Is visual imagery ability higher for orthodontic students than those in other disciplines? A cross-sectional questionnaire-based study.

Robert S. D. Smyth[a], Priti Acharya[b], Nigel P. Hunt[a]

[a]*UCL Eastman Dental Institute, London, UK* [b]*Eastman Dental Hospital (UCLH), London, UK*

Correspondence Address: Robert Smyth, Orthodontic Unit, UCL Eastman Dental Institute, 256 Gray's Inn Road, London, WC1X 8LD, United Kingdom.

Email Address: robert.smyth.16@ucl.ac.uk

Is visual imagery ability higher for orthodontic students than those in other disciplines? A cross-sectional questionnaire-based study.

Objective: The objective of the study was to investigate the effect visual imagery may have on career choice amongst current university students across a range of subjects and disciplines.
Setting: University College London (UCL), United Kingdom.
Design: Cross-sectional questionnaire-based study.
Participants: The study compared four main groups of University College London students; current students at the Slade School of Fine Art, UCL Eastman Dental Institute, UCL Bartlett School of Architecture and the Faculty of Laws.
Method: A questionnaire based on the Vividness of Visual Imagery Questionnaire (VVIQ) was distributed along with questions regarding demographic information.
Results: There were no significant differences between the VVIQ scores across the four included Schools/Faculty; The Slade School of Fine Art, UCL Bartlett School of Architecture, Faculty of Laws and UCL Eastman Dental Institute, $F(3,219) = 2.160$, $p = .094$. There were also no significant differences in the scores for the Eastman ($M = 60.21$, $SD = 13.58$) and the three other Schools/Faculty ($M = 62.87$, $SD = 10.96$); t(-1.317) = 221 $p = .189$, and no significant difference in the scores for the Orthodontic students ($M = 60.80$, $SD = 13.39$) and the remaining other included students ($M = 61.44$, $SD = 9.68$); t(-0.232) = 221 $p = .817$. Aphantasia was uncommon in this sample, with a prevalence of 0.9%. A positive correlation was found between age group and total VVIQ score, with older participants scoring higher on the VVIQ. Females were significantly more likely to say that their ability to visualise had affected their career choice than male respondents.
Conclusions: There were no significant differences between the VVIQ scores across the four included Schools/Faculty. Visual imagery ability did not differ in Dental or Orthodontic students in comparison to other student groups. Further work is needed to replicate these findings in more diverse samples.

Keywords: visual imagery, aphantasia, hyperphantasia, VVIQ, orthodontics

Introduction

Visual imagery is a salient feature of everyday life - for many people it plays a key role in creativity, memory and daydreaming. The classical Greek term for imagination is *phantasia* which was defined by Aristotle as the 'virtue of which we say that an image occurs to us' (Aristotle et al., 1993). Despite giving importance to imagination and images, Aristotle noted that 'there have been cases of people who have not experienced a single dream in the course of a life-time' (Aristotle and Gallop, 1990). In 2010, a case of imagery generation disorder was reported in a 65 year old man who, following coronary angioplasty, became unable to experience visual imagination (Zeman et al., 2010). This was then discussed in an article in *Discover* magazine (Zimmer, 2010) and, subsequently, more than twenty individuals recognising themselves in the article's account of 'blind imagination' contacted Zeman. The authors proposed the term 'aphantasia' to refer to a condition of reduced or absent voluntary imagery (Zeman et al., 2015). Since Zeman coined this term, there has been a notable increase in research relating to both aphantasia, extremely low or lacking visual imagery ability, and hyperphantasia, extremely high visual imagery ability (Morgan, 2016). Aphantasia is uncommon - there is no published large scale study on the phenomenon and existing evidence is sparse, however 2.1% to 2.7% of 2,500 participants in a survey claimed no visual imagination (Faw, 2009). Despite a wealth of literature investigating the psychometric properties of visual imagery measures and their relationship to creativity, questions remain regarding potential associations between career choices and this capacity. This study investigated the associations between career choice, as determined by university course, and visual imagery capacity. It was hypothesised that careers traditionally thought to be more creative, such as Art, or those requiring ability to imagine the construction of an end product, such as Architecture or Dentistry, would be

chosen by those with higher visualisation capacity than other careers, such as Law. Interestingly, in the initial paper on aphantasia, five participants (23.8%) of a survey of people who have blind imagination reported that having aphantasia had influenced their career choice, however, no further information was elicited regarding participants' careers (Zeman et al., 2015). There is also evidence that perhaps students and creative individuals at university or art school can have higher than normal scores in response to the Vividness of Visual Imagery Questionnaire (VVIQ), which is one of the most commonly used measures of visual imagery ability (Stewart, 2015). With respect to Orthodontics, achievement of a training post is nowadays via a competitive National Recruitment process. Applicants to Orthodontic programs tend to be well-balanced individuals who excel at a range of abilities, particularly academic achievement (Ardeshna, 2010). Standard format interviews and situational based judgements tests do not necessarily give an insight into visual imagery ability. Indeed interviewers may not consider these capacities or psychometric characteristics, or consider them less so than say, career progression and academic achievement. If an association existed between visual imagery ability and career choice then it would be a worthwhile assessment to consider at the interview stage. Orthodontics is a speciality where visualisation could be considered important, particularly in having an appreciation of how teeth move, and ultimately where their final position will be. This is important at treatment planning and in assessment of treatment progress at its various stages, and as such this is an area worthy of further investigation.

Materials and methods

Ethical approval was obtained on 18th October 2017 from the UCL Research Ethics Committee, Project ID:10569/001. This was a cross-sectional questionnaire-based study comparing four main groups of University College London (UCL) students; current

students at the Slade School of Fine Art, UCL Eastman Dental Institute, UCL Bartlett School of Architecture and the Faculty of Laws. University College London is the third largest university in the United Kingdom by enrolment numbers, with 41,539 students registered in total for the academic year 2017-2018 (UCL, 2018). In total, there were 2,875 students registered at the included Schools/Faculty for the academic year 2017-2018 (UCL, 2018). These schools were chosen to capture both creative specialisms which require visualisation of an end product, such as Art, Dentistry and Architecture, alongside a discipline which does not require design and construction ability necessarily, such as Law.

Aims and objectives

The objective of the study was to investigate the effect visual imagery may have on career choice amongst current university students across a range of subjects and disciplines. Several research questions were identified:

1. Is visual imagery ability significantly different in Orthodontics and Dentistry compared to other professions (Law, Architecture and Art)?
2. Are people with aphantasia or low visual imagery ability found more frequently in careers where that ability may be less important?
3. Are people with normal or hyperphantasia found more frequently in careers within creative professions?
4. Do people consider their own visual imagery ability when they choose a career?

The null hypothesis was that visual imagery ability has no relation to career choice.

Inclusion criteria

The inclusion criteria for the study were:

- Aged 18 years or over

- Fluency in English language
- No significant visual impairment
- Undergraduate/Postgraduate student at UCL
- Current students at;
    - Slade School of Fine Art
    - UCL Eastman Dental Institute
    - UCL Bartlett School of Architecture
    - Faculty of Laws

Questionnaire

The questionnaire consisted firstly of demographic items alongside several questions relating to participants' ability to visualise and its importance relating to their career choice. Participants were asked their gender, age (within a range), what school/faculty they studied within at UCL, whether they were undergraduate, postgraduate taught or postgraduate research students and which subject they studied. A selection of questions from those utilised by Zeman and colleagues were chosen based on their relevance to the present study (Zeman et al., 2015). They were:

- Is your ability to visualise affected by whether your eyes are open or closed?
- Can you imagine sounds (including music), textures (by imagining touch), tastes or smells?
- Do you dream, and in particular do you see visual images in dreams?
- Can you visualise memorable events from the past, like holidays or celebrations?
- Has your ability to visualise affected your career choice?

All answers were given on a three-point scale of 'Yes', 'No' or 'Not sure'. One question was modified; the original wording by Zeman and colleagues was, 'Do you dream normally, and in particular do you see visual images in dreams?' which was modified

by the researchers. This followed feedback that inclusion of 'normally' may cause participants to think that not having dreams or visual dreams was abnormal. The final wording chosen was, therefore, 'Do you dream, and in particular do you see visual images in dreams?' All other questions included used the same wording as the original versions (Zeman et al., 2015).

The second component was the VVIQ, which measures the vividness of individual's mental imagery and is made up of questions relating to four scenes (relative/friend, rising sun, a shop, a landscape) (Marks, 1973). Four questions requiring visualisation are asked relating to each scene. Participants rate image vividness for each question using a 5-point scale ('perfectly clear and vivid as normal vision when I really look at something' to 'no image at all, I only "know" that I am "thinking" about something'). Total VVIQ scores range from 16 to 80, the highest scores indicting the weakest visual imagery capacity (Marks, 1973). To allow for comparison with ongoing research into the subject of aphantasia, it was felt sensible to utilise the modified version of the VVIQ used by Zeman and colleagues, in which more vivid imagery is assigned a high score, and less vivid imagery is assigned a low score (Zeman et al., 2015). Thus, for the purposes of this study, a score of 16 indicates no visual imagery ability i.e. aphantasia, whereas a score of 80 indicates perfectly clear and vivid visual imagery ability i.e. hyperphantasia. Distribution was electronic via School/Faculty email lists on the SurveyMonkey® website (https://www.surveymonkey.com/r/CSandWLB), and in an adapted paper format.

Sample size calculation

An *a priori* sample size calculation was carried out using G*Power 3, a statistical tool for computing power analyses for a variety of statistical tests (Faul et al., 2007). This calculation was to establish the sample size necessary for a one-way ANOVA

comparing the VVIQ scores, ranging 16-80, across the four groups at a significance level of $p < .05$. The results indicated a required total sample size of 180 participants, with a minimum of 45 in each group, to detect medium effect sizes (f = 0.25) or larger. Power was set at 0.8, meaning such an ANOVA would have an 80% chance of detecting a significant medium sized effect if one were present in the data with a sufficient sample size. A second *a priori* calculation was conducted to establish the sample size necessary for a 3x4 Pearson's chi-squared test examining distribution of low (VVIQ score <30), medium (VVIQ score 31-69) and high (VVIQ Score >70) imagery scores across the four groups at a significance level of $p < .05$. Power was also set to 0.8 and parameters were set so as medium effect sizes (w = 0.3) or larger would be detected. The results indicated a total required sample size of 152 participants, with a minimum of 38 in each group.

Results

Following two months of data collection, (December 2017-January 2018) the required minimum sample size of 180 was achieved and the survey closed. In total, 223 completed responses met the inclusion criteria and were included in the analysis. All statistical analyses were carried out using SPSS Version 24.0 (IBM, 2016).

Demographics

Sixty five percent of respondents were female, 34.08% were male with two individuals who identified themselves as 'Other'. The majority of respondents were under the age of 35 years (89.68%). This is comparable to what would be expected in an average university population. No respondents over 65 years of age completed the questionnaire. Respondents were asked which level of study they were completing at the time of the study. Just under half (47.98%) were undergraduates. Of the postgraduates who responded, the majority were on postgraduate taught programmes (41.70%) and the

remainder were on postgraduate research programmes (10.32%). The results are summarised by School/Faculty attended in Table 1. [Table 1 near here]

Vividness of Visual Imagery Questionnaire

Vividness of Visual Imagery Questionnaire scores range from 16 to 80. The mean score in this study was 60.87 (*SD* = 13.01). Two respondents (0.9%) recorded the minimum score of 16, suggestive of the individual having aphantasia, whilst five respondents (2.2%) fell into the low imagery category (VVIQ score <30). The descriptive statistics for the overall sample are presented in Table 2. [Table 2 near here] The distribution of VVIQ scores for the total included sample for this study are presented in Figure 1. [Figure 1 near here] Descriptive statistics for each School/Faculty with respect to VVIQ scores achieved are presented with mean and standard deviations in Table 3. [Table 3 near here] A boxplot of VVIQ distribution by School/Faculty is presented in Figure 2. [Figure 2 near here] As the data was normally distributed, a one-way ANOVA was carried out which found no significant differences between the VVIQ scores across the four included Schools/Faculty; The Slade School of Fine Art, UCL Bartlett School of Architecture, Faculty of Laws and UCL Eastman Dental Institute, $F(3,219) = 2.160$, $p = .094$, $\eta_p^2 = .029$. There were also no significant differences in the scores for the Eastman ($M = 60.21$, $SD = 13.58$) and the three other Schools/Faculty ($M = 62.87$, $SD = 10.96$); t(-1.317) = 221 $p = .189$. The effect size for these comparisons, calculated using partial eta-squared and Cohen's d respectively, were found to be negligible.

Correlational Analyses

Correlational analyses were completed to identify the presence of any significant correlation between gender, age group, degree level, VVIQ score and effect of visual imagery ability on career choice. A Pearson's *r* correlation coefficient was calculated to assess the relationship between age and VVIQ score. A positive correlation was found

between age group and total VVIQ score, with older participants scoring higher on the VVIQ, however, this should be interpreted with caution as the sample had a preponderance to younger individuals as would be expected in a university population. With respect to people considering their own visual imagery ability when they choose a career, females were significantly more likely to say that their ability to visualise had affected their career choice than male respondents. Spearman's rho correlations were performed to examine relationships between ability to imagine using different senses due to the non-continuous nature of the data. Significant positive correlations were found using Spearman's rho between reported ability to imagine texture and taste (r_s = 0.169, p = .007) texture and smell (r_s = 0.208, p = .001), smell and taste (r_s = 0.470, p = .000). No other significant correlations were found. [Table 4 near here]

Regression Analysis

A linear regression was conducted to examine the relationship between VVIQ score and School/Faculty within the group of participants who responded "Yes" to the question "Has your ability to visualise affected your career choice?". This linear regression was not found to be significant $F(1,72) = 1.39$, p = .242. The adjusted R^2 value is 0.005, which only explains 0.5% of the variance.

Internal Validity

A Cronbach's alpha calculation was carried out to determine the internal validity of the VVIQ for this sample. The Cronbach's alpha was found to be 0.95. This falls above the 0.9 threshold for what is considered to be a very good internal validity. The removal of any single item did not significantly increase internal validity.

Orthodontics

The descriptive statistics for Orthodontic students with respect to their VVIQ scores are presented in Table 5. [Table 5 near here] An independent samples t-test examining the

VVIQ scores between MClinDent in Orthodontics students at the UCL Eastman Dental Institute and the remaining included participants in the study. There was no significant difference in the scores for the Orthodontic students (M = 60.80, SD = 13.39) and the remaining other included students (M = 61.44, SD = 9.68); t(-0.232) = 221 p = .817. A post-hoc power analysis, conducted using G*Power 3 (Faul et al., 2007), indicated that given the relatively small number of Orthodontic students recruited (N = 25) that any t-test would only have the power to detect a large effect size (Cohen's d > 0.8) in terms of difference in mean VVIQ scores for Orthodontic students compared to all other students. Therefore, in this analysis caution should be exercised in the interpretations of non-significant results, particularly if a small to medium effect size is observed. However, as the effect size for this independent samples t-test revealed a negligible effect size (Cohen's d = 0.05), there is no evidence indicating that analysis with a larger orthodontic sample would yield significant results. Levene's test of equal variance revealed no significant variation from homogeneity of variance. Half of the Orthodontic students (52%) felt that their ability to visualise did not have an effect on their career choice, and roughly one third were not sure if it had affected their career choice (32%). Only 16% of the Orthodontic students felt that their ability to visualise had affected their career choice. This is interesting as Orthodontics is a profession where visualisation of an end-product could be considered a useful essential.

Discussion

Visual imagery ability did not differ significantly in Dentistry and Orthodontics compared to the other professions. There were no significant differences between the VVIQ scores, ranging from 16-80, across the four included Schools/Faculty. Schools associated with careers where one might expect visual imagery ability to be important, such as the Slade School of Fine Art or UCL Bartlett School of Architecture, did not

demonstrate a higher frequency of individuals with hyperphantasia. Aphantasia was uncommon in this sample; two participants recorded the minimum VVIQ score of 16, giving a prevalence of aphantasia of 0.9%, whilst five participants (2.2%) fell into the low imagery ability category (VVIQ <30). Whilst a positive correlation was found between age group and total VVIQ score, with older participants scoring higher on the VVIQ, however, the number of participants in older age groups was small. With respect to people considering their own visual imagery ability when they choose a career, females were significantly more likely to say that their ability to visualise had affected their career choice than male respondents.

While these results may not be representative of the entire student body for the included Schools/Faculty, due to the low response rate, the calculated sample size was reached to detect a moderate effect size. Given the nature of this study, recruitment was self-selecting and the sample was a convenience self-selected sample. It could be that people who chose to complete the questionnaire have different visual imagery characteristics compared to those who did not complete the questionnaire. Also, demand bias should be taken into account, i.e. where a participant forms an interpretation of the experiment and then unconsciously changes their response to fit that interpretation. This may have an effect on the overall results.

Given the positive correlation between age group and VVIQ score, it would be interesting to carry out a study that looks at Orthodontists at various stages of their career i.e. Speciality Registrar, Senior Registrar, Specialist Practitioner and Consultant. By recording age in years further investigative work could be carried out to assess the ability to visualise and stage of career in Orthodontics. Another useful study to consider would be a longitudinal study of Orthodontic students during the three years of their registrar training. Participants could complete the questionnaire at the start of their

programme, and be followed up to the completion. A comparison could then be made to see if their ability to visualise has changed during the course of their postgraduate training. To increase the generalisability of the study, it could be extended to include students from other subjects which may rely less on the visualisation of an end product, such as those from the Humanities, or to widen the recruitment to include students from other institutions.

On the basis of the above findings the null hypothesis that visual imagery has no relation to career choice should be accepted, however, our response rate was low and further work in more diverse populations is required.

Conclusions

Based on the findings of the current study we can conclude;

(1) Visual imagery ability did not differ significantly in Dentistry and Orthodontics compared to the other professions.

(2) There were no significant differences between the VVIQ scores, ranging from 16-80, across the four included Schools/Faculty.

(3) Aphantasia was uncommon in this sample, with a prevalence of 0.9%.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

Ardeshna AP, Fong, CA. 2010. Characteristics of applicants who obtain interviews at orthodontic postgraduate programs. Angle Orthod. 80(2):373-377.

Aristotle, Gallop D. 1990. Aristotle on sleep and dreams : a text and translation with introduction, notes and glossary. Peterborough, Ont: Broadview Press.

Aristotle, Hamlyn DW, Shields CJ. 1993. De anima books ii and iii : (with passages from book i). 2nd ed. Oxford: Clarendon.

Faul F, Erdfelder E, Lang AG, Buchner A. 2007. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 39(2):175-191.

Faw B. 2009. Conflicting intuitions may be based on differing abilities- evidence from mental imaging research. J Conscious Stud. 16(4):45-68.

IBM. 2016. SPSS Statistics for Macintosh Version Version 24.0. Armonk, NY: IBM Corp.

Marks DF. 1973. Visual imagery differences in the recall of pictures. Br J Psychol. 64(1):17-24.

Morgan A. 2016. Aphantasia: 10,000 people make contact over visual imagery. [accessed 15 February 2017]. http://blogs.exeter.ac.uk/exeterblog/blog/2016/11/08/aphantasia-10000-people-make-contact-over-visual-imagery/.

Stewart CM. 2015. Aphantasia survey data analysis. [accessed 15 February 2017]. http://nbviewer.jupyter.org/urls/bitbucket.org/agilly/aphantasia/raw/master/report.ipynb.

UCL. 2018. Student Statistics. [accessed 22 March 2018]. https://www.ucl.ac.uk/srs/statistics.

Zeman AZ, Della Sala S, Torrens LA, Gountouna VE, McGonigle DJ, Logie RH. 2010. Loss of imagery phenomenology with intact visuo-spatial task performance: a case of 'blind imagination'. Neuropsychologia. 48(1):145-155.

Zeman AZ, Dewar M, Della Sala S. 2015. Lives without imagery - Congenital aphantasia. Cortex. 73:378-380.

Zimmer C. 2010. The Brain: Look deep into the mind's eye. Discover. March ed. p. 28-29.

Table 1. School/Faculty attended.

School/Faculty	Frequency	Percentage
Slade School of Fine Art	50	22.42%
UCL Bartlett School of Architecture	59	26.46%
Faculty of Laws	59	26.46%
UCL Eastman Dental Institute	55	24.66%
Total	223	100.00%

Table 2. Descriptive statistics for overall sample VVIQ scores.

	N	Minimum	Maximum	Mean	*SD*
Total Sample	223	16.00	80.00	60.87	13.01

Table 3. VVIQ scores by School/Faculty.

	N	Minimum	Maximum	Mean	*SD*
Slade School of Fine Art	50	16.00	80.00	58.78	15.03

UCL Bartlett School of Architecture	59	32.00	80.00	63.15	11.82
Faculty of Laws	59	16.00	80.00	58.49	13.68
UCL Eastman Dental Institute	55	32.00	80.00	62.87	10.96

Table 4. Correlational analysis.

		Age	Gender	Degree Level	Career Choice	VVIQ Score
Age	*r*		0.38	0.614*	0.081	0.194*
	p		.576	.000	.231	.004
	N		223	223	223	223
Gender	*r*	0.038		-0.043	-0.173*	-0.016
	p	.576		.522	.010	.806
	N	223		223	223	223
Degree Level	*r*	0.614*	-0.043		0.081	0.117
	p	.000	.522		.231	.082
	N	223	223		223	223
Career Choice	*r*	0.077	-0.173*	0.081		-0.099
	p	.249	.010	.231		.139
	N	223	223	223		223
VVIQ Score	*r*	0.194*	-0.016	0.117	-0.099	
	p	.004	.806	.082	.139	

N	223	223	223	223

*Correlation is significant at the $p \leq 0.01$ level (2-tailed).

Table 5. Vividness of Visual Imagery Questionnaire scores for MClinDent Orthodontics students.

	N	Minimum	Maximum	Mean	*SD*
MClinDent Orthodontics	25	44.00	76.00	61.44	9.68

Figure 1. Histogram of total VVIQ score distribution.

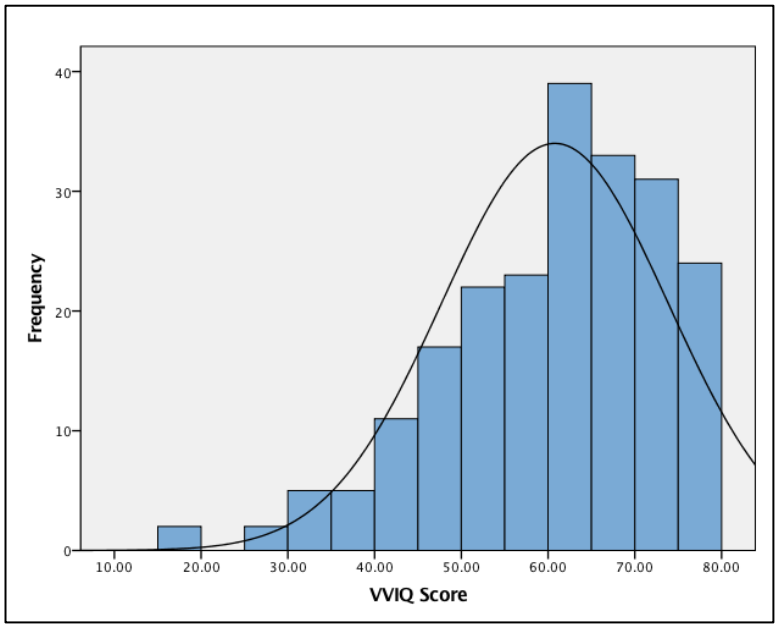
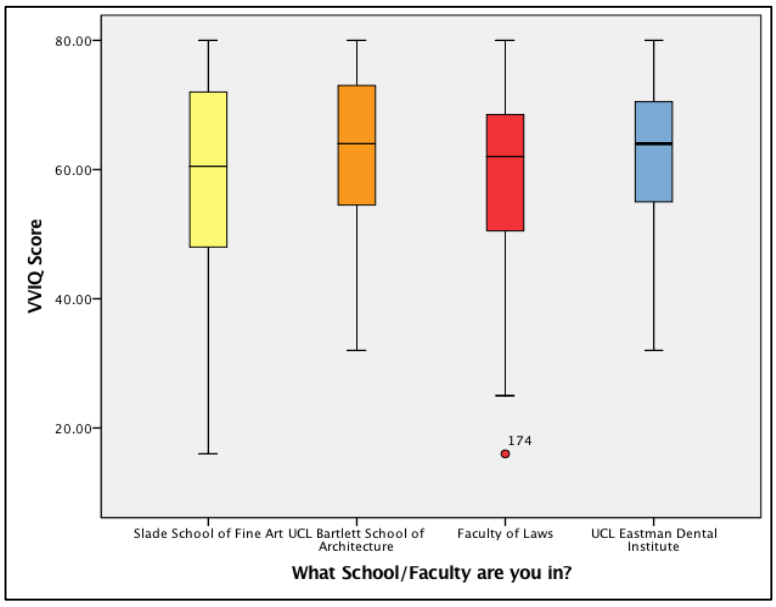


Figure 2. Boxplot of VVIQ distribution by School/Faculty.


80.00
60.00
40.00
20.00
VVIQ Score
174
Slade School of Fine Art
UCL Bartlett School of Architecture
Faculty of Laws
UCL Eastman Dental Institute
What School/Faculty are you in?