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The Effects of Constraining Signatures

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Forensic document examiners are often asked to determine the authenticity or otherwise of signatures on official government forms, most of which use a line or box for the signature space; but the extent to which such lines and boxes affect a natural signature is relatively unknown. Six types of constraints encountered in everyday signature examinations were investigated. All constraints significantly affected the size of the signatures, and anomalies appeared in the constrained signatures (extra artifacts, reduction in complexity, lack of fluency, and hesitation marks).

Introduction

Most official documents which require a signature have a line or box to indicate where the signature should appear. Often the boxes and lines are so restricted that a person's normal signature will not fit into the allotted space. Some forms (such as the current Passport Canada Adult General Passport Application) are void if the signature even touches the border of the box. Anecdotal evidence suggests that signing under such conditions may be affected either by physical limitations or psychological pressure or both as writers alter their signature to fit the circumstances. The extent to which this occurs has been little studied, even though many such signatures are intended for authentication purposes of important documentation.

Forensic document examiners, particularly those at Canada Border Services Agency, are often asked to determine the authenticity of a signature on an official government form such as the Canada Revenue Agency T1 Income Tax and Benefit Return which may have been filled out fraudulently in order to fund illegal activities. If a writer changes his or her signature to suit the circumstances of the form being signed, there is a possibility that it could lead a forensic document examiner to erroneous conclusions when determining whether the signature is genuine or a simulation.

Little is known about how much these lines and boxes change a person's signature. In a study on crowded signatures, Morton (1980) concluded that subjects' signatures changed only a little when lateral and vertical restrictions were imposed on the signature space. Whether this degree of change was sufficient for a document examiner to make a misleading conclusion was not addressed. Other publications on this topic are largely opinion-based, and it is generally concluded that the comparison of a constrained signature and an unconstrained signature will complicate the process (Doud 1981, Lacy 1961, Osborn 1988, Ruenes 1968). It is known that a person's signatures naturally vary and that they are never exactly replicated (Evett and Totty 1985). Their study found that the between batch variation of signatures collected over a 36-month period was statistically significant. However, it is not known if constraint changes a signature more than it would change naturally. Other circumstances affecting a person's signature have been studied including the effects of alcohol (Asicioglu and Turan 2003) and the effects of neurological diseases such as Parkinson's syndrome (Walton 1993).

The purpose of this study was to examine the changes that people made to their signatures in order to fit into certain defined-dimension boxes on forms currently used by the Government of Canada and to determine whether those changes are statistically significant. This study examined the effects of several different types of constraint.

Materials and Methods

A stratified sample of 30 volunteers, mainly student participants from the University of Ontario Institute of Technology, provided a total of 5,400 signatures under different conditions. Human ethics approval was obtained from the university to use human subjects (REB #08-022). A brief background of each subject was obtained in the form of a participant questionnaire. All subjects had no known health issues that might have affected their normal writing style. Subjects were between the ages of 19 and 25 and in the process of completing their post-secondary education. The subjects were told at the beginning of the study that their participation would be anonymous to every extent possible and that the raw data would not leave the university.

Six different constraint conditions, ranging from least to most constrained, were investigated as follows. Signatures were collected on a blank sheet of paper; on a blank sheet of paper bearing centrally a 4.7 cm line (analysing the effect of constraint when only the horizontal axis was constrained); on a blank sheet of paper bearing centrally a 6 cm by 1.2 cm box (similar in dimensions to the signature sections of forms such as the Record of Medical and Personal Expenses from Manitoba Public Insurance and the Alberta Application for Access to Motor Vehicle Data); on a blank sheet of paper bearing centrally a 4.8 cm by 0.96 cm box (generally consistent in size with the signature sections of forms such as the Canada Revenue Agency Notice of Objection (GST/HST) and the Government of Canada Security Clearance form); on a sheet of text bearing a 6.4 cm line with a vertical space of 0.4 cm between the line and the text above, situated towards the bottom of the page (mimicking the current Canada Revenue Agency T1 Income Tax and Benefit Return (Figure 1) and the Canada Border Services Agency Declaration Card); and in a box scanned from the current Passport Canada Adult General Passport Application (PPTC 153 (09-04) M02) (measuring 7.5 cm by 1.5 cm) (Figure 2). The blank sheet of paper served as a control sample with which to compare the constrained signatures but also mirrors the type of known specimens sometimes submitted to the forensic document examiner for analysis. With the exception of the latter "line within text" and "passport" boxes, all boxes were devoid of any surrounding text to minimize distractions.

The Passport Canada Adult General Passport Application signing box contains clear instructions stating that signatures are void if they touch the border. In this study, if any part of the subject's signature touched the border of this particular box, the signature was discarded and the subject asked to provide another since Passport Canada rejects an application bearing a signature outside the delineated boundary. In all other constraint situations, subjects were asked to sign within the space provided and not given specific instructions. Replicate signatures were collected on separate sheets of paper using similar ballpoint pens. Ballpoint ink was chosen because it lends itself to discrimination of fine detail char-

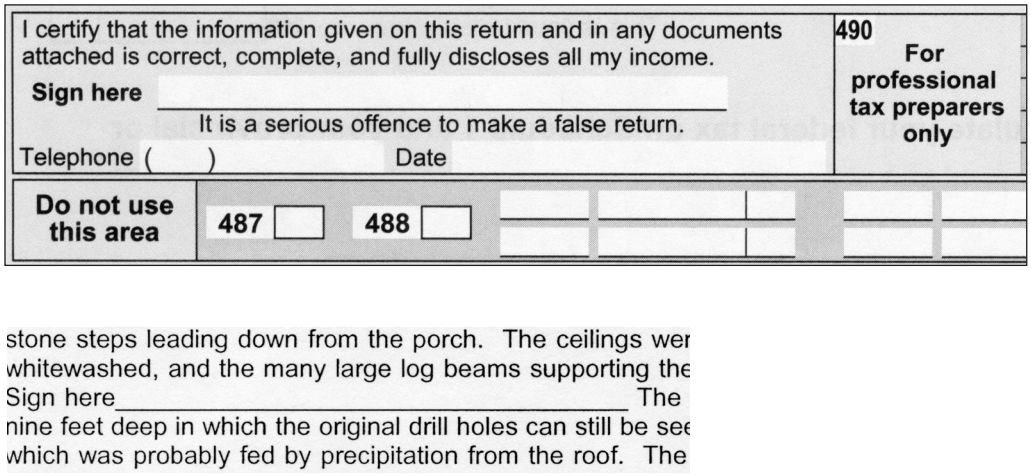


Figure 1 Line within text (portion only) (lower); T1 General 2005 signature box (upper) (neither to scale).

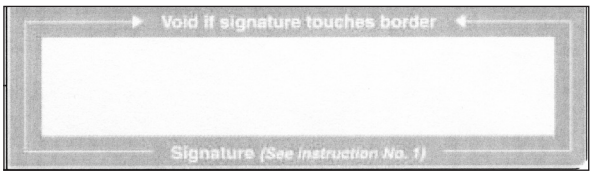


Figure 2 Passport Canada Adult General Passport Application signature box (not to scale).

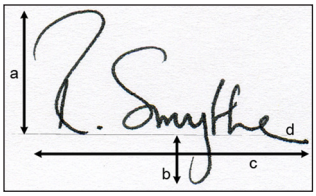


Figure 3 Measurement of ascender (a), descender (b) and overall length of signature (c) against an imaginary baseline (d).

acteristics (Hilton 1984). Signatures were scanned at 800 dpi in greyscale (8-bit, 256 levels) using a Canon© CanoScan LiDE 25 scanner to produce a digital TIFF copy of each ink signature.

Thirty signatures were obtained under each of the 6 constraints, producing a total of 180 signatures per subject. To avoid batch preparation effects, subjects were asked to provide no more than 6 signatures per day, 3 signatures per sitting, with no less than 6 hours between sittings. "Batch preparation effect" in sequentially written signatures can produce greater regularity and consistency since the influences on handwriting variation are less than when signatures are signed at different times (Foley 1987). This protocol replicated conditions in which government forms are normally signed only once, with little "batch effect."

Seated subjects signed 1 of 2 sets of forms. The 1st consisted of the 4.7 cm line, the 6 cm by 1.2 cm box, and passport application box. The 2nd consisted of the blank sheet, the 4.8 cm by 0.96 cm box, and the 6.4 cm line within text. Signatures were collected daily when possible, subject to writer availability. Whilst signing the forms, the subjects were observed. Visible hesitations when presented with a constrained area, retouches during signing, and the ease of writing were noted. Also noted was simplification of the signature and physical differences such as differences in slant or abbreviations in the signature.

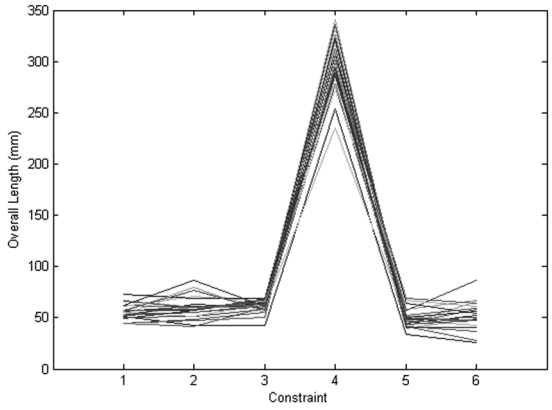
Digital images of signatures were measured using GNU Image Manipulation Program (GIMP) 2.6.4, and accuracy confirmed using an 8X magnifying loop fitted with a 10 mm ruler. The images were not altered in any way using this program since only the measurement tool was used. Measurements included the length of the tallest ascender (height of tallest character), the length of the lowest descender (depth of lowest character), overall length of signature, and changes in proportion of the characters in relation to an imaginary baseline if absent (Figure 3).

Results

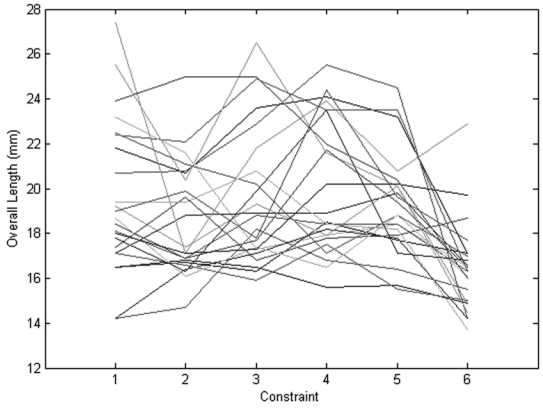
General changes observed in the constrained signatures were a reduction in overall size, reduction in height of ascenders and descenders, abbreviation of the first name, and an increase in overall length of signature in the passport box. Some writers showed a greater range of variation amongst replicates than others (Figures 4a-d). Reduction in overall size occurred most often in the 4.8 cm by 0.96 cm box and the 6.4 cm line within text (Figure 5). Reduction in height of ascenders and descenders occurred in all 3 boxes and the 6.4 cm line within text (Figure 6). Abbreviations of the first name were used by 5 of the participants, and only 1 participant did not abbreviate his 1st name when signing the blank sheet of paper. The increase in the overall length of the signature for the passport box was a general trend among all participants (Figure 7).

Specific anomalies observed in the constrained signatures included artifacts indicating an extra movement, reduction in complexity, lack of fluency, and hesitation marks. The addition of extra artifacts was consistently found in 10% of participants (3 individuals). Extra artifacts generally occurred in the passport-sized box and the 4.8 cm by 0.96 cm sized box (Figure 8). Within this group of participants, the highest occurrence of an extra artifact was in 19 signatures (11%) for the same participant, in either the passport-sized box, the 6 cm by 1.2 cm box or the 4.8 cm by 0.96 cm box). Reduction in complexity (measured subjectively as an omission of signature details) was highest in 43 signatures (24%) relating to 1 participant. These reductions in complexity were seen in only the passport-sized box, the 6 cm by 1.2 cm sized box, the 4.8 cm by 0.96 cm box, and the 6.4 cm line within text (Figure 9). Lack of fluency occurred most frequently, ranging from only the 1st few replicates of the passport-sized signature for some individuals, to every replicate for 1 individual (Figure 10). Hesitation marks (pen

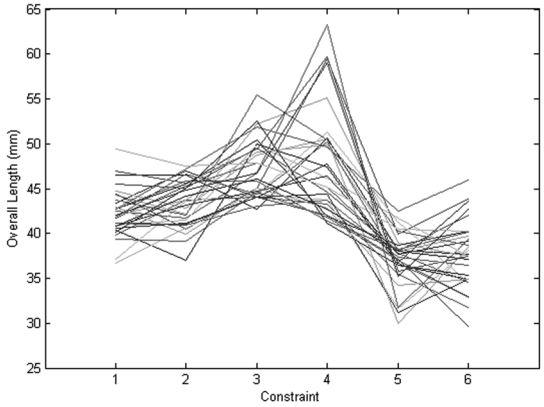
Figure 4 (a-d) Overall length of signatures (mm) for 4 writers under the different forms of constraint (1: line; 2: 6cm x 1.2cm box; 3: passport form; 4: blank sheet; 5: 4.8cm x 0.96cm box; 6: line in text).



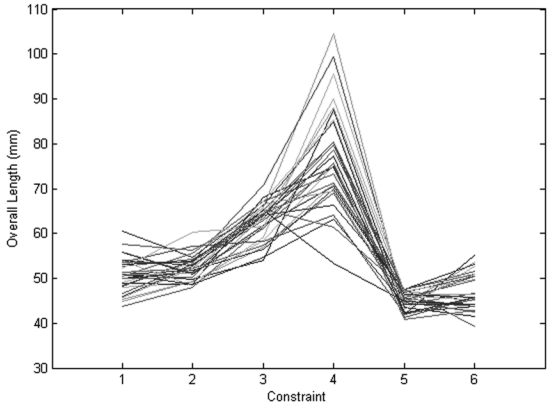
Person 4



Person 5



Person 17



Person 22

stops) were also found in only the passport-sized box and only in small amounts (Figure 11).

Non-parametric methods were used for a within-subjects-repeated-measures analysis (Appendix A). A non-parametric test is a test that is distribution-free; i.e., there are no assumptions made about the distribution of the data. A within-subjects-repeated-measures design is a study that takes repeated measures from the same unit (person) under different conditions (constraints). Twelve separate analyses were performed on the 3 different response variables (overall length, ascender length, descender length) that were subjected to all 6 constraints; that is, for each response variable, the analysis was replicated 4 times using data from 4 randomly chosen replicates. Friedman tests were performed to investigate whether or not there were differences in signature characteristics under different constraints, and *post hoc* tests using methods from W.J. Conover (1999) were performed subsequently to detect where the differences lay.

Discussion

The general characteristics seen in Figures 4, 5, and 6 show the general adaptations people make to fit their signatures into a constrained space. In most cases these adaptations did not greatly affect the appearance of the signatures when compared to the unconstrained signatures and would probably not lead a qualified forensic document examiner to an erroneous conclusion. Signatures in the passport-sized box were, on average, longer

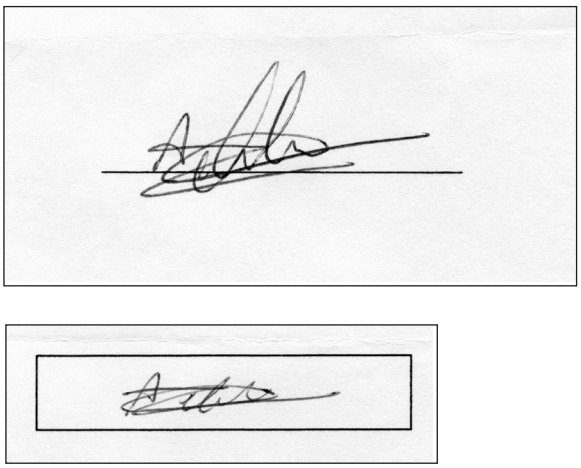


Figure 5 General reduction in size in box (constrained signature shown in lower box) (not to scale).

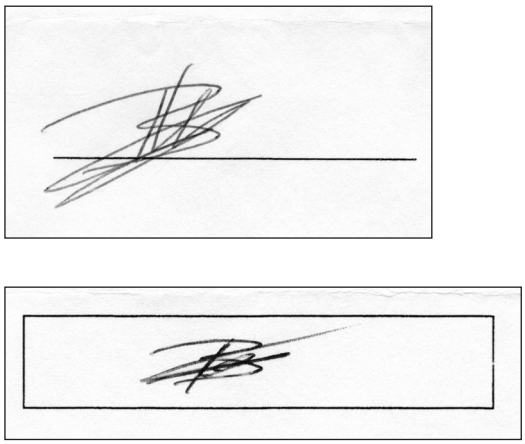


Figure 6 Reduction of ascenders and descenders (constrained signature shown in lower box) (not to scale).

than all other constrained signatures, perhaps to compensate for the stipulation that the signature could not touch any of the borders of that particular box. Throughout the study, subjects would frequently comment that they had to stop and think before signing in that particular box to make sure that they did not touch the borders with their signature. In the future, this experiment will be repeated to measure the speed and time taken for the passport-sized box on a tablet computer. That participants admitted to consciously thinking about their handwriting may explain this difference for the signatures in the passport-sized box.

Another general observation is the similarity between average measurements for the 4.7 cm line and the 6 cm by 1.2 cm box, and the averages for the 4.8 cm by 0.96 cm box and the 6.4 cm line within text. These similarities may be because those combinations of forms were signed in the same sitting. Since these were always given in the same order, this may have had an effect on the way the subjects altered their signatures to fit the given circumstances. In future studies it would be beneficial to randomise the combinations.

The specific anomalies seen in Figures 8, 9, 10, and 11 illustrate random occurrences found in the constrained signatures which could potentially lead a forensic document examiner to make an incorrect conclusion. Extra artifacts, reduction in complexity, and hesitation marks were seen in varying consistencies; and if these anomalies were present in a signature where authenticity was in question, it might lead an examiner to conclude that the signature was a simulation when in fact the signature was genuine. The lack of fluency seen in Figure 10 is the feature that could potentially make the most difficulty for a document examiner or other official, since the signature in the passport-sized box gives the appearance of a poorly attempted forgery. Although in this study lack of fluency tended to lessen with repetition, in 1 participant fluency never resumed.

These observations were not seen in previous studies [Morton 1980], probably due to fewer participants and replicates. All Friedman tests showed that there were statistically significant differences between the constraints at the 5% confidence level; that is, the constraints do not have identical effects on overall length, ascender length, and descender length of signatures. Of the 12 different *post hoc* tests, almost all indicated a significant difference between the effects of the control and the effects of the other 5 constraints on the overall length, descender length, and ascender length. In other words, the *post hoc* tests showed that signature characteristics (overall length, descender length, and ascender length) under each of the 5 constraints are significantly different (at the 5% confidence level) from the 6th (control) constraint (Appendix A).

The findings have implications for document integrity generally in instances where a signature (either ink or biometric electronic) is used for authentication or verification purposes. Unless an "official" specimen signature is representative of an individual's range of variation of naturally executed signatures, a subsequently proffered one may bear little resemblance to it. Designers

Figure 7 Increase in overall signature length in passport box (right) (not to scale).

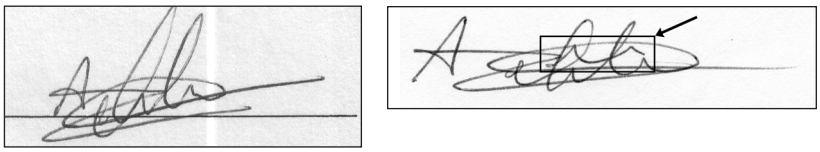


Figure 8 Extra artifact in passport box (right, in box) (not to scale).

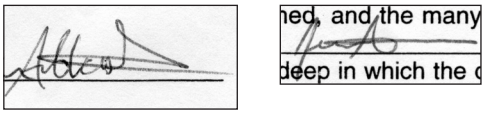


Figure 9 Reduction in complexity on line within text (right) (not to scale).

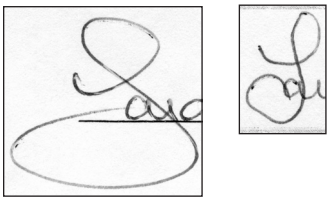


Figure 10 Lack of fluency in passport box (right) (not to scale).

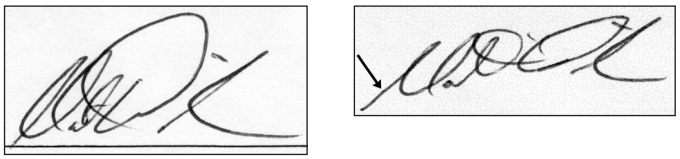


Figure 11 Hesitation mark in passport box (right) (arrowed) (not to scale).

of such documents should be made aware of these issues to produce documents that allow for incorporation of more "natural" signatures.

Limitations to this study have been identified. Firstly, all participants were between the ages of 20 and 25 with a university education. Any future study should be conducted over different age and education ranges. Secondly, only 2 participants were left-handed, so the effect of handedness on constrained signatures could not be investigated. Thirdly, with the exception of 2 participants, all participants' first language was English. Other future considerations include using other examples of constraint from government forms of other countries or other frequently used documents, as well as a signature complexity calculation (Sita, Rogers and Found 2003). Using fewer replicates would reduce the possibility of fatigue or acclimation to the constraint by the participant without adversely affecting statistical significance.

Conclusion

The constraints used in the study were found to have various significant effects on participants' signatures. The general adaptations made by all participants (such as changes in signature size in the constrained spaces) would probably not lead a qualified forensic document examiner to draw an incorrect conclusion but might reduce the certainty of any conclusion given. The random anomalies, however, such as addition of extra artifacts, reduction in complexity, lack of fluency, and hesitation marks, represent significant potential pitfalls which could lead some forensic document examiners to draw incorrect conclu-

sions. It is important that all forensic document examiners be aware that such anomalies readily occur in both known and questioned constrained signatures. This study underlines the necessity in signature comparisons for known and questioned specimens written under similar conditions. Without this, forensic document examiners must exercise extreme caution.

Acknowledgements

The authors would like to acknowledge Dr. Shari Forbes, Assistant Professor (Chemistry/Forensic Science), University of Ontario Institute of Technology for her strong support and interest; Tobin Tanaka, Canada Border Services Agency, for the original idea, support and advice; and all the participants in the study for their much appreciated help.

References

Asicioglu F, Turan N (2003). Handwriting Changes Under the Effect of Alcohol. *Forensic Science International,* Vol. 132, pp. 201-210.

Conover W J (1999). *Practical Nonparametric Statistics*, 3rd ed., John Wiley & Sons, Inc., New York, pp. 369-373.

Doud D (1981). Examination of Union Authorization Card Signatures. Presented at the meeting of the American Society of Questioned Document Examiners, Houston.

Evett I, Totty R (1985). A Study of the Variation in the Dimensions of Genuine Signatures. *Journal of the Forensic Science Society*, Vol. 25, pp. 207-215.

Foley R (1987). Characteristics of Synchronus Sequential Signatures. *Journal of Forensic Sciences*, Vol. 32, No. 1, pp. 121-129.

Hilton O (1984). Effects of Writing Instruments on Handwriting Details. *Journal of Forensic Sciences*, Vol. 29, No. 1, pp. 80-86.

Lacy G (1961). The Significance of Location of a Signature on a Document. Presented at the meeting of the American Society of Questioned Document Examiners.

Morton S (1980). How Does Crowding Affect Signatures? *Journal of Forensic Sciences*, Vol. 25, No. 5, Part 1, pp. 141-145.

Osborn J (1988). A Study of Gasoline Credit Card Receipt Signatures Affected by Adverse Conditions. Presented at the meeting of the American Academy of Forensic Sciences, New York.

Ruenes R (1968). Shrinking and Stretching of Handwriting. Presented at the meeting of the American Society of Questioned Document Examiners, Lexington.

Sita J, Rogers D, Found B (2003). A Model Using Complexity Classification, Spatial Score and Line Quality for Forensic Signature Comparison. Proceedings of the 11th Conference of the International Graphonomics Society, Scottsdale, Arizona.

Walton J (1997). Handwriting Changes Due to Aging and Parkinson's Syndrome. *Forensic Science International,* Vol. 88, pp. 197-214.

Appendix A: Friedman Tests and Post Hoc Tests

Overall Length- Replicate 1

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The FREQ Procedure

Summary Statistics for Constraint by OL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	19.3927	<.0001
2	Row Mean Scores Differ	5	93.7584	<.0001

Overall Length - Replicate 8

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The FREQ Procedure

Summary Statistics for Constraint by OL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	14.9490	0.0001
2	Row Mean Scores Differ	5	84.1595	<.0001

Overall Length - Replicate 20

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The FREQ Procedure

Summary Statistics for Constraint by OL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	7.6786	0.0056
2	Row Mean Scores Differ	5	70.6842	<.0001

Overall Length - Replicate 26

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The FREQ Procedure

Summary Statistics for Constraint by OL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	12.0127	0.0005
2	Row Mean Scores Differ	5	59.2803	<.0001

Ascender Length- Replicate 2

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The FREQ Procedure

Summary Statistics for Constraint by AL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	31.5679	<.0001
2	Row Mean Scores Differ	5	93.1328	<.0001

Ascender Length - Replicate 10

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The FREQ Procedure

Summary Statistics for Constraint by AL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	26.4981	<.0001
2	Row Mean Scores Differ	5	81.0876	<.0001

Ascender Length - Replicate 11

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The FREQ Procedure

Summary Statistics for Constraint by AL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	32.8859	<.0001
2	Row Mean Scores Differ	5	92.9674	<.0001

Ascender Length - Replicate 17

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The FREQ Procedure

Summary Statistics for Constraint by AL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	24.5529	<.0001
2	Row Mean Scores Differ	5	79.9235	<.0001

Descender Length - Replicate 10

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The FREQ Procedure
Summary Statistics for Constraint by DL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.1069	0.7437
2	Row Mean Scores Differ	5	35.8060	<.0001

Descender Length - Replicate 21

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The FREQ Procedure

Summary Statistics for Constraint by DL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	0.8597	0.3538
2	Row Mean Scores Differ	5	35.8853	<.0001

Descender Length - Replicate 24

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The FREQ Procedure

Summary Statistics for Constraint by DL
Controlling for Person

Cochran-Mantel-Haenszel Statistics (Based on Rank Scores)

Statistic	Alternative Hypothesis	DF	Value	Prob
1	Nonzero Correlation	1	3.8611	0.0494
2	Row Mean Scores Differ	5	45.9938	<.0001

Signature Characteristic	Replicate	Comparison of Constraints	Post Hoc Calculated Value	Post Hoc Critical Value	Statistical Conclusion	Conclusion
Overall Length	1	1 vs 4	57	17.84426	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	69.5	17.84426	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	40.5	17.84426	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	117	17.84426	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	112	17.84426	Reject Null	Constraint 6 differs from Constraint 4
Overall Length	8	1 vs 4	64	18.59078	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	60.5	18.59078	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	31	18.59078	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	100	18.59078	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	112.5	18.59078	Reject Null	Constraint 6 differs from Constraint 4

Overall Length	20	1 vs 4	63.5	20.84568	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	65.5	20.84568	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	24	20.84568	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	89.5	20.84568	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	101.5	20.84568	Reject Null	Constraint 6 differs from Constraint 4
Overall Length	26	1 vs 4	49.5	22.68479	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	36.5	22.68479	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	8	22.68479	Do not reject Null	Constraint 3 is the same as Constraint 4
		5 vs 4	79	22.68479	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	85	22.68479	Reject Null	Constraint 6 differs from Constraint 4
Ascender Length	2	1 vs 4	29.5	17.94323	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	70.5	17.94323	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	41.5	17.94323	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	90.5	17.94323	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	122	17.94323	Reject Null	Constraint 6 differs from Constraint 4
Ascender Length	10	1 vs 4	29.5	19.67672	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	66	19.67672	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	35.5	19.67672	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	87.5	19.67672	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	111.5	19.67672	Reject Null	Constraint 6 differs from Constraint 4
Ascender Length	11	1 vs 4	29.5	17.76606	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	67	17.76606	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	61.5	17.76606	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	95	17.76606	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	123	17.76606	Reject Null	Constraint 6 differs from Constraint 4
Ascender Length	17	1 vs 4	34	19.90894	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	66	19.90894	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	49.5	19.90894	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	83	19.90894	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	118.5	19.90894	Reject Null	Constraint 6 differs from Constraint 4

Descender Length	6	1 vs 4	16.5	22.01951	Do not reject Null	Constraint 1 is the same as Constraint 4
		2 vs 4	71.5	22.01951	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	54.5	22.01951	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	82.5	22.01951	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	72	22.01951	Reject Null	Constraint 6 differs from Constraint 4
Descender Length	10	1 vs 4	47	24.52434	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	69	24.52434	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	51	24.52434	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	72.5	24.52434	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	60.5	24.52434	Reject Null	Constraint 6 differs from Constraint 4
Descender Length	21	1 vs 4	40.5	24.97714	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	59.5	24.97714	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	56	24.97714	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	80	24.97714	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	55	24.97714	Reject Null	Constraint 6 differs from Constraint 4
Descender Length	24	1 vs 4	30	23.36874	Reject Null	Constraint 1 differs from Constraint 4
		2 vs 4	57	23.36874	Reject Null	Constraint 2 differs from Constraint 4
		3 vs 4	66.5	23.36874	Reject Null	Constraint 3 differs from Constraint 4
		5 vs 4	84	23.36874	Reject Null	Constraint 5 differs from Constraint 4
		6 vs 4	59.5	23.36874	Reject Null	Constraint 6 differs from Constraint 4