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ABSTRACT

A battery of perceptual motor skills tests was administered to 107 freshman and 84 senior dental students for the purposes of determining the factor structure of the battery and studying differences between the two groups. The tests used included Minnesota Rate of Manipulation Test (MRM), Placing and Turning; O'Connor Finger Dexterity; O'Connor Tweezer Dexterity; Minnesota Spatial Relations; Crawford's Small Parts; and Purdue Pegboard, Both Hands and Assembly. Principal components analysis revealed Manual Dexterity, Finger Dexterity, Tweezer Dexterity and Spatial Relations as interpretable factors for both groups. Comparison of the factor patterns indicated that freshmen and seniors were least comparable on the Spatial Relations factors. It is suggested that as a result of three years of training, perceptual skills become interwined with motor skills and can no longer be expressed as an independent factor. (Author/PR)

Patterns of Perceptual Motor Skills in First and Fourth Year Dental Students

Thomas G. Zullo

The intention of this study was twofold. First, to elucidate the factor structure of a battery of perceptual motor skills tests and, second, to determine what differences, if any, exist between freshmen and senior dental students in regard to such skills as the result of dental education.

The subjects consisted of 107 freshmen and 84 senior dental students at the University of Pittsburgh. The following eight performance tests were administered to all subjects: MRM, Placing and Turning; O'Connor Finger Dexterity; O'Connor Tweezer Dexterity; Minnesota Spatial Relations; Crawford's Small Parts; and Purdue Pegboard, Both Hands and Assembly. For the purposes of this study, all tests were administered to small groups (from two to four subjects) and were timed so that the score was the number of items (pins, blocks, etc.) completed within a given time limit.

The methods of analysis used in this study were principal components analysis to determine the factor structure of the battery of tests and Ahmavaara's Transformation Method to determine the degree of equivalence of factor patterns for the two classes.

The matrices of intercorrelations of the eight tests for the freshmen and seniors are shown in Tables 1 and 2, respectively. Following principal components analysis, it was decided to retain four factors for rotation. Rotations were performed using the Varimax method of analytical rotation. The rotated factor pattern for the freshmen is shown in Table 3. The identification of the four factors along with the tests that load on them is as follows:

I. Finger Dexterity
   - (A) O'Connor Finger Dexterity
   - (B) Purdue Pegboard - Both Hands
   - (C) Purdue Pegboard - Assembly

II. Tweezer Dexterity
   - (A) O'Connor Tweezer Dexterity
   - (B) Crawfords Small Parts

III. Manual Dexterity
  (A) MRM - Placing
  (B) MRM - Turning
IV. Spatial Relations
  (A) Minnesota Spatial Relations

Table 4 represents the rotated factor patterns for the senior class on the test battery. Below are the four factors extracted and the tests that loaded on them:

I. Finger Dexterity
  (A) Purdue Pegboard - Both Hands
  (B) Purdue Pegboard - Assembly
II. Tweezer Dexterity
  (A) O'Connor Tweezer Dexterity
  (B) Crawford's Small Parts
III. Manual Dexterity
  (A) MRM - Placing
  (B) MRM - Turning
IV. Spatial Relations/ Dexterity
  (A) O'Connor Finger Dexterity
  (B) Minnesota Spatial Relations

For both classes, Factor I was identified as a Finger Dexterity factor with high factor loadings (>.50) on the two subtests of the Purdue Pegboard. In addition, the O'Connor Finger Dexterity Test loaded on this factor for the freshmen but not for the seniors.

Factor II, the Tweezer Dexterity factor, was defined solely by the O'Connor Tweezer Dexterity and Crawford's Small Parts Tests for both groups. Although there have been very few studies that have attempted to extract such a factor (none of which have been successful) such tests were included in this battery because of the special skills requisite for the group in the study (i.e. dental students). It remains to be demonstrated whether this Tweezer Dexterity factor is peculiar to the specific population studied.

The tests loading on Manual Dexterity, Factor III, were identical for both classes. Specifically, they were the Placing and Turning subtests of the MRM.

Although the Minnesota Spatial Relations Test may be considered to be a performance test, for the freshmen, it loaded exclusively as a Spatial Relations factor. (An adjunct study conducted by the author in which paper and pencil spatial relations tests were used indicated that the Minnesota measured only perceptual skills in this group.) However, for the seniors, the O'Connor Finger Dexterity Test was also found to load on this factor.

Simple visual comparison of the factor patterns of the two groups reveals that while there is a great deal of similarity between the factor patterns of the two classes there also exists some differences. As was stated, Ahmavaara's Transformation method was used to compare the factor patterns of the two classes in an objective manner. Table 5 represents the T matrix produced by Ahmavaara's Transformation, with the diagonal values representing the measure of correspondence between two equivalent factors.

Since there is no test of significance for the homogeneity of structures, it cannot be determined which factors are "statistically" equivalent. However, visual inspection indicates that Factors I, II and III have a fairly high degree of equivalence with coeffecients of .82, .83, and .87. Only Factor IV, the "Spatial Relations" factor shows a rather low degree of equivalence between the two groups with a coeffecient of .67. It should be recalled that although the Minnesota Spatial Relations Test loaded as a pure spatial relations factor for the freshmen, it did not for the seniors. Factor IV for the seniors was composed of both the O'Connor Finger Dexterity Test as well as the Minnesota. In addition, the Minnesota was also found to have a moderate loading (.45) on the Tweezer Dexterity factor for the seniors. These data may lead one to conclude that not only did this fourth factor measure somewhat different traits in the two groups but specifically, that spatial relations is a factorially complex trait for the seniors.

The findings of this study may be considered to be of relevance in two areas. First, in the general area of motor skills learning, the identification of a Tweezer Dexterity factor may be of value in the development of a Taxonomy of objectives in the motor skill domain. Secondly, these findings should be of relevance in the area of dental education. While perceptual motor skills learning is considered to be an integral part of the dental education process, little has been done to study the effects of

dental education on such skills. This study at least provides a first insight in that it would appear that after three years of education, spatial relations (or perceptual) skills become intertwined with motor skill and are no longer expressable as an independent factor. This finding may lend credence to the position held by some dental educators that the dentist improves in perceptual rather than motor skills as the result of his training.

TABLE 1

INTERCORRELATION MATRIX OF THE EIGHT PERFORMANCE TESTS, FRESHMEN

Test		1	2	3	4	5	6	7	8
1.	MRM-Placing	1.00	.62	.33	.50	.34	.33	.42	.36
2.	MRM-Turning		1.00	.30	.34	.22	.23	.42	.33
3.	O'Connor Finger Dexterity			1.00	.31	.23	.25	.33	.40
4.	O'Connor Tweezer Dexterity				1.00	.14	.45	.26	.25
5.	Minnesota Spatial Relations Test					1.00	.16	.27	.27
6.	Crawford's Small Parts Dexterity						1.00	.26	.24
7.	Purdue Pegboard Both Hands							1.00	.53
8.	Purdue Pegboard Assembly								1.00

TABLE 2

INTERCORRELATION MATRIX OF THE EIGHT PERFORMANCE TESTS, SENIORS

Test		1	2	3	4	5	6	7	8
1.	MRM-Placing	1.00	.58	.42	.18	.23	.16	.29	.40
2.	MRM-Turning		1.00	.21	.18	.14	.23	.16	.34
3.	O'Connor Finger Dexterity			1.00	.22	.30	.13	.28	.15
4.	O'Connor Tweezer Dexterity				1.00	.36	.38	.16	.23
5.	Minnesota Spatial Relations Test					1.00	.18	.08	.25
6.	Crawford's Small Parts Dexterity						1.00	.24	.30
7.	Purdue Pegboard Both Hands							1.00	.46
8.	Purdue Pegboard Assembly								1.00

TABLE 3

ROTATED FACTOR PATTERN, EIGHT PERFORMANCE TESTS, FRESHMEN

Test	Factors I	II	III	IV	h^2	R^2
1. MRM-Placing	19	33	77	23	80	53
2. MRM-Turning	23	09	86	03	81	42
3. O'Connor Finger Dexterity	67	33	03	12	57	24
4. O'Connor Tweezer Dexterity	10	76	38	-01	72	36
5. Minnesota Spatial Relations Test	17	06	14	97	99	16
6. Crawford's Small Parts Dexterity	18	84	04	08	74	24
7. Purdue Pegboard Both Hands	70	03	40	08	65	37
8. Purdue Pegboard Assembly	83	08	18	09	74	36

Note.--Rounded from three places and decimals omitted.

TABLE 4

ROTATED FACTOR PATTERN, EIGHT PERFORMANCE TESTS, SENIORS

Test	Factors I	II	III	IV	h^2	R^2
1. MRM-Placing	24	00	78	35	80	47
2. MRM-Turning	05	16	91	01	85	37
3. O'Connor Finger Dexterity	23	-05	20	81	75	27
4. O'Connor Tweezer Dexterity	02	77	04	32	69	24
5. Minnesota Spatial Relations Test	-07	45	05	67	66	22
6. Crawford's Small Parts Dexterity	27	76	14	-11	69	22
7. Purdue Pegboard Both Hands	91	05	03	16	86	28
8. Purdue Pegboard Assembly	66	31	36	02	65	37

Note.--Rounded from three places and decimals omitted.

TABLE 5

TRANSFORMATION MATRIX, EQUIVALENCE OF FACTORS BETWEEN FRESHMEN AND SENIORS

Factor	I	II	III	IV
I. Finger Dexterity	.82	.03	.07	.26
II. Tweezer Dexterity	-.03	.83	-.04	.32
III. Manual Dexterity	.05	-.08	.87	-.07
IV. Spatial Relations	-.07	.34	-.04	.67