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Short Summary

Cognitive Performance as a Function of Job Match Logic Aptitude Test

Trevor Archer*, **Bengt Jansson, Klaus Olsen and Rose Mary Erixon**

Job Match Talent, Sweden

ABSTRACT

In the present study, the relationships between the correct answering of the JML apti-tude test, i.e. "correct answers", and the time each participant required to answer for each item, i.e. "time to answer", were assessed. Both single and combined measures were used to analyse the results that were derived from 1028 participants using the JobMatch Logic Aptitude test instrument. These showed that the correlations between "Correct answers" and "Time to answer" were, to the greater extent, both high and in the negative direction (-0.60 to -0.89), which implied that the "correct answers" related strongly with the shorter intervals within the "time to answer". One exception though arises concerned the mathematical items (-0.27), wherein the tendency of shorter re-sponse time versus a higher proportion of correct answers, seemed not to reach a level of sufficiency. The combined measure of "Rate of answering" produced even higher, yet positive, correlations with "Correct answers", than did "Time to answer", with compa-rable relationships appearing for the other combined measure "Prediction of outcome". The findings are discussed within the context of intuitive processing among individu-als presenting high-capacity logic reasoning in cognitive performance.

Keywords: Cognition - JML - logic reasoning - "correct answers" - "time to answer" - high-capacity - performance.

INTRODUCTION

The highly complicated notion of 'rationality' may often be construed from distinctive constructs derived principles taken from physics, social sciences, psychology, evolu-tion, economy, political studies, philosophy, and other disciplines that contribute to 'in-tuitive rationalisation for logical inferences (Morado and Savion, 2007). It has been hy-pothesised that 'intuitive' (Type I) processes, as opposed to 'deliberate' (type II) en-gagement, may differentiate between high- and low-capacity reasoners, rationalisers, in adjudging the performance phenomenon of high-capacity individuals on reasoning tasks (Stanovich and West, 2000; Stanovich and Toplak, 2019). In a reasoning study, it was found that high-capacity reasoners performed at higher levels for logic/statistics than did belief judgments when these two were conflicted, whereas the reverse was true for low-capacity reasoners. Specifically, for high-capacity reasoners, statistical in-formation interfered with their ability to make belief-based judgments, suggesting that, for them, probabilities may be more intuitive than stereotypical notions (Thompson et al., 2018) with an extent of the accuracy-capacity relationship observed in reasoning occurring as a consequence of the 'intuitive' (Type I) processing propensity. Certain studies have been focussed upon the necessity of understanding cognitive performance of logic mathematics amongst young college-attending individuals by the Chinese students' performance on a test battery consisting of advanced mathematics and a battery of seventeen cognitively-oriented tasks utilising basic numerical processing, complex numerical processing, spatial abilities, language abilities, and general cognitive pro-cessing (Wei et al., 2012). They observed that spatial abilities were significantly corre-lated with the subjects' performance in advanced mathematics, after controlling for other factors. Additionally, certain language abilities (such as the comprehension of words and sentences) made unique contributions to the results also. Contrastingly, the levels of basic numerical processing and computation were not generally correlated with performance in advanced mathematics (see also, Houdé and Tzourio-Mazoyer, 2003). Finally, among a population of young adult medical students

Correspondence to: Trevor Archer, Department of Psychology, Job Match Talent, Sweden. Email: trevorcsarcher49@gmail.com

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several character-istics of logic reasoning ability were observed, namely taking control of events, recog-nising and responding to relevant information concerning issues, specifying signs and symptoms, asking specific questions that focussed upon the pathophysiological think-ing and etiology, placing each question in its logical order, checking for agreement with patients, summarising conclusions and body language (Haring et al., 2017).

The recently introduced recruitment instrument JobMatch Aptitude Logic (JML) test in-strument was evolved to estimate cognitive performance within the scope of logic and intelligence testing. Central to its endeavours, the processing of rational reasoning within cognitive tasks of complex demands is required. In this context, the responses of high-capacity, as opposed to low-capacity, reasoners, applying the accuracy-capacity relationship observed in reasoning occurring as a consequence of the 'intuitive' (Type I) processing propensity, is expected to produce both higher levels of accuracy com-bined with a greater rate-of-processing (more speed) in cognitive performances.

Purpose

The purpose of the present study was to analyse the relationships between the correct answering of the JML aptitude test instrument and the "time needed taken to answer" for each item. Essentially, would the proportion of "correct answers" be liable to in-crease as longer response times, "time to answer" were registered, or would the reverse be observed, i.e. a greater number of "correct answers" would be associated with short-er response times, i.e. shorter "times to answer"?

METHOD AND MATERIALS

Selection of Participants

A total of 1028 individuals participated in the study, aggregated over the 84 items of the JML test. Selection of participants: Participants were recruited by use of two social net-working services. Invitations were sent to specific groupings in LinkedIn and Face-book. Through these procedures the final of 1,028 subjects were assembled for partici-pation in the study.

Participants

In this study, 385 students were selected through proportionate stratified random sampling from 10 public secondary schools in Mbeere South Sub-county of Embu County, Kenya. One hundred and ninety six (50.26%) were boys while 189 (48.46%) were girls. The participants were aged 16 to 23 years (M = 16.65, SD=1.31) and they were all form three students. Majority of the participants (78 %) were aged were aged between 15 and 17 years. Form three students were selected for the study for two reasons: First, in Kenya, form three students are in middle and late adolescence. These students had been in secondary school for at least three years and had already selected subjects for the KCSE examination. The students were likely to have definite academic values and to be pursuing specific achievement goals. In addition, using secondary school students in Kenya helped address a gap in literature.

Demographical issues

A greater proportion of female participants (72.9%) women took part in the study, whereas the proportion of male participants amounted to 25.4%, with 1.7% of the popu-lation failing to specify their gender. Furthermore, the mean age was 44.7 years (SD = 12.6), with the female participants presenting a slightly older (M = 4 6.0, SD = 11.6) age level than were males (M = 41.4, SD = 14.4).

The participants all reported their educational levels: University level (5 years or more) was postulated by 24.7%, and a post-secondary education was specified by 50.5%. The educational level for the remaining participants was postulated as secondary school level (20.8%), and elementary school level (3.4%), respectively. Furthermore, 504 participants (49.0%) accounted for their occupational areas, or professional roles, during the last five years. Four occupational areas (in sum, 29.9%) were of highest oc-currence: health care (8.8%), consulting (8.3%), administrative work (7.1%), and lead-ership (5.7%). The remaining part (19.1%) included nine different areas.

Instrument

The JobMatch Logic (JML) Aptitude test consists of 84 items which were divided into five categories: Complex, Mathematical, Numerical, Logical, and Speed.

JobMatch Logic offers a Cognitive Aptitude test instrument that is designed to predict and esti-mate Cognitive performance in relation to problem-solving and logical reasoning.

The instrument presents five main traits:

Numeric understanding

The person´s general understanding of numbers based on basic arithmetic's

Mathematical understanding

The person´s general understanding of mathematics principles.

Logical reasoning

The person's ability to make inference-based conclusions.

Complex Cognition

The person's ability to understand complex ideas and information.

Cognitive Processing Speed

The speed in which the person can understand and react to information.

Design

The study was focused on the item level of the JML test. As a consequence, use of ag-gregated data was convenient. Two types of measures were used to analyse the rela-tionships between "correct answers" on each item, and the "time needed for answer-ing".

The first type was characterised as single measures. The first single measure was the proportion of "correct answers" on each item. The other single measure was the mean "time for answering" each item.

The second type was characterised as combined measures. "Rate of answering" was defined as the proportion of correct answers divided by time for answering. This was performed for each JML test item. In addition, a measure of predicted outcome was re-lated to each item. This was accomplished by use of logistic regression of answers on time with interactions between item (describing 84 levels) and time. The corresponding regression coefficients were used as a combined measure.

Statistical procedure

The single measures were built up by aggregating "correct answers" for each item, which in turn was based on a sample of 1028 participants. Moreover, the combined measure concerned with logistic regression was controlled for model fit (pseudo R-square), and also percentage of correct predictions.

The main purpose of the statistical analyses was to show correlations between "correct answers" and the other single and combined measures.

RESULTS

The logistic regression of "correct answers" on time with interactions between items and time showed acceptable model fit. In this study, R-square was 0.20 (the Nagelkerke R square: Nagelkerke's R square provides an adjusted version of the Cox & Snell R-square that adjusts the scale of the statistic to cover the full range from 0 to 1), and the percentage of correct predictions was 72.8%.

The frequency distributions of the single and combined measures were controlled for digressions from the normal distribution. All four measures were somewhat skewed, but in a rather similar, systematic manner. Thus, it would seem that the correlations were not likely to be particularly affected (See further details in Figure 1).

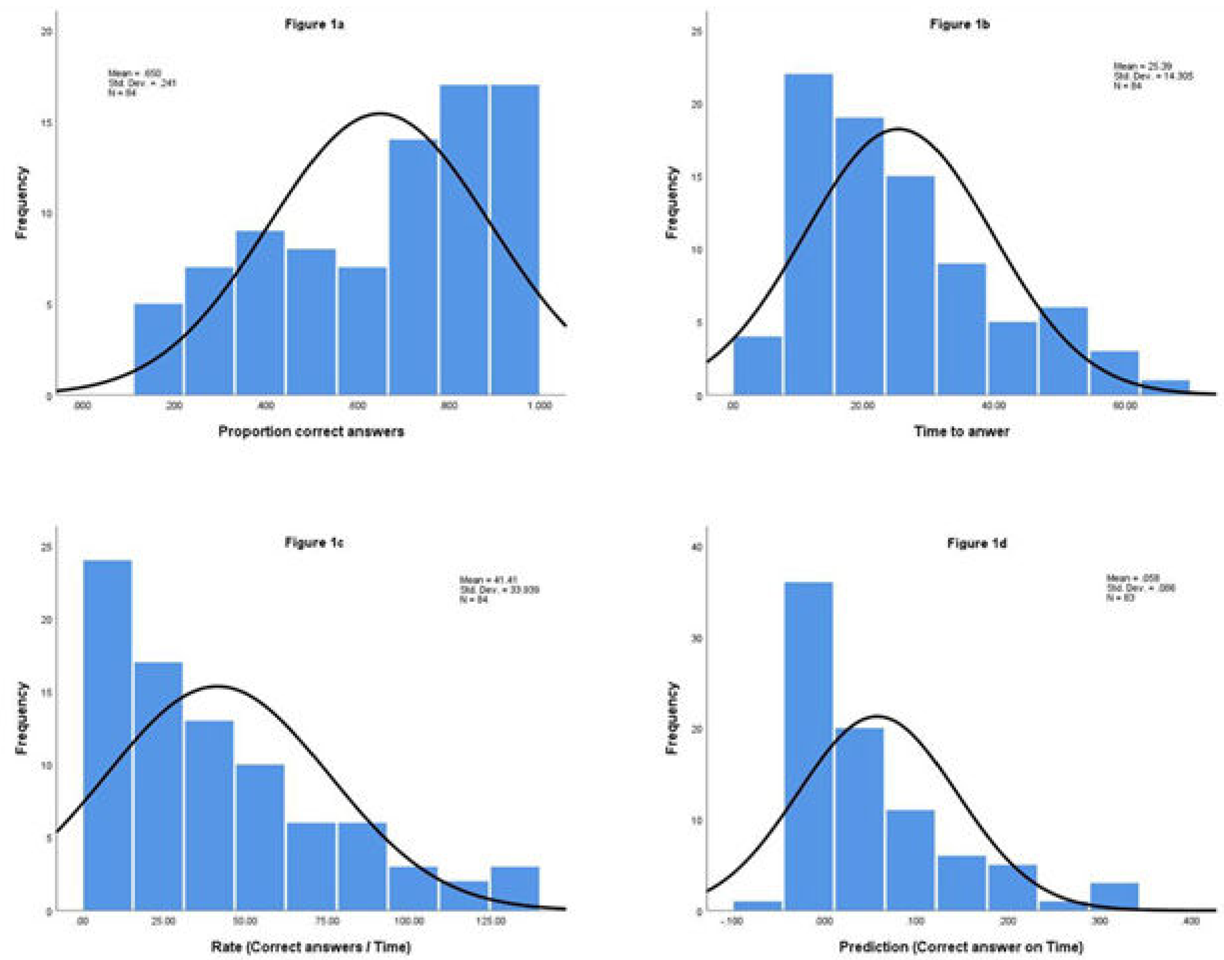

Figure 1a – d. Distributions of single measures (Figures 1a – b), and of combined measures (Figures 1c – d), respectively, for the JML items (N = 84).

The correlations between "Correct answers" and "Time to answer" were, to the greater extent, both high and in the negative direction (- 0.60 to - 0.89), implying that the former related strongly with the shorter intervals within the latter. However, there was one ob-vious exception that concerned with mathematical items (- 0.27). For these items, the tendency of shorter response time vs higher proportion of "correct answers", seemed not to reach a level of sufficiency.

Moreover, the combined measure of "Rate of answering" had even higher, but positive, correlations with "Correct answers", than did "Time to answer". Similar relationships appeared for the other combined measure "Prediction of outcome" (For more detailed results, see Table 1).

Table 1. Pearson correlational analysis for the JML aptitude test between "correct answers" and (i) "time to answer", (ii) "rate of answering", and (iii) predicted outcome, respectively (N=84#)

JML	Correct WITH		
category	Time	Rate	Prediction
All items (N = 84)	–.75**	.79**	.77**
Complex (n = 22)	–.62**	.92**	.84**
Mathematical (n = 15)	–.27	.57*	.78**
Numerical (n = 20)	–.83**	.82**	.82**
Logical (n = 30)	–.89**	.80**	.78**
Speed (n = 12)	–.60*	.72**	.84**

* p < .05; ** p < .01, two-tailed.

Notations:

Correct = Proportion of "correct answers";

Time = "Time to answer";

Rate = "Correct answers" / "Time";

Prediction = Logistic regression of Correct answers on Time using regression coefficients.

Note#. Observations were aggregated values (number of Ss was 1025) over JML items. Furthermore, 15 items (out of 84) were included in two JML categories.

In sum, "Correct answers" was related negatively to "Time to answer", and, yet more highly, related to the combined measures (Rate and Prediction), which as noted above implies that higher levels of "Correct answers" required shorter times to be answered. With the exception of mathematical items, the tendency mentioned above was rather consistent across the other four JML categories.

DISCUSSION

The findings of the present study were remarkably unambiguous and consistent: greater performance through the production of more "correct answers" required shorter intervals for each of the four categories, i.e. complex, numerical, logical and speed, whereas the fifth, mathematical items, did not reach a sufficient level of correlational significance. These items seem to be 'part-and-parcel' of complex numerical and gen-eral cognitive processing, and therewith suitable for the assessment of rationality and logical reasoning tasks.

As indicated (above), the notion that 'intuitive' (Type I) processes, as opposed to 'delib-erate' (type II) engagement, may differentiate between high- and low-capacity reason-ers, rationalisers, in adjudging the performance phenomenon of high-capacity individ-uals on reasoning tasks has been lent some degree of credence. In this context, the ability to make rapid intuitive logical judgments has been shown to be related to indi-vidual differences in strategy use, essentially high-capacity versus low-capacity rea-soners (e.g. Bago and de Neys, 2017; de Chantal et al., 2019). Consequently, it is un-surprising to observe that placed under conditions of severe time constraint, cognitive capacity offers an extremely limited and poor predictor of reasoning capacity, whereas the mobilisation of 'strategy use' becomes a stronger predictor of fast high level perfor-mance (Markovits et al., 2020). Their findings have been extended to the notion that these individuals have developed a capacity for deriving rapid intuitive "logical" judg-ments and concurrently highlight the necessity for 'strategy use' as a central individual propensity for fast, high-performance reasoning. The present findings demonstrate that individuals showing high levels of logical reasoning respond with higher levels of speed and "rate-of-answers" in a similar fashion to that observed among high-capacity responders utilising 'intuitive' processes. Further investigation ought to be directed to-wards the influences of other parameters upon the 'fast-and-correct' performance with-in logical reasoning, such as gender and age, e.g. since gender differences have been obtained in the processing of negative emotions and in complex mental rotation tasks (Benenson et al., 2018; Markovits, 2019).

Limitations

This study has applied its focus on the JML test item level, an approach that made it convenient to utilise the aggregated data resulting in a sample size that was equal to the number of JML items (N = 84). Nevertheless, future studies pertaining to relation-ships between "Correct answers" and "Time to answer" ought to choose a different strategy in order to investigate specific individual outcomes between these relation-ships. Nevertheless, it would appear that the existing level of power remains reassur-ing.

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