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Cognitive Performance as a Function of JobMatch Logic Aptitude Test: Individual Differences Associated With Response Time

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Abstract

In a study of cognitive performance based upon the JobMatch Logic Aptitude test that was comprised of 1025 participants, of whom 75% were female and 25% were male, the associations between individual differences with response time were investigated. It was observed that the frequency distributions of individually based correlations between 'Correct answer' and corresponding 'Response time' were all normal, despite a small degree of 'flatness'. Furthermore, the correlations between 'Correct answer' and corresponding 'Response time' over JML category showed increasing and incremental absolute values from complex to mathematical to numerical to logical to speed. Finally, the variance analysis of Fisher's z' values over JML category showed a monotonously decreasing curve over the skills categories. Thus, two types of cognitive processing were distinguished: (a) 'experiential', involving the Complex and Mathematical skills; and (b) the 'intuitive', involving the Logical and Speed skills, respectively, whereas numerical skills are construed as invoking an 'intuitive processing within framed experience'.

Keywords: ***JML – correct answers – response time – correlation – complex – mathematical – numerical – logical – speed – 'experiential.***

1. Introduction

It has been observed that the performance of reasoning and logical aptitude testing is affected, to greater or lesser extents by the direct and indirect relationships between word problem solving, logical reasoning, inference making, and reading comprehension skills. It appears to be the case also that reading comprehension affects a partially mediatory role in the relationship between logical reasoning and word problem-solving supported by positive correlations between word problem solving and logical reasoning skills; presupposing that those activities intended to improve word problem-solving performance, it is likely that the notion ought also to be supported by logical reasoning- and inference making-related activities [2]. Other studies have focused upon the assessment of cognitive performance of logic mathematics amongst young college-attending Chinese students' reasoning pursuance on a test battery consisting of advanced mathematics and a battery of seventeen cognitively oriented tasks utilizing basic numerical processing,

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complex numerical processing, spatial abilities, language abilities, and general cognitive processing [8]. Their spatial abilities were significantly associated with the students' capacity in performing advanced mathematics, after controlling for other factors whereas certain language abilities, such as the comprehension of words and sentences, rendered unique insights regarding the logical processing. In a related study, several characteristics of logic reasoning ability were presented to a cohort of young adult medical students [3], such as taking control of events, recognizing, and responding to relevant information concerning issues, specifying signs and symptoms, asking specific questions that focused upon the pathophysiological thinking and etiology, placing each question in its logical order, checking for agreement with patients. They observed that to the students participating the patients' acts and the course, the results and efficiency of the conversation were identified as indicators of clinical reasoning, whereas context, using self as a reference, and emotion/feelings were identified by the clinicians as variables in their assessment of clinical reasoning.

In a previous study, applying the JML logical aptitude test [1], cognitive performance was investigated by relationships between proportion of correct answering and corresponding time to respond. Data was analyzed on an aggregated level with JML items as a breaking point. The number of observations was 84. In the reliability-validity assessment 'follow-up, the levels of construct validity, both external and internal, intrinsic to the JML recruitment logical aptitude instrument was measured through methods including the analyses of 'internal' features, e.g., factor structure, as well as corresponding estimations of reliability [4]. Additionally, the relationships between JML categories and other 'external' issues were investigated also. Cognitive presence, the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication, has been speculated to show correlation with higher order thinking skills. However, in a study of young adult college students it was observed that high cognitive presence density was not associated with the promotion of higher order thinking skills but rather that social presence was positively related to the quality of cognitive presence [5]. Thus, the emerging impression from the previous findings [1], reinforces the notion that relationships exist between reasoning and logical, rather than, social entities. Previous findings implied that when an interference task occurs immediately after initial temporal encoding, it affects the process of consolidation in reference memory whereas simple delay of propensity for faster responding to provide higher probability of greater performance ought to fit those observations.

In the present study, individual correlations were calculated for each participant (N = 1,025). These calculations were performed upon pairs of items over the five JML categories (i.e., numerical, mathematical, logical, complex, speed). Thus, in all, about 5,000 individual correlations were at focus for analyses. The purpose of the present study was to describe, and compare, individual relationships over the five skills, or aptitudes, representing types of categorization. These relationships (using the Pearson analysis) were performed between correct answering of the JML test, and time-to-respond.

2. Method and Materials

2.1 Participants

Participants were recruited by use of two social networking services. Invitations were sent to specific groupings in LinkedIn and Facebook. In all, 1,025 participants were included in the study. Almost 75% were female participants who took part in the study, and 25% men. The mean age of the participants was 45 years (SD = 12.6), where female participants were somewhat older.

2.2 Instrument

The JobMatch Logic (JML) Aptitude test consists of 84 items which were divided into four basic categories: Complex, Mathematical, Numerical, Logical, an additional category, labeled as Speed, was created with a subset of items from the Complex and Logical categories. The JML offers a cognitive aptitude test instrument that is designed to estimate cognitive performance concerning problem-solving and logical reasoning.

The instrument presents five main categories and that are as follows:

- *Complex Cognition*: the person's ability to understand complex ideas and information;
- *Mathematical understanding*: the person´s general understanding of mathematics principles;
- *Numeric understanding*: the person´s general understanding of numbers based on basic arithmetic's;
- *Logical reasoning*: the person's ability to make inference-based conclusions;
- *Cognitive Processing Speed*: the speed in which the person can understand and react to information.

2.3 Statistical procedures

Individual Pearson correlations were computed for each subject, and over the five JML categories. Since these correlations were compared with respect to mean values over JML categories, all correlations were transformed to Fishers z'.

Differences between the JML categories were calculated with the SPSS Linear Mixed Model procedure (version 26) using a repeated measures design. The F test statistic was based on an unstructured covariance matrix. Moreover, the linearly independent pairwise differences were adjusted for multiple Bonferroni comparisons, based on estimated marginal means.

3. Results

All frequency distributions of individual correlations between 'Correct answer' and corresponding 'Response time' were normal, although somewhat flat, and with increasing negative mean values over 'JML category'. The sample size for each JML category ranged about 800 to 1000. For further details, see Fig. 1.

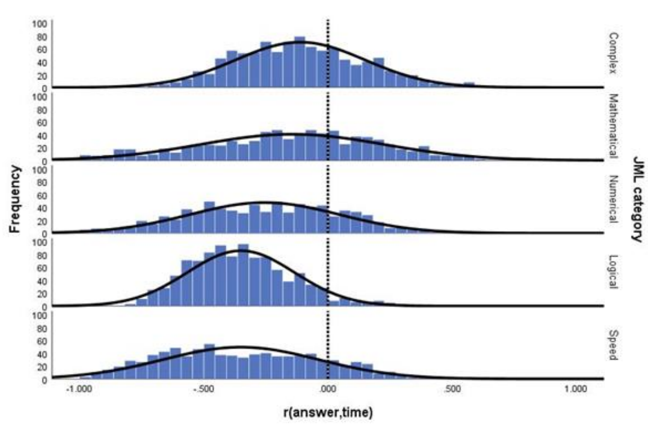

Fig. 1. Frequency distributions of individually based correlations between 'Correct answer' and corresponding 'Response time'. Distributions are shown across JML category. The vertical dashed line represents the position for zero correlation. The sample size for each JML category ranged approximately between 800 to 1000.

The Complex skills category produced the lowest absolute negative value, followed by the Mathematical category. The highest absolute negative values were associated with Logical and Speed skills categories. Descriptive statistics for the Fisher's z' transformed correlations (between Correct answer and Response time) showed increasing and incremental absolute values from complex to mathematical to numerical to logical to speed. In all, 4505 values were included in analyses (1025 Ss over the five JML categories). Thus, about 500 correlations were not computed due to missing values. For further details, see Table 1.

Table 1: Descriptive Statistics for Individual Fisher's z' Transformed Pearson Correlations (by 1025 Ss Over 5 Categories of JML Items) Between Correct Answer and Corresponding Response Time (N = 4,505).

Fishers z'			
JML category	**Mean**	**N**	**Std. Deviation**
Complex	-.120	1013	.288
Mathematical	-.187	828	.515
Numerical	-.307	791	.407
Logical	-.388	1021	.262
Speed	-.428	852	.425
Total	-.284	4505	.400

A line graph of means of Fisher's z' transformed correlations over JML category showed decreasing values. Means were shown to decrease from Complex skills down to Speed skills with confidence intervals (at 95%) generally not overlapping with each other. For details, see Fig. 2 (below).

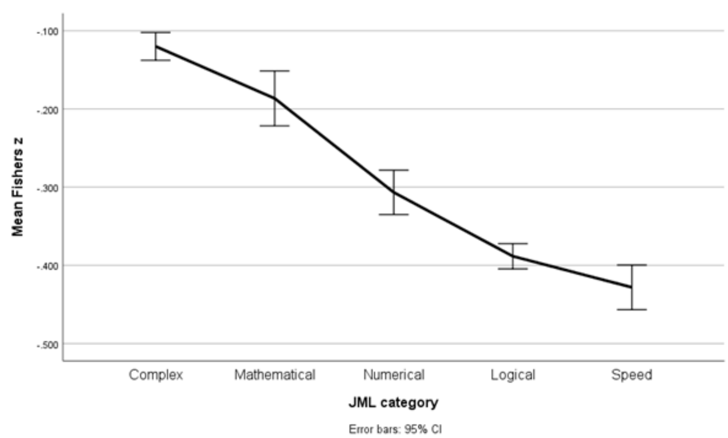

Fig. 2. Means of individual Fisher's z' transformed Pearson correlations between 'Correct answer' and corresponding 'response time' over JML category. Error bars represent 95% CI. (N ranged about 800 – 1000 over categories).

The ANOVA with repeated measures of Fisher's z' values over JML category was significant (F = 180.79 (4, 919.57), p = 0.00). A monotonously decreasing curve over categories was found. Adjacent categories differed significantly for Fisher's z' values over JML category (using adjustment for multiple Bonferroni comparisons). See Table 2 (below), for a detailed overview.

Table 2: Adjacent Pairwise Comparisons for Fischer's z' Values Over JML Categories Using Adjustment for Multiple Bonferroni Comparisons (Based on Estimated Marginal Means).

(I) JML category	**(J) JML category**	**Mean Difference (I - J)**	**Std. Error**	**df**	**Sig.**	**95 % Lower Bound**	**Confidence Interval for Difference Upper Bound**
Complex	Mathematical	.070	.019	862.578	.003	.016	.124
Mathematical	Numerical	.121	.023	818.122	.000	.057	.185
Numerical	Logical	.077	.016	841.044	.000	.032	.123
Logical	Speed	.055	.014	858.064	.001	.016	.095
Note: JML = JobMatch Logic; CI = confidence interval.							

Given the results presented above, the JML categories may be described alternatively: At the upper end of the curve, Complex and Mathematical are grouped, and at the lower end Logical and Speed. In the middle resided the Numerical category. Behind this pattern, two types of cognitive processing could be discerned: 'experiential' (Complex, Mathematical) vs 'intuitive' (Logical, Speed), respectively. The intervened category, Numerical, could be described as 'intuitive processing within framed experience'. Thus, the JML categories could be ordered from 'experiential' to 'intuitive' (Complex, Mathematical, Numerical, Logical, Speed).

4. Discussion

The present findings may be summarized as follows.

- The frequency distributions of individually based correlations between 'Correct answer' and corresponding 'Response time' were all normal, despite a small degree of 'flatness'.
- The correlations between 'Correct answer' and corresponding 'Response time' over JML category showed increasing and incremental absolute values from complex to mathematical to numerical to logical to speed.
- Variance analysis of Fisher's z' values over JML category showed a monotonously decreasing curve over the skills categories.

It seems to be the case that 'experiential' skills acquisition may be: (a) tied to emotional arousal, (b) renders a safe environment [6], and (c) maintains adequate processing time and understanding of the process [7], whereas 'intuitive' skills induce logical reasoning performances at higher levels for logic/statistics [1].

5. Limitations

No demographic aspects, such as age, education, or occupational orientation, were included in the present analyses. It ought not to be concluded that the present results were assumed to be demographically invariant. On the contrary, these aspects will be addressed in future studies.

6. Conclusions

The propensity for an interference task, occurring immediately after the initial temporal encoding to affect the process of consolidation in reference memory implies that higher levels of cognitive performance ought to be associated with lower response time (i. e. faster rate) among skill categories.

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