observations on reported effects of alcohol on handwriting are valid and to establish the predictability of observing specific effects. A total of 73 participants, who completed all steps of the experiment, were surveyed. Handwriting samples were taken before and after the consumption of alcohol. The test form, including criteria of prior studies used by document examiners, was evaluated with the help of a Olympus X-Tr stereo microscope, direct and oblique angle lighting and a video spectral comparator (VSC 2000). Measurements were done by means of digital caliper, statistics using repeated measures ANOVA, Pearson correlation, Pearson Chi square test, McNemar test and Wilcoxon signed rank test.

The results revealed that the handwriting parameters such as word lengths, height of upper and lower case letters, height of ascending letter, height of descending letter, spacing between words, number of angularity, number of tremor, and number of tapered ends are all significantly increased under the effect of alcohol.

It was also determined that the significant correlation between the alteration of handwriting parameters such as height of upper and lower case letters, number of angularity, number of tapered ends and the amount of alcohol. Furthermore, it does not confirm the conclusions of previous studies stating that alcohol levels are not proper indicators. Our data strongly confirms that handwriting changes can be observed at any level of alcohol.

None of the alterations in handwriting can be attributed to the effects of alcohol intake alone. However, the presence of some alterations together is strongly suggestive that the person was under the influence of alcohol.

First of all, the duty of handwriting examiner is to identify if the questioned and known sample are coming from the same source. Consequently, as this explanatory analysis suggests that differences between sober and intoxicated persons can be identified in handwriting, but the examiner’s judgement must be proportionately cautious, keeping in mind the abnormally wide range of variation.

© 2003 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Questioned documents; Handwriting; Alcohol; Turkey

1. Introduction

Occasionally, document examiners are faced with handwritings written by an individual who is under the influence of alcohol. Indeed, alcohol can cause observable effects

upon a person’s handwriting [1–3] and an amnesic state may occur after alcohol consumption, which rises questions of authenticity in practice as Hilton implied. On the other side, if a person combines alcohol with drugs like triazolam, he may write anonymous or non-anonymous threatening notes and subsequently deny authorship [4]. Numerous research studies, articles and discussions have concentrated on the effect of alcohol on handwriting [1–7]. However, the results are mostly not based upon statistical data and therefore unsatisfying.

* Corresponding author. Present address: Haseki Cad. Keçihatun Mah., Küpeşteçiler Sok. No: 26/7, 34300 Haseki, İstanbul, Turkey. Tel.: þ90-532-520-3489; fax: þ90-212-251-2304. E-mail address: fascioglu@hotmail.com (F. Aşicioğlu).

This study was carried out in order to learn how alcohol and alcohol-related neurological deterioration affect handwritings. They were compared before and after alcohol consumption and evaluated statistically. The aim of this research is to determine whether previous observations on reported effects of alcohol on handwriting are valid and to establish the predictability of observing specific effects.

2. Materials and methods

Participants were chosen among attendees, who joined the annual foundation party of a leading company in Turkey. Prior to the sample taking, expiration breath alcohol content was measured in consenting attendees. Subsequently, sober handwriting samples were taken and a short questionnaire of demographic information was filled out by the attendees. Two of the participants could not complete the text after consumption of alcohol, and therefore they were excluded.

Of 73 participants, 65 males and 8 females, who completed all steps of the experiment, were surveyed. The volunteers

had no diagnosed health problems and were social drinkers with no history of alcohol abuse. The written material used for standard text was selected based on familiarity and simplicity of content, reasonably balanced number of upper-lower extender, middle zone characters, and each letter of alphabet was incorporated among the words. The standard text stated “Afyon’dan Denizli yönüne doğru 20 km kadar uzaklaşmıştık ki kendimizi demiryolunu atlayıp turunç bahçeleri arasına dalan yolda bulduk. İki yanımızı süsleyen erken bahar müjdecileri papatyalar ve gelincikler, bizi Eskişehir köyüne dek çekip götürdü. Böylece ilk çay molamızı köy kahvesinde vermiş olduk”. Similar conditions such as a paper pad, a standard A4-sized, unlined piece of paper and a medium ballpoint pen were maintained in a sober and an intoxicated state. The text was written while seated at a desk under adequate illumination.

The participants consumed ethyl alcohol without limitation. The selection of the type of alcoholic beverage taken was at the discretion of each volunteer. They were also notified to attend a breath test after 10 min they stopped drinking. For breath testing “Alco-sensor 4 Screener

Table 1

Checklist used for the methodical assessment of handwriting change under the influence of alcohol

-
1. Word length (measured words as follows “Afyon’dan, demiryolunu, bahçeleri, müjdecileri, molamızı”)
 2. Height of upper case character bodies (measured “A” of Afyon, “D” of Denizli, “B” of Böylece)
 3. Height of lower case character bodies (measured “o” of doğru, “r” of kadar, “e” of kendimizi, first “a” of bahar, “v” of ve)
 4. Height of ascending letter character bodies (“d” of doğru, “t” of turunç, “k” of bulduk)
 5. Height of descending letter character bodies (“y” of yönüne, first “p” of papatya, “g” of gelincik)
 6. Spacing between words (space measured between “Denizli and yönüne”, “atlayıp and turunç”, “müjdecileri and papatyalar”, “bizi and Eskişehir”, “molamızı and köy”)
 7. Variation in spacing between lines (1: none remarkable, 2: moderate, 3: significant)
 8. Variation in spacing between words (1: none remarkable, 2: moderate, 3: significant)
 9. Variation in spacing between characters (1: none remarkable, 2: moderate, 3: significant)
 10. Alignment to margins (1: alignment to left, 2: alignment to right, 3: alignment to both margin, 4: both margin is disorder)
 11. Alignment of words to baseline (1: closely adhering, 2: wavy, 3: words slope downwards, 4: words slope upwards, 5: Peak or dip, otherwise straight)
 12. Number of angularity (count)
 13. Number of tremor (count)
 14. Number of tapered ends (tapered beginnings and conclusions of strokes) (count)
 15. Misspelling (count)
 16. Omission of characters (count)
 17. Duplication of characters (count)
 18. Displace of wrong characters (count)
 19. Abnormal use of upper case letters (count)
 20. Abnormal use of lower case letters instead of upper case letters (count)
 21. Number of corrections (count) (1: none, 2: subtle retouching, 3: overwritten word, 4: scribble)
 22. Diacritics (count) (1: no distinguishing characteristic, 2: missing diacritics, 3: unusual shape, 4: superfluous diacritics)
 23. Slurring (count) (1: simplification of characters, 2: flattening of characters, 3: deterioration of characters, 4: abbreviation of letter form)
 24. Writing quality (departures from the consistency of character shape, spacing, line direction, and deterioration, casualness, carelessness, and less accurately formed letters were accepted as indicator of poor handwriting quality. If no significant change in writing quality was noted, it received perfect, a score of 1, then they are classified a score of 2–5 as good, medium, poor and very poor, respectively)
 25. Pen pressure (the amount of embossing was assessed by observing the back of each writing sample under low angle lighting by means of VSC 2000 and comparing each sample to three standard embossing—little or no embossing, medium embossing, heavy embossing—samples of our laboratory)
 26. Rhythm (rhythm was assessed by noting inconsistent slope and /or character size; 1: regularity in both slope and character size, 2: regularity in slope, but not in character size, 3: regularity in character size but not in slope, 4: irregularity in both)
-

(Intoximeters Inc., St. Louis, MO)” was used. Prior to testing, control of sensitivity was done according to manufacturer recommendations and the volunteers were instructed to rinse their mouth with tap water. The handwriting samples taken in state of intoxication were taken under the same conditions as mentioned above.

The test forms were evaluated by using some of the criteria used by document examiners in prior studies. All handwriting specimens taken were assessed using a multiple-choice checklist (Table 1). Handwriting comparisons and examinations were performed in a laboratory setting with the assistance of a Olympus X-Tr stereo microscope (Olympus Optical Co. Ltd., Tokyo, Japan), a direct and oblique angle lighting and a video spectral comparator (VSC 2000, Foster and Freeman Ltd., UK). Measurements were done by means of a digital caliber. The status of writers, sober or intoxicated, were not known by the authors during measurement. Rhythm was assessed according to Table 1 (in article 26, item 2, 3, and 4 accepted as rhythmic irregularity). Likewise, writing quality and pen pressure were assessed according to Table 1 (article 24 and 25). About 1 month later, assessment of rhythm, writing quality, and pen pressure were repeated, and it was determined that the results obtained between two observations had very little differences. Therefore, the results were reassessed and the controversy disappeared.

All data was entered into the computer to form a database in order to aid various analyses. Repeated measures ANOVA, Pearson correlation, Pearson Chi square test, McNemar test and the Wilcoxon signed rank test were used for statistical evaluation. Repeated measures ANOVA was applied to Table 3 for the comparison of more than two groups; sober, with alcohol, high school and below, university degree and above. Pearson correlation test was used to evaluate the correlation between alcohol level and the change of handwriting characters as shown at Table 5. The alterations in pen pressure (in percentage) before and after alcohol intake were evaluated by Pearson Chi square test. McNemar test was found to be useful for comparison of results in sober and intoxicated individuals. We preferred Wilcoxon signed rank test for comparison of writing quality. Because the comparison of scores, such as perfect, good, medium, poor and very poor, related to both sober and intoxicated groups were necessary.

3. Results

Total 23 participants reached a blood alcohol concentration of 50 mg/100 ml or below (31.5%), 51 mg/100 ml to 100 mg/100 ml by 24 (32.9%) and 101 mg/100 ml or above by 26 (35.6%) participants (mean: $83:14 \pm 41:67$, median: 86). Mean age of participants was $36:78 \pm 10:16$ (median: 35), ranged between 20 and 59. The demographic characteristics of volunteers were given in Table 2. The original handwriting parameters such as word length, height of upper

Table 2
Demographic of volunteers

Characteristic	n	Percentage
Gender		
Male	65	87.7
Female	8	12.3
Marital status		
Married	55	74
Single	17	24.7
Divorced	1	1.3
Handedness		
Right	66	90.4
Left	7	9.6
Occupation		
Engineer	18	24.65
Employee	31	42.46
Technician	5	6.84
Manager	2	2.73
Officer	17	23.28
Education		
High school and below	40	54.8
University and above	33	45.2

case, lower case, ascending and descending letter, spacing between words, number of angularity, tremor and tapered ends are all significantly increased under the effect of alcohol as shown in Tables 3 and 4. Except the noticeable increase of the height of upper and lower case letters by high school graduates (Table 3), no significant differences could be seen according to educational degrees between high school and university graduates. Markedly, correlation could be observed between the changing of handwriting parameters, such as the height of upper and lower case letters, number of angularity and tapered ends and the amount of alcohol (Table 5). As for correlation between handwriting characters, word length enlargement was also associated with the increase of height in all character bodies which are listed at articles 2, 3, 4, 5 in Table 1 (Table 6). All other correlations are given in Table 6. There were significant correlation between number of tremor and angularity, While negative correlation was observed between both number of tapered ends-angularity and number of tremor-tapered ends (Table 6).

Writing specimens were categorized according to the degree of variation in space between letters, words and lines by evaluating a one to three rating, which is called “none remarkable” “moderate” and “significant”. The data, which was seen as “moderate” and “significant” were assessed as variation, and illustrated at Table 7. Statistically, significant variations were determined between sober and intoxicant samples (Figs. 1 and 2). The data of the alignment to margin and the alignment of words towards the baseline showed marked impairment. In addition, an increase of misspelling was seen on handwriting written under the

Table 3
Changes in handwriting to both alcohol consumption and educational level

	High school and below				University degree and above				Alcohol	Education
	Mean	S.D.	Minimum	Maximum	Mean	S.D.	Minimum	Maximum	F; P	F; P
Word length										
S	27.31	4.70	15.60	37.87	27.79	4.51	15.80	38.41	40.53; 0.0005	0.65; 0.421
WA	31.36	6.89	19.40	51.00	30.92	6.87	20.30	45.34		
Height of upper case										
S	5.25	0.97	3.55	7.24	5.45	1.25	3.22	9.29	15.99; 0.0005	3.99; 0.050
WA	5.86	1.34	3.70	8.85	5.65	1.13	3.60	7.83		
Height of lower case										
S	2.31	0.43	1.20	3.21	2.33	0.46	1.20	3.27	10.43; 0.002	11.44; 0.001
WA	2.69	0.67	1.83	4.58	2.32	0.46	1.69	3.16		
Height of ascending letter										
S	4.99	0.84	3.54	7.29	4.92	1.02	3.19	7.51	11.71; 0.001	1.94; 0.168
WA	5.46	1.27	3.59	9.60	5.11	1.20	3.28	7.89		
Height of descending letter										
S	5.48	1.18	3.51	7.66	5.52	1.33	3.22	8.51	13.87; 0.0005	0.13; 0.720
WA	5.80	1.45	3.75	9.63	5.91	1.44	3.69	9.44		
Spacing between words										
S	4.60	1.28	1.14	7.67	4.77	1.77	2.30	9.17	36.11; 0.0005	0.97; 0.328
WA	5.21	1.28	2.54	8.02	5.61	1.69	2.09	9.54		
Number of angularity										
S	2.05	2.11	0.00	10.00	1.15	1.62	0.00	6.00	7.63; 0.007	0.21; 0.644
WA	2.53	2.39	0.00	10.00	1.82	2.08	0.00	10.00		
Number of tremor										
S	2.48	2.21	0.00	10.00	1.94	1.77	0.00	6.00	9.83; 0.002	1.14; 0.289
WA	4.33	4.82	0.00	21.00	2.85	2.67	0.00	10.00		
Number of tapered ends										
S	32.05	19.73	1.00	90.00	39.52	26.75	9.00	107.00	25.45; 0.0005	1.85; 0.178
WA	46.13	25.87	6.00	110.00	47.61	23.49	5.00	117.00		

S: sober, WA: with alcohol, F: test value, P: significance of test.

influence of alcohol; however, it was not significant, statistically.

The results, concerning omission, duplication and displacement of wrong letters, indicated a huge increase under the effect of alcohol, however, only omission showed

significant increase as seen in Table 8. An increase of abnormal use of both upper and lower case letters was observed; however, it was determined that the latter was significant, statistically. No attempt was made to correct these types of errors. Although an increase was found at

Table 4
Range of changing handwriting parameters under the influence of alcohol

Variables	Unchanged (%)	Decreased (%)	Increased (%)
Word length	1.07	20.36	78.57
Height of upper case	1.37	27.4	71.23
Height of lower case	1.37	31.51	67.12
Height of ascending letter	1.37	32.88	65.75
Height of descending letter	0.00	28.77	71.23
Spacing between words	0.00	24.70	75.30
Number of tremor	17.81	20.55	61.64
Number of angularity	32.88	21.92	45.2
Number of tapered ends	1.37	23.29	75.34

Table 5
Correlation between handwriting parameters and alcohol level

	r	P
Word length	0.079	0.509
Height of upper case	0.305	0.009
Height of lower case	0.236	0.044
Height of ascending letter	0.069	0.563
Height of descending letter	0.121	0.306
Spacing between words	0.212	0.072
Number of angularity	0.416	0.0005
Number of tremor	0.032	0.788
Number of tapered ends	0.251	0.032

r: test value, P: significance of test.

Table 6
Correlation between handwriting parameters

	r	P
Word length–height of upper case	0.38	0.001
Word length–height of lower case	0.35	0.002
Word length–height of ascending letter	0.51	0.0005
Word length–height of descending letter	0.41	0.0005
Number of tremor–number of angularity	0.59	0.0005
Number of tremor–number of tapered ends	−0.23	0.0005
Number of tapered ends–number of angularity	−0.30	0.009

r: test value, P: significance of test.

corrections generally, it was not found meaningful at subtle retouching and scribble, except overwritten words. While the retouching and overwriting were made carefully by sober, in no example was any effort made by intoxicated participants to conceal their corrections. Another significant increase was determined to be at use of diacritics such as the use of missing and superfluous diacritics and of unusual shape. A statistically meaningful alteration was also seen at every sort of slurring, such as simplification, flattening, deterioration and abbreviation of letters. The results can be seen in Table 8.

Rhythm did not change after alcohol consumption by 44 participants (72%), whose writings were also rhythmic before alcohol was taken, but the irregularity in rhythm, involving inconsistent slope and/or character size after the use of alcohol, by 17 persons (27.9%) became statistically significant ($P < 0.003$) (Figs. 3 and 4). Although the writing

Table 7
Significance of variation-excess in spacing between lines, words, characters

	Sober	With alcohol	P
Variation in spacing			
Between lines	39.7	65.7	0.001
Between words	31.9	50.0	0.011
Between characters	26.0	58.9	0.0005

P: significance of test.

Table 8
Impairment at other handwriting parameters

Parameters	Sober	With alcohol	P
Alignment to margins	0.2	38.4	0.008
Alignment of words to baseline	31.0	69.9	0.001
Misspelling	33.0	42.5	0.230
Omission of characters	8.0	23.0	0.013
Duplication of characters	23.0	30.0	0.267
Displace of wrong characters	22.0	29.0	0.424
Abnormal use of upper case letters	25.0	29.0	0.508
Abnormal use of lower case letters	4.0	16.0	0.004
Corrections			
Subtle retouching	23.0	34.2	0.169
Overwritten word	26.0	50.7	0.001
Scribble	7.0	15.0	0.180
Diacritics			
Missing diacritics	30.0	46.6	0.012
Unusual shape	5.0	14.0	0.031
Superfluous diacritics	4.0	17.0	0.012
Slurring			
Simplification	1.0	14.0	0.004
Flattening	3.0	25.0	0.001
Deterioration	3.0	22.0	0.001
Abbreviation	5.0	18.0	0.004

P: significance of test.

quality of a few seemed to get better after alcohol consumption, the impairment was found significant ($z \frac{1}{4} 5.46$; $P \frac{1}{4} 0.001$; Wilcoxon signed rank test) (Figs. 2 and 4). Surprisingly, at the pen pressure the changing was not meaningful ($\chi^2 \frac{1}{4} 6.14$; $P \frac{1}{4} 0.119$; Pearson Chi square test).

4. Discussion

Because handwriting is arranged mentally and performed neuro-muscularly, it is affected by alcohol consumption. The effect of alcohol specifically occurs first in the frontal lobe, which removes the superego control, and then in the cerebellum. Thus, all hierarchical pressings and restrictions are due to authority decrease. This causes emotional, behavioral, psycho-neuro-motor and cognitive changes, such as euphoria, logorrhea, an increase in self-confidence, emotional exaggeration, tremor, obvious unskillful movements, a lack of synergic movements, difficulties in pupil accommodation, ataxic movements depending upon the level of alcohol [8].

These data suggest that physical and psychological effects of alcohol are indeed reflected in handwriting and can be predicted by the selected handwriting characteristics. These changes on handwriting depending upon the effect of alcohol present special problems to the document examiner in evaluating the authenticity of handwriting and in judging whether the writer was sober or intoxicated.

Ege'de Bahar 1931 2344 691

Agyon'dan Denizli yönüne doğru 20 km
kadar yaklaşmıştık ki kendimizi demiryolu
nu atlayıp tarla bahçeler arasına
dalan yolda bulduk

İki yanımızı süsleyen erken bahar niç
değil mi papatyalar ve gelincikler biçi
Eski hisar köyüne dek çekip götürdük
Böylece ilk çay molasını köy kahvesi
(a) de vermiş olduk.

Agyon'dan Denizli yönüne doğru 20 km
kadar yaklaşmıştık ki kendimizi demiryolu
nu atlayıp tarla bahçeler arasına
dalan yolda bulduk.

İki yanımızı süsleyen erken bahar
niç değil mi papatyalar ve gelincikler
biçi Eski hisar köyüne dek çekip
götürdük. Böylece ilk çay molasını
(b) köy kahvesinde vermiş olduk.

Fig. 1. Woman, 55 years old, married, teacher, university degree educated: (a) sober handwriting; (b) handwriting under the influence of alcohol (alcohol level: 76 mg/100 ml). The variation in spacing between words, characters and lines can be seen respectively from top to bottom.

Almost all authors agree with the increase in size, carelessness, casualness, deterioration, spacing of writing and decline in legibility at handwriting written under the effect of alcohol [1–3,9–11]. Unfortunately, in these studies descriptive terms, such as “a few” or “increased” have been used to describe the results. Phrases, like “appeared more”, “observed seldom” or “did not appear” have been also used without sufficient statistically evaluation. Although, in previous studies at least 42% of the participants' samples demonstrated an increase in size [9], this work shows an

increase at the range of 65.75% in ascending letters and 78.57% at word length (Table 4).

An increase in errors, corrections and omissions displayed by 51% of the participants [2] and additionally only 8% of the samples in mixing upper and lower case letters [10]; however, this work shows an increase of total 45.2% in mixed upper and lower case letters, and in the mean time, there is an increase in errors and corrections by 23 participants (31.5%).

The consensus within the previous studies shows that the alcohol level is not a proper indicator of the effects on an

(a)
 Afyon'dan Denizli yönüne doğru 20 km kadar
 uzaklaşmıştık ki kendimizi demiryolunu atlayıp
 Turunç bahçeleri arasına dalar yolda bulduk
 İki yanımızı süsleyen erken bahar müjdecileri
 Papatyalar ve gelincikler, bizi Eskişehir
 köyüne dek. Çekip götürdü Böylece ilk
 Çay. molamız köy kahvesinde vamaş,
 oldu

(b)
 Afyondan. Denizli yönüne 20 km. kadar.
 uzak. laşmıştık ki kendimizi demiryolunu.
 Atlayıp. Turunç bahçeleri arasına. dalar
 yoldan. bulduk.
 İki yanımızı süsleyen. erken.
 bahar. müjdecileri. papatyalar. ve.
 gelincikler. bizi Eskişehir
 köyü dek. Çekip. götürdü Böylece ilk
 Çay molamız köy kahvesinde
 kermiş olduk.

Fig. 2. Man, 39 years old, married, worker, only 5 year educated: (a) sober handwriting; (b) handwriting under the influence of alcohol (alcohol level: 148 mg/100 ml). Variation in spacing between characters and lines are marked. Enlargement of writing and decrease in writing quality are determined.

individual's handwriting [2]. Indeed, we observed some participants with a low blood alcohol concentration, whose handwritings have been deteriorated greatly, but conversely some others showed a few changes. However, we have found a statistically correlation between alcohol level and increasing of the height of upper and lower case letters, the number of angularity and tapered ends (Table 5). In our opinion, especially the measurement of upper case letters and the

count of angularity may be a predictive test of the alcohol consumption level. People were known susceptible to the effects of alcohol on motor performance at levels more than 50 mg/100 ml and were allowed to drive below this level in Turkey, but our data strongly confirm, that any level of alcohol, even below 50 mg/100 ml may cause handwriting changes.

In questioned document field, an increase at the amount of tapered ends (tapered beginnings and conclusions of

EĞEDE BAHAR

Afyon'dan Denizli yönüne doğru 20 km kadar uzaklaşmıştık ki kenarımızı demiryolunu atlayıp tarımın bahçeleri arasında dalan yolda bulduk. İki yanımızı süsleyen erken bahar meyveleri papatyalar ve gelincikler, bizi Eskişehir köyüne dek çekip götürdü. Böylece ilk çay molamızı. (a) köy kahvesinde vermiş olduk.

Afyon'dan Denizli yönünde doğru 20 km kadar uzaklaşmıştık ki kenarımızı Demiryolunu atlayıp tarımın bahçeleri arasında dalan yolda bulduk. İki yanımızı süsleyen erken bahar meyveleri papatyalar ve gelincikler, bizi eskişehir köyüne dek çekip götürdü. İlk çay molamızı (b) köy kahvesinde vermiş olduk.

Fig. 3. Man, 53 years old, married, technician, high school degree: (a) sober handwriting; (b) handwriting under the influence of alcohol (alcohol level: 127 mg/100 ml). Irregularity in rhythm is significant, especially in character size.

strokes) is known as an indicator of the speed of handwriting [12]. In this study, a significant increase (75.34%) at the amount of tapered ends was seen after alcohol consumption ($F \frac{1}{4} 25:45$; $P \frac{1}{4} 0:0005$).

The Galbraith [2] study, in which a nursery rhyme was timed, 70.76% of the persons needed more time after drinking. But in the same study, two of the control volunteers were nondrinkers; one of them still needed more time than the other. These results are thought to reveal that persons under the effect of alcohol are writing faster, due to euphoria and increasing self-confidence; nevertheless, they may spend more time at the relaxation interval because of decreased concentration.

The increase in the amount of tremor and angularity, as well as impairment of alignment control suggest physical

difficulties in manipulating the pen. If a limited document, which contains these signs, has been a problem of authenticity, one must be carefully with discriminative diagnoses like neurologic disorders, such as Parkinson and multiple sclerosis. It must be looked over for the lack of fluency, slowness, careful and deliberate writing contrary to carelessness and casualness, also seen in handwriting under the effect of alcohol [12,13]. One may say, that the intoxicated and the neurological ill persons' handwriting are different from each other; one represents loss of control due to relaxation, the other one loss of control due to tension [11].

None of the alterations mentioned above can be attributed to the effects of alcohol intake alone. However, the presence of some alterations together is strongly suggestive that the person was under the influence of alcohol.

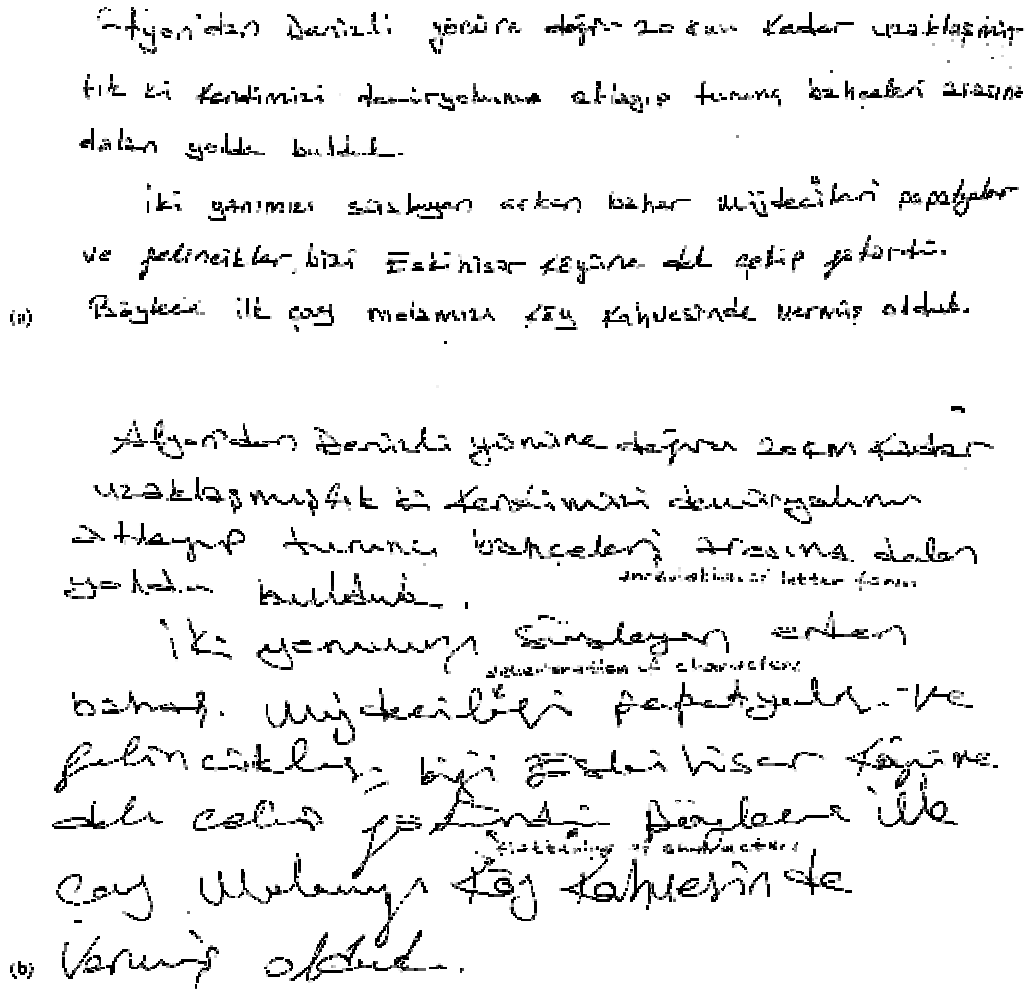


Fig. 4. Man, 33 years old, married, worker, high school educated: (a) sober handwriting; (b) handwriting under the influence of alcohol (alcohol level: 196 mg/100 ml). Irregularity in rhythm is significant, especially in character size. Enlargement of writing and decrease in writing quality are significant with slurring.

First of all, the duty of handwriting examiner is to identify if the questioned and known sample are coming from the same source. Consequently, as this explanatory analysis suggests that differences between sober and intoxicated persons can be identified in handwriting, but the examiner's judgement must be proportionately cautious, keeping in mind the abnormally wide range of variation expected.

Acknowledgements

We thank the participants of Sarkuysan Group of Company for making this work possible and the President Hayrettin Çaycı for his valuable support.

References

- [1] O. Hilton, A study of alcohol on handwriting, *J. Forensic Sci.* 14 (1969) 309–316.
- [2] N.G. Galbraith, Alcohol: its effect on handwriting, *J. Forensic Sci.* 31 (1986) 580–588.
- [3] O. Hilton, *Scientific Examination of Questioned Documents*, Elsevier, Amsterdam, 1984, pp. 322–323.
- [4] D.E. Boatwright, Triazolam, handwriting, and amnestic states: two cases, *J. Forensic Sci.* 32 (4) (1987) 1118–1124.
- [5] T.S. Lewinson, Handwriting analysis in diagnosis and treatment of alcoholism, *Percept. Mot. Skills* 62 (1986) 265–266.
- [6] R.L. Watkins, J. Gorajczyk, The effect of alcohol concentration on handwriting, in: *Proceedings of the Annual Meeting*

- of the American Academy of Forensic Sciences, February 19–24, Nashville, Tennessee, 1996.
- [7] E.S. Geller, S.W. Clarke, M.J. Kalsher, Knowing when to say when: a simple assessment of alcohol impairment, *J. Appl. Behav. Anal.* 24 (1991) 65–72.
- [8] M.A. Schuckit, Alcohol and alcoholism, in: E. Braunwald (Ed.), *Harrison's Principles of Internal Medicine*, 11th ed., McGraw-Hill, NY, 1987, pp. 2106–2108.
- [9] M.D. Stinson, A validation study of the influence of alcohol on handwriting, *J. Forensic Sci.* 2 (1997) 411–416.
- [10] D.M. Duke, B.B. Coldwell, Blood alcohol levels and handwriting, in: *Proceedings of the Joint Meeting of the Royal Canadian Mounted Police and the American Society of Questioned Document Examiners*, Ottawa, Ont., Canada, 1965.
- [11] J. Beck, Handwriting of the alcoholic, *Forensic Sci. Int.* 28 (1985) 19–26.
- [12] J. Walton, Handwriting changes due to aging and Parkinson's syndrome, *Forensic Sci. Int.* 88 (1997) 197–214.
- [13] J.P. Wellingham, Characteristics of handwriting of subjects with multiple sclerosis, *Percept. Mot. Skills.* 73 (1991) 867–879.