An Exploratory Approach to Scores on a Japanese-Language Version of the Learning Channel Preference Checklist

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Introduction

Learning styles constructs featured quite strongly in applied linguistics literature from the 1980s and through to the 2000s (e.g. Cheung & Banya, 1998; Ehrman & Oxford, 1990; Hyland, 1993; Keefe, Monk, Letteri, Languis, & Dunn, 1989; Kinsella, 1995; Kratzig & Arbuthnott, 2006; Melton, 1990; O'Brien, 1989; Oxford & Anderson, 1995; Ramburuth, 1998; Reid, 1987; Trayer, 1991; Wintergerst & DeCapua, 1999; Wintergerst, DeCapua, & Itzen, 2001). Perceptual learning styles represent a subset of constructs in this area, and are claimed to represent proclivities that individuals have for working and learning through particular perceptual modalities, and these have included the visual, auditory, tactile, haptic, and kinesthetic modalities. The constructs initially entered the literature in the general field of education from the mid-1970s to early 1980s (Dunn, Dunn, & Price, 1985; Dunn, Dunn, & Price, 1975, 1978, 1979), and then entered the applied linguistics literature via the Perceptual Learning Styles Preference Questionnaire (PLSPQ; Reid, 1984, 1987). The PLSPQ gained significant early traction in the literature (e.g. Bowman, 1996; Hyland, 1993; Kelly, 1998; Melton, 1990; Sy, 1991; Yamashita, 1995), but it was not the only instrument to emerge claiming to measure perceptual learning styles. Shortly afterwards three other instruments entered the literature: the Learning Channel Preference Checklist (LCPC; O'Brien, 1990, 2002), the Style Analysis Survey (SAS; Oxford, 1993a, 1993b), and the Perceptual Learning Preference Survey (PLPS; Kinsella, 1995).

The underlying rationale for measuring and then researching these constructs relates to individual differences (Skehan, 1991) and pedagogy (Coffield, Moseley, Hall, & Ecclestone, 2004; Dunn et al., 1978; Nieman & Flint Smith, 1978; Thomas, Cox, & Kojima, 2000). The implicit assumption underlying all of this is that individuals will tend to favor some modalities more than others, and that this could, in turn, assist or prejudice any given individual depending on how any particular teacher chooses to deliver a class. For example, if a teacher delivers a class with a particular emphasis on visual aids, one would presume that students for whom the visual modality is a preferred modality would do well. Conversely, students for whom the visual modality is less preferred, in favor of some other modality like the auditory modality, will not do so well. This hypothetical state of affairs raises the specter of the teacher having to match teaching in some way to preferences for learning style modality (Dunn & Dunn, 1979; Dunn et al., 1978; Peacock, 2001; Reid, 1998). Hypothetical is the operative word here because there is no empirical evidence, thus far, for this to be the case, and debate concerning this absence of evidence for the impact of these presumed modality preferences featured quite strongly in early educational literature on perceptual learning styles. Kampwirth and Bates (1980) and Tarver and Dawson (1978) conducted secondary research in the field of education, before these constructs had emerged into applied linguistics, and did not find evidence for a link between modality preference and learning outcome. This debate resumed a few years later in an exchange between Kavale and Forness (1987, 1990) and Dunn (1990); see Isemonger (2012) for a review of how applied linguistics proceeded on research into these constructs with significant enthusiasm, but without heed to these earlier debates.

Another underlying rationale for taking an interest in these constructs goes beyond individual differences and into the area of group differences, usually under the theme of cross-cultural differences (Dirksen, 1988; Eliason, 1995; Hyland, 1993; Kelly, 1998; Melton, 1990; Nelson, 1995; O'Donoghue, Oyabu, & Akiyoshi, 2001; Oxford & Anderson, 1995; Park, 2002; Stebbins, 1995; Wintergerst & DeCapua, 2001; Yu-rong, 2007). Most of this research, however, is either discursive (perhaps even speculative), or if it is empirical, tends to comprise a study of one culture alone, with this study being descriptive (e.g. Dirksen, 1988; Hyland, 1993; Ihara & Kitazawa, 1992; Kelly, 1998; Melton, 1990; O'Donoghue et al., 2001; Wintergerst & DeCapua, 2001; Yamashita, 1995). To make secure inferences concerning the learning style differences between cultural groups, one would need data derived from the study of two cultures at least, with a variety of controls in place. These might include age, educational level, field specialization and so forth. Even if one identifies two separate studies involving two separate authors in two different cultures, the comparison of results between these two studies is still problematic, even if most of the sampling characteristics are otherwise approximately equal. The instrument in question needs to have been appropriately adapted into the two respective cultures, with psychometric reporting on scores generated by the adaptation available. The methods for this psychometric reporting also need to proceed beyond the reporting of Cronbach's alpha, to more powerful methods such as confirmatory factor analysis (CFA) which demonstrate the unidimensionality of scores on the respective constructs represented in the instrument. Also, and ideally, there also need to have been measurement invariance studies (i.e. the group analyses aspect of CFA) conducted on scores derived with the two versions of the same instrument and across the two cross-cultural populations of interest. This assists with empirically establishing equivalence of measurement across the populations of interest, so that inferences will be secure. Overall, this sort of foundation for making cross-cultural inferences is sparse in the literature, or even absent.

Whether preference for these modalities, across individuals or across cultures, has real impact on learning outcome is, however, secondary to the prior issue of whether they can be successfully measured at all. If they cannot be satisfactorily measured with suitable inventories there are no prospects for intervention in, or adaptation of, the pedagogical process to accommodate their presumed implications. The importance of this issue was first raised by Deverensky (1978) who argued that finding sensitive measures of preferences for these perceptual modalities was problematic. Later, in a line of research which corresponds with this concern, psychometric evidence emerged that these constructs are indeed not easily operationalized, and that instruments claiming to measure them produce scores with questionable psychometric properties (Isemonger, 2008, 2012; Isemonger & Sheppard, 2007; Isemonger & Watanabe, 2007). All of these psychometric studies, except for the 2012 study which was an analytical and review article, have used CFA as the primary method to examine scores produced by the respective instruments. This was to address an argued deficit in this regard and also because, in the case of each instrument, an a priori measurement model had been hypothesized by the respective author whether explicitly or implicitly (i.e. via the scoring regime offered for the instrument). CFA is used to test a hypothesized model against the actual empirical properties and dimensionality of a dataset for which the hypothesized model should fit. Isemonger and Sheppard (2007) focused on the PLSPQ (Korean version), Isemonger and Watanabe (2007) on the SAS (Japanese version), and Isemonger (2008) on the LCPC (Japanese version). In all cases, the CFA provided negative evidence for the measurement models hypothesized by the respective authors, and the theoretical and operational reasons for this overall weakness across perceptual learning styles instruments were further discussed by Isemonger (2012) in a wide-ranging review of the psychometrics of learning styles research.

When a measurement model hypothesized a priori for any particular instrument is rejected in a CFA of that model, the implication is that the properties and dimensionality of scores, collected using the instrument in question, do not in fact correspond with the model. This has the further implication for the practitioner that there is no evidence-based support for scoring responses on the instrument according to this measurement model. Rejection of the a priori model, therefore, raises the question as to what the dimensionality of scores actually is, if not in conformity with the originally hypothesized model. The most suitable tool for this question is exploratory factor analysis (EFA). The LCPC is one instrument for which there has been limited psychometric evidence of structural validity in scores under the confirmatory approach (Isemonger, 2008); and to date an EFA has not been conducted, to the best of this author's knowledge. In the 2008 study by Isemonger, the measurement model hypothesized for the instrument by the original author was rejected, and Cronbach's alpha values were low on the subscales (Visual, .52; Auditory, .42; and Haptic, .51). In this study, therefore, an exploratory approach to scores produced by the instrument is taken. This approach to examining the scores is a bottom-up approach, and it produces a model which is a posteriori to the data. This a posteriori model may, or may not, conform to the model originally posited by the author of the instrument (or the model implied via the scoring regime advocated for it). It is important, however, to note that while EFA is revealing of what the structure of the scores produced by a particular instrument may actually be for a particular dataset, it remains an exploratory approach, and does not constitute a direct test of the a priori model.

Method

The instrument was administered to a sample of Japanese University students in Western Japan, and then analyzed using EFA as the primary method. Consideration of univariate non-normal properties was also a feature of the statistical analysis.

Instrument

The instrument was translated with permission into Japanese. The procedure for the translation followed the Test Adaptation Guidelines of the International Test Commission (International Test Commission, 2001) which involves a process of translation and back translation to establish the most suitable and appropriate rendering of the original items in the target language which was Japanese. The instrument uses a Likert scale with five items. These items have semantic anchors which are as follows (score allocation for each anchor in brackets): almost always (5), often (4), sometimes (3), rarely (2), and almost never (1). This represents an ordinal, rather than interval, scale, which theoretically does not meet assumptions for methods of estimation which presume interval scales. However, it is typical in factor analytic studies to treat ordinal scales as interval, provided that there are at least five points of discrimination on the scale (West, Finch, & Curran, 1995). In this respect, therefore, the Likert scale presented as acceptable for methods of estimation (e.g. ML estimation) which presume interval scales. The instrument has three subscales representing the visual, auditory, and haptic modalities of perception. The following items were hypothesized to measure the following constructs by the original author: Items 1, 5, 9, 10, 11, 16, 17, 22, 26, 27, 32, and 36 (Visual); Items 2, 3, 12, 13, 15, 19, 20, 23, 24, 28, 29, and 33 (Auditory); and Items 4, 6, 7, 8, 14, 18, 21, 25, 30, 31, 34, 35 (Haptic). However, this is for reference purposes only, because this study does not seek to confirm the hypothesized measurement model. A previous study by Isemonger (2008) employing a confirmatory approach (CFA) demonstrated that the measurement model did not fit the dimensionality of the data in this same sample. The purpose of the current study is to explore the dimensionality of the data with no presumptions about the measurement model, and EFA is the most suitable analytical tool for this.

Participants

Data was collected from 288 participants who were university students in Western Japan. Of these 288 cases, there were 28 cases where one or more items received no response from a participant. There are two ways to deal with such missing data. One approach is to impute the missing scores and the other is to delete the entire case, provided that the missing data is at random and not systematic. By inspection, it was observed that missing values were indeed at random, and thus 28 cases with missing values were remove from the dataset, leaving a final sample of 260.

Most of the students were freshmen or second-year students, and 98% of the sample was within the age range of 18 to 20 years of age. There were 150 females and 90 males (14 nonresponses). Students completed the questionnaire under informed consent.

Procedure

Students were required to complete the questionnaire under instructions consistent with the original English-language version of the instrument. The data was entered into a Microsoft Access database, and then transferred to Statistical Package for the Social Sciences (SPSS Version 21; IBM) using a Structured Query Language (SQL) command. The data was then analyzed in terms of descriptive statistics focusing on the means, standard deviation, skewness and kurtosis. Following this, the primary analysis, involving EFA was conducted.

Results

The results are presented in terms of the descriptive statistics and the main analysis which is the EFA. For descriptive statistics, the mean, standard deviation, skewness and kurtosis are reported for each item. The EFA is reported in terms of two solutions to simple structure.

Descriptive Statistics

Table 1 below presents the means, standard deviation, skewness and kurtosis for each item. Items 01, 14, 16, 34 presented with particularly high means (i.e. above 4.0), and these items are also associated with particularly high levels of negative skewness (i.e. univariate non-normality). There were no cases of particularly low means (i.e. below 2.0), although there were cases of positive skewness. The threshold for skewness was set at absolute value 3.0 (which is a more relaxed criterion than previously applied in Isemonger [2008] where skewness and kurtosis were not reported in detail). The four items referred to above with high values for negative skewness were all above an absolute value of 5.0 with Items 14 and 34 being extreme (-9.143 and -8.042, respectively). In all, 12 items presented with skewness values above the threshold of absolute value 3.0. Eight items presented with kurtosis values above the threshold of absolute value 3.0, with Item 14 being the highest (5.316) and the only case of positive kurtosis.

Table 1. Mean, Standard Deviation, Skewness and Kurtosis for Items on the LCPC

Item	Mean	Standard Deviation	Skewness	Kurtosis
Item 01	4.16	0.945	-6.858*	1.85
Item 02	3.83	1.006	-4.555*	-0.023
Item 03	3.51	0.94	-1.69	-1.311

Item 04	3.21	1.001	0.812	-2.473
Item 05	3.9	0.86	-3.059*	-1.279
Item 06	2.6	1.295	1.5	-3.648*
Item 07	3.42	1.131	-1.361	-2.773
Item 08	2.52	1.225	2.472	-2.718
Item 09	3.21	1.131	-0.031	-3.211*
Item 10	3.77	1.116	-3.269*	-2.263
Item 11	3.97	1.017	-5.7	0.123
Item 12	3.42	1.1	-1.688	-2.128
Item 13	3.1	1.202	-0.174	-3.214*
Item 14	4.19	0.99	-9.143*	5.316*
Item 15	2.97	1.216	0.084	-3.229*
Item 16	4.14	0.904	-5.379*	0.282
Item 17	3	1.067	0.176	-1.898
Item 18	2.44	1.091	1.982	-2.116
Item 19	3.28	1.092	-0.66	-1.799
Item 20	3.39	1.189	-1.128	-3.443*
Item 21	2.64	1.051	2.908	-1.392
Item 22	3.84	1.215	-4.639*	-1.982
Item 23	2.29	1.039	3.296*	-1.142
Item 24	3.29	1.076	-1.378	-1.712
Item 25	2.97	1.29	0.068	-3.634*
Item 26	2.92	1.14	0.374	-2.823
Item 27	2.64	1.094	2.556	-1.946
Item 28	3.62	1.016	-2.509	-1.758
Item 29	3.7	0.975	-3.998*	-0.371
Item 30	2.36	1.258	3.951*	-2.263
Item 31	2.88	1.309	1.026	-3.694*
Item 32	3.67	0.908	-2.336	0.18
Item 33	2.23	1.127	4.708*	-0.578
Item 34	4.23	0.943	-8.042*	3.21
Item 35	2.87	1.065	0.839	-0.692
Item 36	3.47	1.088	-1.791	-2.377

Note: Items with a skewness or kurtosis value above 3 are marked with an asterisk.

Figures 1, 2, and 3 represent the box-and-whisker plots for Items 1-12, 13-24, and 25-36, respectively. The plots provide a visual perspective on the score distributions for each item, although this has to be treated with care because the potential score distribution is limited to the five points on the Likert scale, and this represents a fairly course scale. Items 4, 9, 13, 15, 17, 20, 25, 26, and 31 all present with good distributional properties in terms of these plots. In the case of these items, the median is at the center point on the scale (i.e. value 3), and the interquartile range is between 2 and 4 on the scale.

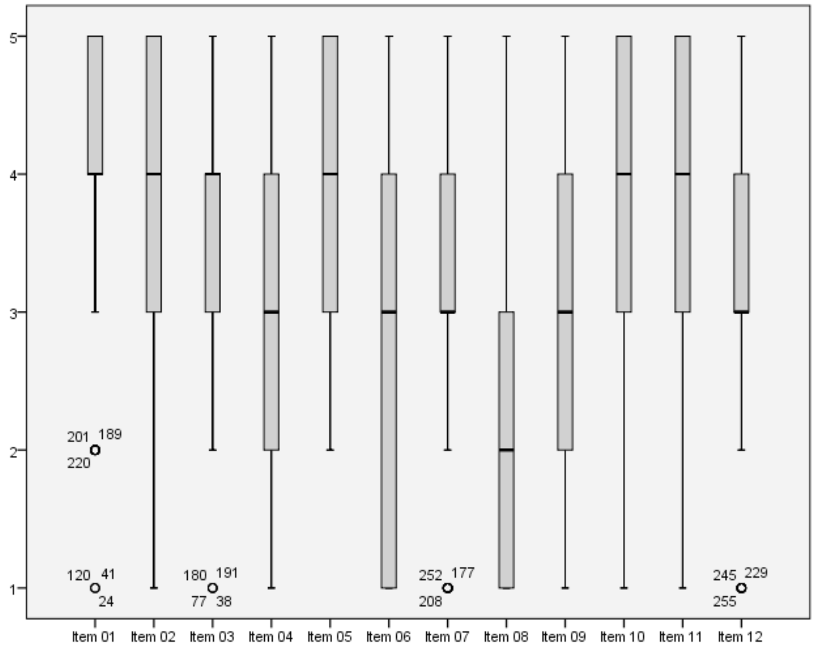

Figure 1. Box-and-whisker plots of scores on Items 1 through 12 on the Learning Channel Preference Checklist. The y axis represents points on the Likert scale. The x axis represents each item (1 - 12). In each plot the shaded box represents the interquartile range, and the black horizontal line represents the median. Small circles represent outlying cases.

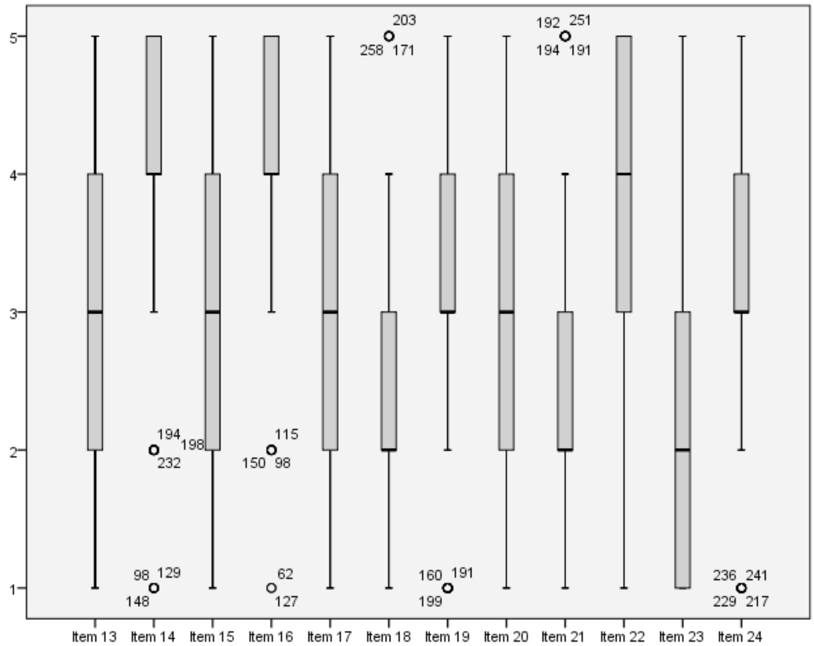

Figure 2. Box-and-whisker plots of scores on Items 13

through 24 on the Learning Channel Preference Checklist. The y axis represents points on the Likert scale. The x axis represents each item (13 - 24). In each plot the shaded box represents the interquartile range, and the black horizontal line represents the median. Small circles represent outlying cases.

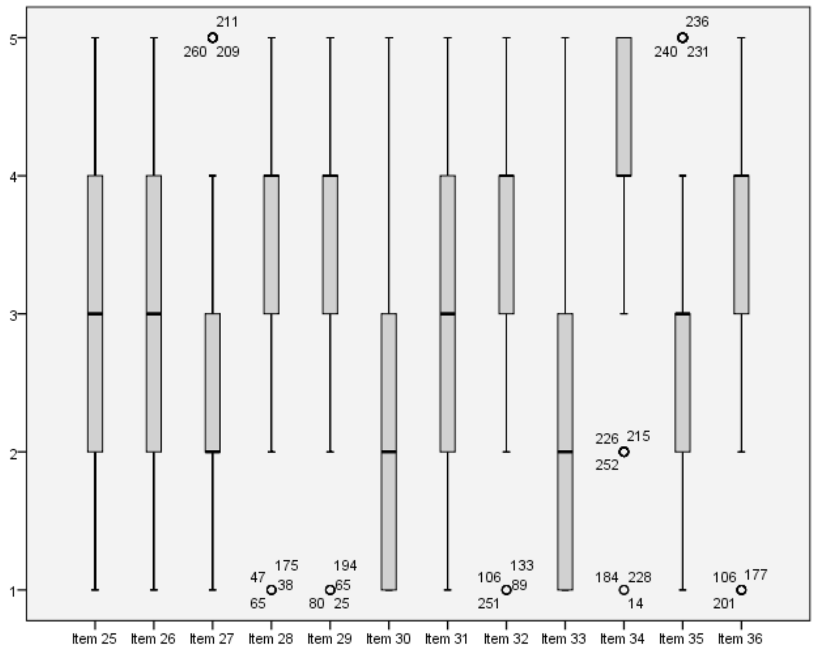

Figure 3. Box-and-whisker plots of scores on Items 25 through 36 on the Learning Channel Preference Checklist. The y axis represents points on the Likert scale. The x axis represents each item (25 - 36). In each plot the shaded box represents the interquartile range, and the black horizontal line represents the median. Small circles represent outlying cases.

Exploratory Factor Analysis

The exploratory factor analysis was conducted following a typical execution procedure. An initial solution was derived using an un-rotated principal components analysis. Following this, and from this solution, the eigenvalues were inspected (under the eigenvalue-less-than-one rule) as well as a scree plot to determine the number of factors to extract in a subsequent rotated solution. For the rotated solutions (Solution 1 and Solution 2) ML estimation was used. The solutions were rotated using Direct Oblimin which is an oblique (or correlated) form of rotation, consistent with the principle that factors in social science data are unlikely to be orthogonal (Kline, 1994).

Initial solution

As part of the initial solution, the Kaiser-Meyer-Olkin Measure (KMO; Kaiser, 1961) of sampling adequacy and Bartlett's test (Bartlett, 1950) of sphericity were requested from SPSS.

The result for the KMO was .629, only slightly higher than the minimum threshold of .60. This result therefore indicates that the data matrix is suitable for factor analysis, but only just so. The result for Bartlett's test was significant indicating suitability for factor analysis.

Table 2. Eigenvalues and Variance Explained in Initial Solution

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	Percentage of Variance	Cumulative Percentage	Total	Percentage of Variance	Cumulative Percentage
1	3.102	8.617	8.617	3.102	8.617	8.617
2	3.011	8.365	16.982	3.011	8.365	16.982
3	2.558	7.106	24.087	2.558	7.106	24.087
4	1.922	5.338	29.426	1.922	5.338	29.426
5	1.517	4.214	33.640	1.517	4.214	33.640
6	1.449	4.024	37.664	1.449	4.024	37.664
7	1.372	3.811	41.474	1.372	3.811	41.474
8	1.320	3.667	45.142	1.320	3.667	45.142
9	1.231	3.419	48.560	1.231	3.419	48.560
10	1.217	3.380	51.940	1.217	3.380	51.940
11	1.093	3.035	54.975	1.093	3.035	54.975
12	1.040	2.890	57.865	1.040	2.890	57.865
13	1.025	2.847	60.712	1.025	2.847	60.712
14	.956	2.656	63.368			
15	.904	2.510	65.878			
16	.876	2.434	68.312			
17	.870	2.416	70.728			
18	.812	2.256	72.984			
19	.781	2.170	75.155			
20	.764	2.123	77.277			
21	.733	2.035	79.312			
22	.692	1.923	81.235			
23	.672	1.867	83.102			
24	.630	1.751	84.852			
25	.602	1.673	86.525			
26	.585	1.626	88.151			
27	.569	1.580	89.731			
28	.530	1.473	91.204			
29	.507	1.408	92.612			
30	.479	1.330	93.942			
31	.428	1.189	95.131			
32	.419	1.165	96.296			
33	.373	1.035	97.332			
34	.355	.985	98.317			
35	.314	.873	99.190			
36	.292	.810	100.000			

From the results in Table 2, and using the eigen-value-greater-than-one rule, it is clear that the number of factors suggested for extraction (13) is very high and far exceeds the original number of three hypothesized by the author. With this in mind a scree plot was inspected (Figure 4).

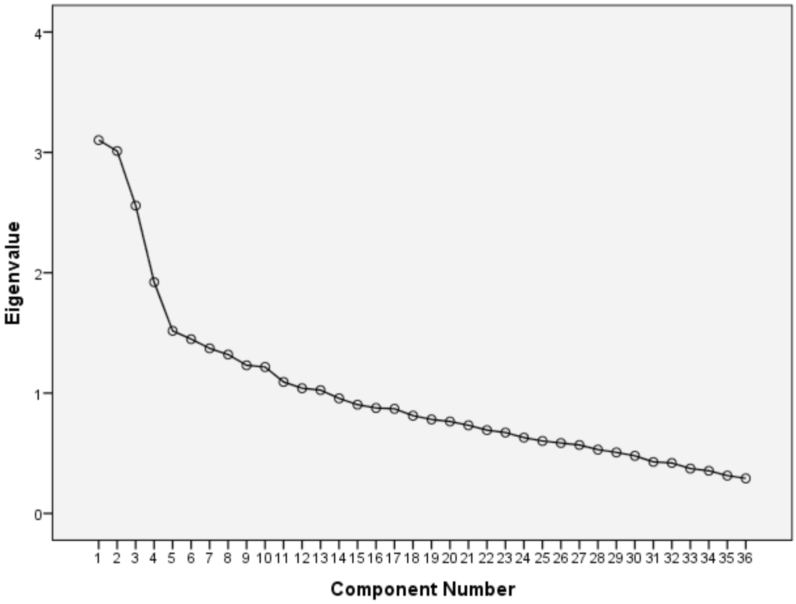

Figure 4. Scree plot of Principal Components extraction for scores on the LCPC. The x axis represents each successive component extracted, and the y axis represents the eigenvalue at each point of extraction.

The scree plot indicated, by inspection, a five-factor solution. After the fifth component, subsequent components tend to level off in aspect after the initial steeper slope of the first five components. This indicator of the number of factors to extract significantly departs from the eigen-value-greater-than-one rule. Importantly, a five-factor solution only accounts for 33.64% of the variance which is only a third of the variance to be explained. The 13-factor solution accounts for 60.71% of the variance, but at the notable expense of data-reduction, or parsimony, because so many factors have to be extracted to achieve this level of explained variance. A parallel analysis was considered as a further option to determine the number of factors. However, it was determined by trial run of a five factor solution that it failed to converge, and any solution with more than five factors also failed to converge. As a result, two solutions were obtained, a four-factor and three-factor solution. The solutions were obtained using Direct Oblimin as the rotation method which results in oblique or correlated factors. The pattern matrices are presented rather than the structure matrices. The pattern matrices represent unique contribution by the factor to the item. Note that in theoretical terms, the factor causes the item, and not the other way around, because the factor is latent, and the latent is said to be the cause of the value on the operational or observable variable which in this case is the item and its associated value. The threshold for a coefficient being determined as caused by the factor was set at .40.

Solution 1 (Three-Factor Model)

Table 3 presents the factor pattern matrix for the three-factor solution. A number of initial observations can be made about these results. The first is that only 13 items appear in the model, meaning that 23 items (64%) fail to appear in a 3-factor model, and a 3-factor model corresponds with the number of factors hypothesized by the author. Furthermore, the items which are represented, present with nonetheless low coefficients. Only one item (Item 09) has a coefficient over .50. Thus, while 13 items are present in the model, they are only just so.

Table 3. Factor Pattern Matrix for Three-Factor Solution

	Factor		
	1	**2**	**3**
Item 01	.474[V]		
Item 02			
Item 03			
Item 04			
Item 05			
Item 06			.490[H]
Item 07		.443[H]	
Item 08			.425[H]
Item 09	.512[V]		
Item 10			
Item 11			
Item 12		.470[A]	
Item 13			
Item 14			
Item 15		-.479[A]	
Item 16			
Item 17		-.420[V]	
Item 18			
Item 19			
Item 20			.410[A]
Item 21			
Item 22	.417[V]		
Item 23		.406[A]	
Item 24	.453[A]		
Item 25			
Item 26			
Item 27			
Item 28			
Item 29			
Item 30			
Item 31			
Item 32			

Item 33			
Item 34			
Item 35			
Item 36	.480^{V}		

Note that only results over .40 are represented, for ease of inspection. Blank spaces do have a coefficient, but it falls below an absolute value of .40. This was the threshold set in advance. The superscript indicates the construct which the item was originally hypothesized to measure in the scoring regime advocated by the author.

The first factor (Factor 1) comprises four of the original Visual items (Items 01, 09, 22, and 36) and one of the original Auditory items (Item 24). The second factor (Factor 2) comprises three of the original Auditory items (Items 12, 15, and 23), one of the original Haptic items (Item 07) and one of the original Visual Items (Item 17). The third factor (Factor 3) comprises two of the original Haptic items (Items 06 and 08) and one of the original Auditory items (Item 20). These factors were labelled as follows: Preference for Text Factor (Factor 1), Preference for Oral Instruction Factor (Factor 2), and Preference for Relaxed Learning Factor (Factor 3). See the discussion section on Solution 1 for the interpretive rationale for these labels.

Solution 2 (Four-Factor Model)

Table 4 presents the factor pattern matrix for the four-factor solution. In terms of these results, only 12 items appear in the model, which is less than the number which appears in the three-factor model. The presence of 12 items means that 24 items (66%) fail to appear in the 4-factor model. This would suggest that increasing the number of factors does not improve the resultant model. In this model, more items appear with slightly higher coefficients (six items with a coefficient of more than absolute value .50).

Table 4. Factor Pattern Matrix for Four-Factor Solution

	Factor			
	1	**2**	**3**	**4**
Item 01		.521^{V}		
Item 02				
Item 03				
Item 04				
Item 05	-.839^{V}			
Item 06			.507^{H}	
Item 07				.464^{H}
Item 08			.413^{H}	
Item 09		.539^{V}		
Item 10				
Item 11				
Item 12				.440^{A}
Item 13				
Item 14				
Item 15				
Item 16				

Item 17				
Item 18				
Item 19				
Item 20				
Item 21				
Item 22			-.432[V]	
Item 23	.673[A]			
Item 24		.481[A]		
Item 25				
Item 26				
Item 27				
Item 28				
Item 29				
Item 30				
Item 31				
Item 32				
Item 33				
Item 34				.513[H]
Item 35				
Item 36		.429[V]		

Note that only results over .40 are represented, for ease of inspection. Blank spaces do have a coefficient, but it falls below an absolute value of .40. This was the threshold set in advance. The superscript indicates the construct which the item was originally hypothesized to measure in the scoring regime advocated by the author.

The first factor (Factor 1) comprises one of the original Visual items (Items 05) and one of the original Auditory items (Item 23). The second factor (Factor 2) comprises three of the original Visual items (Items 01, 09, and 36) and one of the original Auditory items (Item 24). The third factor (Factor 3) comprises two of the original Haptic items (Items 06 and 08) and one of the original Visual items (Item 20). The fourth and final factor (Factor 4), comprises two of the original Haptic items (Items 07 and 34) and one of the original Auditory items (Item 12). These factors were labelled as follows: Preference for Mental Visualization (Factor 1), Abridged Preference for Text Factor (Factor 2), Relaxed Learning [2] (Factor 3), and Anomalous Factor (Factor 4). See discussion section on Solution 2 for the rationale for these labels.

Discussion

The discussion of the results reported above deals first with the score distributions of the items; i.e. the univariate normality of the items. While the Likert scale is, strictly speaking, ordinal, and we may not expect perfectly normal distributions, relatively normal distributions would be a positive characteristic of the scores generated. Following the score distributions for items, the discussion turns to the EFA, and deals with each solution (the three-factor and four-factor solutions) in turn, before making some overall comments on the results.

Item Score Distributions and Central Tendency

Overall, univariate non-normality was a significant property of the data. Negative skewness featured more prominently than positive skewness. Of the twelve items which had absolute values higher than 3.0 for skewness, nine were negatively skewed. When the skewness was quite extreme, this was naturally also associated with a particularly high mean for the item (defined as above 4.0). Kurtosis was less of a problem, relative to skewness, in that fewer items presented with kurtosis (eight items), and all but one of these items were above the threshold of absolute value 3.0 but also below absolute value 4.0. Only one item (Item 14) had kurtosis over absolute value 5.0. This was also the only item which had positive kurtosis. The other seven items had negative kurtosis.

The non-normality observed in the data may have been associated with the low value for the KMO (.629), because poor distribution is associated with a loss of information which can suppress shared variance. Put simply, the amount of variance in data with poor distributions is low, and this obviously impacts shared variance between items making up the instrument. Ultimately, this will impact on the process of data reduction via EFA leading to weak models, and this presents as one part of the explanation for the results of the two solutions for the EFA discussed immediately below.

Exploratory Factor Analysis (Solution 1)

The first solution extracted was a three-factor solution, and it included 13 of the original 36 items making up the instrument. The first factor in this solution comprised the following items (letter in italics denotes originally hypothesized construct for item):

Item 01 *V*:	*I can remember something better if I write it down.*
Item 09 *V*:	*I take lots of notes on what I read and hear.*
Item 22 *V*:	*When I am concentrated on writing or reading the radio bothers me.*
Item 24 *A*:	*I find it helpful to talk myself through my homework assignments.*
Item 36 *V*:	*When I get a great idea, I must write it down right away or I will forget it.*

This factor is dominated by the items originally hypothesized to operationalize the Visual construct. Only Item 24, originally from the Auditory construct, is an exception here. Under this initial analysis, it would seem inviting to claim that the Visual construct from the original instrument remains intact here in this first factor, if only highly abbreviated. Closer inspection of the content of the items indicates otherwise, however. All of the original Visual items imply writing, except for Item 09 and Item 22 which reference writing, but additionally reference reading and hearing. To the extent that reading and writing are visual, they represent the visual construct only very narrowly and with reference to text specifically. There are no items covering images and schematics and so forth. This construct could therefore be labelled as a

Preference for Text factor, and in so doing the circumscription of item content for the factor by the label would be more precise.

The second factor in the three-factor solution also had five items appear on it, although it was less dominated by items from one particular construct in the originally hypothesized model for the instrument. This factor comprised the following items:

Item 07 *H*:	*I need frequent breaks while studying.*
Item 12 *A*:	*I prefer having someone tell me how to do something rather that reading the directions.*
Item 15 *A*:	*I can easily follow a speaker even though my head is down or I am staring out of the window.*
Item 17 *V*:	*It's easy for me to understand maps, charts, and graphs.*
Item 23 *A*:	*It's hard for me to picture things in my head.*

This factor has three of the items originally hypothesized to measure the Auditory construct. There is also one item originally hypothesized to measure the Visual construct, which may appear to be anomalous, but it is worth noting that it is negatively oriented to the factor in this solution (indicated in Table 3 by the negative sign in front of it). If we take these four items together, it is therefore plausible that these items could be labelled under a Preference for Oral Instruction construct, especially on the basis of the content of Item 12 and Item 15. However, Item 07 is definitely anomalous under this analysis.

The third factor in the three-factor solution presented as weaker in terms of its operational representation, because only three items appeared on it. This factor comprised the following items:

Item 06 *H*:	*I can study better when music is playing.*
Item 08 *H*:	*I think better when I have the freedom to move around.*
Item 20 *A*:	*I remember things better if I study aloud or with someone.*

The three items comprising this third factor include two items from the originally hypothesized Haptic construct (Item 06 and Item 08) and one item from the originally hypothesized Auditory construct. Abstracting the common operational content from these three items is difficult. The notion of haptic learning implies learning through touch, and none of these items directly reference this. The two items from the originally hypothesized Haptic construct could be better circumscribed as representing a Preference for Relaxed Learning, and while Item 20 has some social content, it could also indirectly imply relaxed learning.

Exploratory Factor Analysis (Solution 1)

The second, and four-factor, solution, included 12 of the original 36 items making up the instrument; one less item than the three-factor solution, and distributed over more factors. This led to fewer items per factor, and therefore weaker operational expression of the factors. The first factor in the four-factor solution comprised the following items:

Item 05 *V*:	*I am able to visualize pictures in my head.*
Item 23 *A*:	*It's hard for me to picture things in my head.*

This factor presents as weak with only two items, and the low operational bandwidth of the construct is amplified by the almost identical content of these items, except for first one being positively worded and the second one negatively worded. As one would expect from the results, one item (Item 05) was negatively oriented toward the factor, and one item (Item 23) was positively oriented. This reflects, mathematically, the semantic inversion of the operational content of the two, otherwise nearly identical, items. A label for this construct, concisely restricted to item content, would have to be Preference for Mental Visualization; and of course one item would have to be reverse-coded to accommodate for the negative orientation to the factor were these two items to be used in a composite score. However, using them in a composite score would be subject to the criticism that only one score is actually needed, because the second score adds no operational bandwidth to the first; in these two items we have a clear case of operational redundancy. In addition, it is notable that neither of these two items appeared on any of the factors in the first solution (three-factor) discussed above.

The second factor in the four-factor solution was slightly stronger, in term of number of items appearing in the factor, than the first. There were three items and these were as follows:

Item 09 *V*:	*I take lots of notes on what I read and hear.*
Item 24 *A*:	*I find it helpful to talk myself through my homework assignments.*
Item 36 *V*:	*When I get a great idea, I must write it down right away or I will forget it.*

All three items were positively oriented toward the factor. There were two items from the originally hypothesized Visual construct (Item 09 and Item 36), and one item from the originally hypothesized Auditory construct (Item 24). Inspection of the three items reveals correspondence with the first factor (Factor 1) in the three-factor solution above. All three items, in fact, appeared in that factor discussed above. Thus this factor could be regarded as a reduced version of the Preference for Text construct above and, therefore, is labelled the Abridged Preference for Text Factor.

The third factor in the four-factor solution, as with the second factor, included only three items. These three items were as follows:

Item 06 *H*: *I can study better when music is playing.*
Item 08 *H*: *I think better when I have the freedom to move around.*
Item 22 *V*: *When I am concentrated on writing or reading the radio bothers me.*

In this factor (Factor 3), Item 06 and Item 08 are the same two items (they were Haptic in the originally hypothesized construct) which appear in the third factor (Factor 3) of the three-factor solution discussed above. In the third factor of the three-factor solution, these two items (Items 06 and 08) were associated with one item which was originally hypothesized to measure the auditory construct, namely, "I remember things better if I study aloud or with someone." Item 22, in the above set of three items from the third factor in the solution, may appear to be anomalous to the other two originally-Haptic items. However, the negative sign in front of it (see Table 4) indicates that it is negatively oriented to the construct, and when this is considered, it is arguable that the item is commensurate with the other two items (Items 06 and 08), under the same label as given to Factor 3 in the three-factor solution; i.e. a Preference for Relaxed Learning factor. Given that Item 22 has replaced Item 20 in the factor in this four-factor solution, the factor is labelled Preference for Relaxed Learning [2] to distinguish it from the label for the similar factor (Factor 3) in the three-factor solution.

The fourth and final factor in the four-factor solution, like the second and third factors, also comprised three items. These were as follows:

Item 07 *H*: *I need frequent breaks while studying.*
Item 12 *A*: *I prefer having someone tell me how to do something rather that reading the directions.*
Item 34 *H*: *I daydream in class.*

Two of the items (Item 7 and Items 12) appeared in the second factor of the three-factor solution reported above which was labelled Preference for Oral Instruction. However, Item 07 was anomalous to that factor, so one would have to be careful interpreting this factor as a reduced version of it. This is more particularly the case when one considers Item 34. This item clearly relates to some kind of attentional construct, and it is difficult to relate it to any of the original constructs hypothesized for the instrument, Visual, Auditory or Kinesthetic. It also does not appear to relate to any of the labelled constructs for factors emerging in this EFA, three-factor or four-factor solution, and should be considered as entirely anomalous. This factor was therefore labelled Anomalous Factor.

Overall and Summative Analysis

The overall picture from both solutions sought in the EFA is that the three-factor solution probably offers a more coherent reduction of the data than the four-factor solution. The first and fourth factors in the four factor solution are essentially weak; the first because it comprises only two items with operational redundancy, even if inversional in meaning, and the fourth because interpretation of the factor breaks down, with one clearly anomalous item relating to an attentional construct rather than perceptual construct. Factor 2 and Factor 3 in the four-factor solution also present as reduced versions of Factor 1 and Factor 3 in the three-factor solution which were labelled as a Preference for Text factor and a Preference for Relaxed Learning factor, respectively.

Although, the three-factor solution presents as better than the four-factor solution, it remains nonetheless a problematic solution in terms of the original three constructs hypothesized for the LCPC. In the first place, only 13 of the original items appear in the solution, and all of these items appear with relatively weak coefficients; i.e. greater than the .40 threshold stipulated in advance for this analysis but, nonetheless, still not high. In the second place, the content of items which appear on the factors does not comport with the originally hypothesized perceptual constructs which were hypothesized for the instrument, namely, the Visual, Auditory, and Haptic constructs.

The first factor (Preference for Text factor) relates, whether receptively (reading) or productively (writing), to the visual modality in as far as reading and writing involve vision. However, it does not include items which would operationalize other aspects of a preference for the visual modality such as dealing with diagrams/schematics and pictures and so forth. A Preference for Text could also be associated with more traditional learning and individual learning, and it is indeed these underlying constructs which could be providing the coherence, in terms of the mutual presence of these items on a single factor, rather than the visual modality which reading and writing presume. In addition, reading and writing also presume inner speech to some extent, and here too the rationale for them representing the visual modality of perception becomes clouded.

The second factor (Preference for Oral Instruction), again, while it could be argued to relate to the auditory modality of perception in as far as oral instruction involves audition, also seems to circumscribe something less than the operational bandwidth of a preference for the auditory modality of perception in learning. As with the first factor, there is some resonance perhaps with the original construct hypothesized, in this case audition, but it is only that. There does not appear to be full operational expression of a preference for the auditory mode of perception in the items which appear on this factor.

The final factor in the three-factor solution does not appear to resemble a preference for haptic learning in terms of item content. Haptic learning refers, as the name would suggest, to learning through the modality of touch perception. The item content in the third factor does not operationalize such a preference. Instead, the items would appear to cohere under some form of preference for informal learning, and hence the label ascribed in this study which is Preference for Relaxed Learning.

Conclusion

The analysis of scores produced by the LCPC in this study, using the data-driven or a posteriori approach of EFA, lends explanation to the confirmatory results reported by Isemonger (2008) where the hypothesized measurement model for the instrument was subjected to a CFA in an a priori test. The results in that study provided negative evidence for the model. The results here indicate what the LCPC might actually be measuring, which is different to the research question informing the results reported in Isemonger (2008), and which was about the question of whether or not the LCPC measures what it is claimed to measure in a direct test of the claim. Of particular importance in the results reported in this study is the interpretive analysis of the item content of these obtained factors, and what these items do actually represent from an operational point of view. Overall, the data matrix was not particularly amenable to data reduction, and this was reflected in the relatively low value derived for the KMO test. This property of the matrix, arguably accounted for the difficulties with convergence in extracting any more factors than four. The three-factor solution, however, is commensurate in number of factors with the original measurement model for the instrument hypothesized by the author, and associated with the scoring regime offered for it, and this solution was interpretively instructive.

Of the limited amount of variance accounted for by the three factors, there would appear to be a factor related to preference for text, a factor related to preference for oral instruction, and a factor related to a preference for relaxed learning. The first two bear some resemblance perhaps to the original constructs of preference for the visual and auditory modalities, respectively, but do not fully operationalize those constructs with sufficient bandwidth. These limitations in the scores generated by the LCPC have two possible explanations. The first is that the limitations are native to the instrument, and that the items could be revised. The second, and consistent with arguments made by Isemonger (2012), is that the constructs relating to preferences for perceptual modality are inherently difficult to operationalize in self-report instruments, and that the LCPC and the scores it generates are simply one instance of a more general problem with all of these types of instruments, rather than a special case. In view of these overall conclusions, the future research trajectory of perceptual learning styles would benefit from a two-fold agenda. This should include, first, the empirical question as to whether any of these constructs can be measured through self-report inventories and second, the also empirical question of whether other instruments claiming to measure the constructs also suffer the limitation of having restricted and insufficient operational bandwidths for these constructs.

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An Exploratory Approach to Scores on a Japanese-Language Version of the Learning Channel Preference Checklist

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Abstract

In this research paper, the results are reported from an exploratory factor analysis (EFA) of the Learning Channel Preference Checklist. The sample comprised 288 college students (150 females and 90 males with 98% between the ages of 18 and 20 years). The instrument claims to measure preferences for perceptual learning styles; including the visual, auditory and haptic learning styles. Previous confirmatory factor analysis failed to confirm the model. Two solutions were obtained: a three-factor model (including 13 of the original 36 items) and a four-factor model (including 12 of the original 36 items). The two solutions are interpreted in terms of which items associate with each other on each factor, and what the original placing of these items were in the original model offered by the author. The evidence suggests three plausible, but relatively weak, factors representing a preference for text, a preference for oral instruction, and a preference for relaxed or informal learning.

本研究論文では、「学習チャネル好みチェックリスト」という尺度の探索因子分析（EFA）結果を報告する。本研究の標本は288の大学（女性150名および男性90名でそのうち98％が18歳から20歳の間である）から収集した。この尺度は、視覚、聴覚および触覚の学習スタイルを含む知覚学習スタイルの好みを測定するために作られた。以前の確証要因分析では本尺度のモデルを確認することができなかった。EFAによって３つの因子モデル（元の36項目のうち13項目を含む）と４つの因子モデル（元の36項目のうち12項目を含む）の２つの分析結果が得られた。この２つの分析結果は、どの項目がそれぞれ互いに関連しているのか、また尺度の作者によって示された元のモデルにおいて元の項目配置がどのようなものであったのか、という２つの点で解釈された。本研究結果は、比較的弱くはあるが、３つの妥当性のある因子、つまり、テキスト、口頭による教授、より和らいだ形式ばらない学習を、調査参加者は嗜好することを示唆している。

Keywords: Learning Styles, Exploratory Factor Analysis, Perceptual Learning Styles