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ABSTRACT

The Luria-Das Information Processing Model of human learning holds that information is analysed and coded within the brain in either a simultaneous or a successive fashion. Simultaneous integration refers to the synthesis of separate elements into groups, often with spatial characteristics; successive integration means that information is processed in a serial order, so that information is surveyable only in a temporal, orderly manner, with knowledge of each bit of information dependent on the previous bit. To investigate the relationship betwen simultaneous-successive processing and academic achievement, undergraduate college students (N=157) completed six processing tasks: the Raven Progressive Matrices, memory for design, and figure copying (indices of simultaneous processing); and free recall, serial recall, and digit span-forward (indices of successive processing). Students' task scores were then compared with their cumulative grade point average (GPA) and American College Testing (ACT) composite scores. Analyses of results indicated that the level of simultaneous and successive processing was related systematically to GPA; high levels of both processing modes were necessary for high GPA achievement. Simultaneous processing seemed relatively more important than successive processing for high ACT performance, perhaps due to the ACT's emphasis on complex reading. (WAS)

The Relationship Between Simultaneous-Successive Processing and Academic Achievement

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Running head: Simultaneous-Successive Processing and Achievement

Abstract

The present study investigated the relationship between simultaneous-successive information processing and academic achievement among 157 college students. A factor analysis of 6 tasks comprising the simultaneous-successive battery yielded a two factor solution. Four processing groups were formed using factor scores as criteria. Cumulative grade point average (GPA) and composite American College Testing (ACT) scores represented the dependent (achievement) variables. Results indicate that level of simultaneous and successive processing is related systematically to GPA; high levels of both processing modes are necessary for high GPA achievement. Alternatively, simultaneous processing seems relatively more important for high ACT performance. These results are discussed as they relate to task demands of the ACT and GPA.

The Relationship Between Simultaneous-Successive Processing and Academic Achievement

The study of human learning often progresses by using scientific models consistent with the existing zeitgeist. For example, several current cognitive models utilize computer programming to simulate learning. Similarly, increasingly sophisticated neurophysiological research has made neuropsychological models more relevant. Recently, these two types of models have been integrated, creating a neuropsychological model of human learning which is typically described in computer processing terminology. Founded upon A.R. Luria's clinical observations (Luria, 1966a, 1966b), this model has been elaborated and extended by J.P. Das and colleagues via empirical research (see Das, Kirby, & Jarman, 1979). This model is often termed the Luria-Das Information Processing Model.

The structural and processing features of the Luria-Das model can be briefly described as follows. The brain is composed of three units. Unit 1 is primarily composed of upper/lower brain stem organs and is responsible for the arousal or motivational function; Unit 2 is located in the posterior region of the neocortex including the occipital, temporal, and parietal lobes. Unit 2 structures receive information, analyze it into elementary components, and code it into a symbolic/physiological form useful to the entire brain. Information is analyzed and coded within Unit 2 in either a simultaneous or a successive fashion. Simultaneous integration refers to the synthesis of separate elements into groups, often with spatial characteristics. Any part of the gestalt and its relative position is immediately surveyable. On the other hand, successive integration refers to the processing of information in a serial order so that information is surveyable only in a temporal, orderly manner, with knowledge of each bit of information dependent upon the previous bit. Finally, Unit 3 is comprised of the prefrontal lobes, and is responsible for planning, executing, and evaluating problem-solving strategies.

Conceptualizing human learning within this comprehensive model should provide guidance in the selection, validation, and interpretation of measurement instruments. Contrasted to traditional empirical approaches to intellectual assessment which are primarily based on predictive validity, the Luria-Das model utilizes relevant theoretical and empirical research to conceptualize cognitive functioning. Therefore, results from testing are amenable to interpretation within a meaningful conceptual framework and subsequent remedial strategies are easily established (e.g., Kaufman & Kaufman, 1979; Krywaniuk & Das, 1976).

Obviously, empirically derived tests which predict achievement are valuable to educators. Tests yielding good predictive validity and information relevant for interpreting performance would be even more valuable. Studies exploring the relationship between simultaneous-successive processing described within the Luria-Das model and academic achievement offer evidence that such tests may be possible in the near future. Results from elementary school age children indicate that simultaneous-successive processing and achievement are related, but in a complex way. For example, when a simultaneous-successive battery is administered along with reading achievement tests, results reveal that successive processing is the mode often employed by beginning readers; more sophisticated readers seem to rely on both modes (Das, Kirby, & Jarman, 1979).

The present study was designed to investigate the relationship between simultaneous-successive processing and academic achievement in college students. Questions focused on whether simultaneous-successive processing ability varied systematically with achievement. Individuals demonstrating high simultaneous and successive processing skills were expected to earn the highest achievement scores whereas those demonstrating low simultaneous and low successive processing skills were expected to earn the lowest achievement scores; consistent with the non-hierarchical nature of the model (Das, et al., 1979; Jarman, 1978), individuals demonstrating high simultaneous-low successive ability should perform similarly to those exhibiting low simultaneous-high successive ability.

Method

Subjects

Participants included 157 juniors and seniors enrolled in Educational Psychology courses at a mid-sized southeastern university. This sample was composed of 53 males, 104 females; 122 were white, 24 black. Ninety-seven were education majors. Data from males and females were combined for analyses (see Merritt & McCallum, in press; Kirby, cited in Das et al., 1979, for justification).

Simultaneous and Successive Tasks

Six tasks commonly used to assess simultaneous-successive processing were administered in group format. The tasks included:

Raven Progressive Matrices. This test is described as a culture-reduced measure of nonverbal reasoning (Raven, 1958). Participants indicated which of a given set of alternatives correctly completes a visual pattern. Fifteen of the 60 available items (every fourth item) were chosen for presentation.

Memory for Designs. The nine items from the Bender Visual Motor Gestalt Test (Bender, 1946) were presented for four seconds each. Following the presentation, examinees constructed the figures from memory.

Figure Copying. The last 12 figures from the Developmental Test of Visual Motor Integration (Beery & Buktenica, 1967) were presented for 30 seconds each and copied during that time.

Free Recall. Ten lists containing six monosyllabic words were presented orally. All 60 words appeared at the 1st, 2nd, or 3rd grade levels of the Slosson Oral

Reading Test (Slosson, 1963) or the Basic Sight-Word Test (Dolch, 1942). The order of recall was not critical.

Serial Recall. Ten additional lists of 6 monosyllabic words from the 1st, 2nd, and 3rd grade levels of the Slosson Oral Reading Test and the Basic Sight-Word Test were presented orally. The order of recall was critical.

Digit Span-Forward. This task required recall of increasingly longer lists of digits. The 14 lists ranged from 4 to 10 digits in length. Each was recalled and written immediately after oral presentation.

Rationale for Task Selection

Of the six tasks, Raven Matrices, Figure Copying, and Memory for Designs are considered indicies of simultaneous processing. Serial Recall, Free Recall, and Digit Span-Forward are purported to be measures of successive processing. Evidence for construct validity of the battery comes from several sources. Luria's clinical observations of brain-damaged individuals clearly indicate the existence of these two modes of processing, and the six tasks described above exhibit face validity; i.e., they appear to assess the two basic processing modes described by Luria. And though the simultaneous-successive tasks have been psychometrically classified into parallel categories such as nonverbal-verbal, visual-auditory, and reasoning-memory, the two factors which have emerged from analyses can be appropriately termed simultaneous and successive processing. For example, simultaneous processing is utilized in verbal tasks such as the perception of lexical ambiguity (Das& Jarman, 1980), in auditory tasks such as syllogisms (Cummins, cited in Das, Kirby, & Jarman, 1975), and in memory tasks such as memory for designs (McCallum & Merritt, in press). Additional convergent and discriminant validity is provided by Das et al.(1979).

Achievement Measures

Achievement measures were cumulative grade point average (GPA) and the

American College Testing (ACT) composite score. The scores were obtained from student records kept by the university.

Procedure

Before the simultaneous-successive battery was administered, a questionnaire requesting demographic data was completed by each student. The six tasks were then administered in group form, with simultaneous tasks alternating with successive tasks. The order of presentation of the tasks shifted systematically with each presentation. Administration was standardized using a slide projector and taped audio, and required approximately 55 minutes.

Task scores were subjected to a principal components analysis; factors with eigenvalues greater than 1.0 were rotated according to a varimax criterion. Grouping of subjects was accomplished on the basis of mean splits of factor scores. Therefore, group assignments reflect relative ability to process information. Performance of the group members were compared on ACT scores and cumulative GPA, the dependent variables. Contrasts predicted from the model employed one-tailed tests of significance.

Results

As in a previous study employing a college student sample (McCallum & Merritt, in press), the factor analysis of task scores yielded two factors labelled simultaneous processing (defined by Raven Matrices, Memory for Designs, and Figure Copying) and successive processing (defined by Free Recall, Serial Recall, and Digit Span-Forward). (See Table 1 for factor loadings.) Factor scores were subsequently obtained and became the criteria for assignment to one of four groups--high simultaneous-high successive (HiSim-HiSuc), high simultaneous-low successive (HiSim-LoSuc), low simultaneous-high successive (LoSim-HiSuc), and low simultaneous low successive (LoSim-LoSuc). Because group assignments were based on mean splits of factor scores, groups reflect relative ability to process information.

As previously mentioned, in order for performance to be consistent with the model, members of the HiSim-HiSuc group should have earned significantly higher achievement scores than members of any other group. Conversely, members of the LoSim-LoSuc group should have earned scores significantly lower than those from any other group. These ten contrasts were predicted by the model and allowed use of a priori *t* tests.[1] Performance of the group members within the two intermediate or "off-diagonal" groups should have been similar because the model suggests a nonhierarchical arrangement of the two processing modes. That is, the two groups high on only one processing dimension should have performed about equally. These two contrasts employed two-tailed criteria. Means, standard deviations, and *t* ratios for all group comparisons are presented in Table 2.

Insert Tables 1 and 2 about here

Results employing the cumulative GPA were consistent with predictions from the model for all contrasts. Table 2 presents the relevant values for the cumulative GPA analyses.

Results from analyses using the composite ACT scores were more ambiguous. Examination of the relevant values in Table 2 reveal only partial support for the processing mode. Three predictions were supported; three were not. The mean composite ACT for the HiSim-HiSuc group was significantly higher than the mean scores obtained by the LoSim-HiSuc group and the LoSim-LoSuc group. Also, the HiSim-LoSuc group mean score was significantly higher than the mean obtained by the LoSim-LoSuc group. However, contrary to prediction, the mean HiSim-HiSuc group score was not significantly greater than the mean from the HiSim-LoSuc group. Nor was the mean from the LoSim-HiSuc group significantly higher than the mean from the LoSim-LoSuc group. Finally, the two intermediate group means were not equivalent; the HiSim-LoSuc group mean was significantly higher than the mean from the LoSim-HiSuc group.

Discussion

The strong two-factor solution obtained from the initial factor analysis of the six cognitive tasks was anticipated. The solution is consistent with a rational analysis of task demands and with findings from numerous studies (see Das et al., 1979). Since these factors did emerge, further analyses were conducted to investigate the relationship of college achievement to simultaneous-successive processing.

When cumulative GPA was employed as the dependent measure, all predictions were confirmed. The cumulative GPA reflects performance in a wide variety of skill areas; apparently both simultaneous and successive processing substantially mediate broadly-based classroom performance. Individuals within the HiHi group performed better than those high in only one area; those high in only one processing dimension out-performed those in the LoLo group; and those in the two "off-diagonal" groups performed equally well. These results provide support for the model and are consistent with the contention that the modes are nonhierarchical.

Three of the six predictions using the composite ACT score were not supported--the HiSim-HiSuc group did not earn a higher mean ACT score than the HiSim-LoSuc group; the LoSim-HiSuc group did not earn a higher mean ACT score than the LoSim-LoSuc group; and, finally, the HiSim-LoSuc group did earn a significantly higher mean score than the LoSim-HiSuc group. Thus, the contrasts not conforming to predictions substantiate the relative importance of the simultaneous processing mode for attaining higher ACT scores. But because test reviewers (e.g., Wallace, 1975) have criticized the ACT for a heavy reading component, the exceptions may be interpreted within the context of previous results which emphasize the importance of simultaneous processing skills for complex reading (Cummins & Das, 1977). That is, if the ACT is interpreted as a measure of sophisticated reading skills, then the superordinate status of simultaneous processing in the ACT measure may be explained by the theory.

In summary, the present results are consistent with the Luria-Das model. Specifically, there appears to be a relationship between cognitive processing ability and academic achievement of college students. In general, higher simultaneous processing is important for superior ACT performance whereas higher simultaneous and successive processing are necessary for superior GPA.

Implications

Rigorous experimental hypotheses testing of the Luria-Das model is clearly needed. Thus far, educators have been relatively unsuccessful in identifying appropriate treatment x aptitude models (Reynolds, 1981). But research into cognitive functioning within this model appears promising. For example, once simultaneous or successive deficits have been identified, remedial strategies become apparent. Means of identifying simultaneous-successive deficits include the use of the battery and methodology described within the present paper. A second method, currently becoming available, is called the Kaufman Assessment Battery for Children (K-ABC) (Kaufman & Kaufman, 1983). The availability of this instrument and the increasingly abundant research findings investigating the model should hasten efforts to explore the efficacy of the model within educational and clinical settings.

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Footnote

[1]The model-based hypotheses of the present study were based on the assumption that the dependent achievement measures required both processing modes in about equal proportions. Therefore, the use of multiple a priori *t*'s was justified, and the concomitant increased probability of Type I error was tolerated. In retrospect, this assumption was not justified for the ACT dependent measure (i.e., simultaneous processing is apparently more important), but the *t* ratios of the ACT measure exceed the more conservative $\alpha < .01$ value in all cases of significance.

Table 1

Factor Analysis of Scores from Six

Cognitive Tasks-A Varimax Rotation

Tasks	Successive	Simultaneous
Digit Span	.85	-.02
Free Recall	.76	.34
Serial Recall	.81	.24
Raven Progressive Matrices	.11	.77
Memory for Designs	.22	.58
Figure Copying	.10	.85

Table 2

Comparison of the Means of Cumulative GPA and Composite ACT for Information Processing Groups

GROUPS	ACT				GPA			
	M	SD	t	df	M	SD	t	df
HiSim-HiSuc	18.92	3.80	.07	63	3.04	.48	2.47**	82
HiSim-LoSuc	18.85	4.58			2.77	.50		
HiSim-HiSuc	18.92	3.80	3.35**	60	3.04	.48	2.21*	77
LoSim-HiSuc	15.70	3.43			2.79	.49		
HiSim-HiSuc	18.92	3.80	4.73**	63	3.04	.48	4.37**	90
LoSim-LoSuc	14.38	3.77			2.56	.56		
HiSim-LoSuc	18.85	4.58	2.69**	47	2.77	.50	.15	63
LoSim-HiSuc	15.70	3.43			2.79	.49		
HiSim-LoSuc	18.85	4.58	3.83**	50	2.77	.50	1.71*	76
LoSim-LoSuc	14.38	3.77			2.56	.56		
LoSim-HiSuc	15.70	3.43	1.27	47	2.79	.49	1.79*	71
LoSim-LoSuc	14.38	3.77			2.56	.56		

* $p < .05$

** $p < .01$