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Word Processing:
What Cognitive Abilities Play
an Important Role in
Determining New Users' Performance?

By

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Abstract

This study explores the spatial and verbal cognitive skills involved in learning to use a word processor. Forty students were trained, and then, tested on how well they learned to use a word processing program on the Macintosh computer system. An assessment of each individual's spatial and verbal skills, previous experience with and attitudes towards computers, and profile of hemispheric processing were obtained. Because self-reported computer skill predicted how quickly the 40 participants completed the computer test, a subgroup composed of the 33 most naive users was created. Reported skill did not correlate significantly with performance for this subgroup. The best predictor of performance was the WAIS-R Block Design ($r = -.486$, $p < .005$) followed by ACT score ($r = -.378$, $p < .025$). Although the Block Design score was correlated with ACT score, the Block Design score was still a significant predictor of performance ($r = -.400$, $p < .05$), even after partialling out the effect of ACT. Thus, individuals with high Block Design scores completed the computer test more quickly than individuals with low scores. No other tasks significantly predicted performance, although, as found by other researchers (Gomez, Egan & Bowers,1986; Sebrechts, Deck, Wagner & Black,1984), good performance on the Nelson-Denny reading test was associated with good performance on the computer test ($r = -.202$, $p > .10$). This pattern of results suggests that spatial abilities with a sequencing component, such as the Block Design task, may best predict the ability to learn to use a word processing program on the Macintosh computer system.

Word Processing: What cognitive abilities play an important role in determining new users' performance?

As the number of jobs for which people use word processors continues to grow, it would be useful to predict which prospective employees will learn to use a word processor most quickly. In addition, the capability to tailor computer lessons to fit a new user's particular cognitive style would be extremely advantageous if it enabled him or her to learn more efficiently.

An extensive search of the literature revealed that most of the studies on word processing to date have explored areas other than the topic of interest- the cognitive abilities of naive users that predict success in learning to use a computer. For example, some experimenters studied the effect of different command names on learning (Landauer, Galotti & Hartwell, 1983; Ledgard, Whiteside, Singer & Seymour, 1980), and others worked on creating a model to predict how an expert user makes corrections to manuscripts (Card, Moran & Newell, 1980). Only two studies have focused directly on the question of what cognitive factors predict a new user's word processing abilities. These two studies found that reading ability, spatial abilities and age predicted performance (Gomez, Egan & Bowers,1986; Sebrechts, Deck, Wagner & Black,1984).

In one study, Gomez, Egan and Bowers (1986) had 33 naive users learn three commands with the help of a tutorial. To assess performance Gomez et al. chose to use three measures- reading time between exercises on the tutorial, execution time of a successfully completed command, and the proportion of times an error was made the first time a command was attempted. They were interested in what characteristics of an individual could predict performance on their computer tasks. Thus, Gomez et al. measured characteristics including spatial and verbal skills, typing ability, amount of education, age, and reasoning ability. Three of the characteristics- age, reading ability, and spatial memory, correlated with the performance measures used. The Nelson-Denny Reading Test- a three-part test measuring reading comprehension, vocabulary, and reading speed, was the best predictor of the reading time performance measure ($r = -.66, p < .001$) and also correlated with execution time persuccessful change ($r = -.41, p < .05$). Thus, people who had good reading skills (a high score) had a lower reading time performance score and a lower execution time score because he or she read and performed the text changes faster.

Age and spatial memory were the best predictors for first-try errors and execution time per successful change. Age correlated with first-try errors ($r = .50, p < .01$) and with execution time per successful change ($r = .57, p < .001$). These results indicate that older individuals tend to make more mistakes and work more slowly than younger individuals. Spatial memory was assessed by the Building Memory test for which subjects were presented with a map of 12 buildings, and then, asked to recall the placement of the buildings on a blank map. This task correlated with first-try errors ($r = -.49, p < .01$) and with execution time per a successful change ($r = -.58, p < .001$). Therefore, people with good spatial memory scores made fewer mistakes and had faster execution times compared to individuals who had poor spatial memory scores. In addition, spatial memory correlated with the reading time performance measure ($r = -.40, p < .01$). Thus, an individual with a good spatial memory score read the tutorial faster.

Several other characteristics assessed by Gomez et al. did not correlate significantly with any of the performance measures. These were attitudes towards computers, estimated typing speed, text-editing vocabulary, and experience with computer-like devices.

Sebrechts, Deck, Wagner and Black (1984) had their 24 subjects work through a tutorial and then make modifications to two documents. The number of modifications completed in a specified time period on these two documents served as the performance measure. Sebrechts et al. assessed the reading, spatial memory, associative learning, sequence recognition, format checking and logical thinking abilities of their subjects. The Nelson-Denny Reading Test correlated with their performance measure ($r = .52, p < .05$) as it did in Gomez et al.'s study. Thus, the higher an individual's reading ability score, the more modifications that individual successfully made in the allotted time. In addition, two other tests correlated with performance- format checking ($r = .40, p < .05$) and sequence recognition ($r = .42, p < .05$). Here again, a good score on these two tasks is associated with an individual successfully making more modifications to the documents. Both of these tests are part of the Computer Operator Aptitude Battery. Format checking entails performing string conversions based on a set of simple rules. Sequence recognition involves ordering items in the order of their occurrence. Although not elaborated upon by Sebrechts et al., both of these tasks seem to require that the subject follow or replicate a particular order or sequence in order to correctly perform the task. However, the Building Memory test did not correlate significantly with performance ($r = .27$). Also, the performance measure did not correlate significantly three other abilities that were measured- typing speed, a logical thinking test requiring the subject to fill in missing information in flowcharts, and a paired-associate learning task which uses pictures and numbers.

The authors of both studies agreed that the Nelson-Denny Reading Test correlations are a reflection of the reading necessary for word processing. Sebrechts et al. also postulated that the consistency was due to the fact that verbal abilities generally correlate with other measures of reasoning, seeming to infer that the Nelson-Denny Test is correlated with general intelligence.

However, the role of spatial abilities was not agreed upon by the authors. Gomez et al. postulate that spatial memory is important for word processing because users must scan both the computer screen and the sheet of paper with the changes to be made on it in order to make the modifications. In addition, they postulated that people with good spatial memory may be able to remember the order of the different parts of each of the word processing commands more accurately than those people with poor spatial memory. Sebrechts et al. interpreted their results differently. Sebrechts et al. claim that their system is more complex than the one used by Gomez et al. because it had a larger range of commands and also allowed the user to use the computer to find the location of the change to be made through context searching. Consequently, Sebrechts et al. postulate that spatial memory will only have an effect on simpler systems such as the one used by Gomez et al. because the need to find the location of the change to be made is decreased in the system used by Sebrechts et al. However, they pose another reason for the obtained results- that spatial memory is a component of an ability to recall the order of items which is measured by their sequence recognition and format checking tasks. This alternative is supported by their finding that the scores on the format checking exercise correlated with those of the Building Memory test (r = .40). Thus, the Building Memory test should correlate positively with the performance measure if the effect of the format checking exercise is removed from the correlation. Unfortunately, Sebrechts et al. did not perform partial correlations on their data.

However, cognitive abilities are not the only characteristics that are related to word processing which should be taken into account. A review article of other studies not specifically directed towards using cognitive abilities as a predictor of word processing abilities revealed that gender, age, grade point average, previous experience using a computer, level of education, and typing speed are related to the ability to learn to use a computer (Allwood, 1986). In addition, attitude and anxiety towards computers have been found to affect the ability to learn to use a computer (Paxton & Turner, 1984; Cambre & Cook, 1985). Although not specified, it is plausible that grade point average, previous experience, level of education and typing speed all should be positively correlated with learning to use a computer. However, Gomez et al.'s and Sebrechts et al.'s studies did not show an effect for typing speed. This may have occurred because both studies used rather homogeneous groups, secretaries and students, as their subjects. Gomez et al. did find a relationship between age and computer skills such that older individuals tended to make more mistakes and worked more slowly than younger individuals. A review article by Paxton and Turner (1984) states that a negative attitude towards computers impedes learning because individuals learn slower, make more mistakes, and are less motivated to work with computers. In addition, Cambre and Cook's (1985) review article, as well as Paxton and Turner's (1984), concluded that computer anxiety adversely affects learning to use a computer. Gender seems to have an effect on performance in that males tend to be less computer anxious than females (Cambre & Cook, 1985).

Thus, the current literature indicates that reading comprehension, spatial memory, sequence recognition, and format checking are all cognitive abilities associated with learning to use a computer. However, the importance of each is still relatively unknown. In addition, several other characteristics have been correlated with a new user's performance, but none consistently. These characteristics include age, gender, grade point average, level of education, typing speed, and attitudes and anxiety towards computers.

Hence, more research is needed to expand upon what cognitive abilities and other individual characteristics are important for word processing. The purpose of the present study is two-fold. First, the present study attempts to replicate and expand upon parts of Gomez et al.'s (1986) and Sebrechts et al.'s (1984) experiments by attempting to tease apart the specific verbal and spatial abilities needed for word processing. In the present study, performance is assessed by the average of the standardized times it took to complete each of a variety of word processing commands on two documents using the Macintosh computer. The reading comprehension subtest and the reading rate subtest of the Nelson-Denny Reading test, and a word fluency task are used to assess verbal abilities. Spatial abilities are measured by Thurstone's spatial thinking test (Flags), the WAIS-R Block Design subtest, and a design fluency task. Each one of these tasks incorporates a different spatial component. The Flags task is an index of the ability to visualize a rigid configuration when it is moved into different positions. The Block Design test involves constructing predetermined designs using four to nine colored blocks. The design fluency task is a paper and pencil task for which individuals create unique designs using lines. Therefore, if one test predicts performance better, the specific spatial abilities needed for word processing will become more evident (i.e. is motor manipulation, visualization or creativity more important?). In addition, the characteristics- gender, age, attitudes towards and anxiety of computers, typing speed, and experience with computers, implicated as important by Paxton and Turner (1984) and Allwood (1986), are assessed by written questionnaires.

Second, this study attempts to determine if individual differences in hemispheric processing of information can predict who will learn word processing quicker. For the most part, it is accepted that the right hemisphere is better at performing spatial tasks while the left hemisphere is better at verbal tasks for right handers (see for instance, Springer & Deutsch, 1985). Furthermore, individuals appear to have a characteristic tendency to engage one hemisphere in processing information more than the other hemisphere (e.g. Gur & Reivich, 1980). Therefore, regardless of whether the task is verbal or spatial in nature, some individuals tend to have a greater than average participation of the right hemisphere while others tend to have a greater than average participation of the left hemisphere. These characteristic tendencies may play a role in word processing. Thus, if spatial abilities are more important for learning to word process, then one would expect that a person who prefers to use his or her right hemisphere will perform better than the one who prefers the left hemisphere, whereas, if verbal abilities are more important, then a person who prefers to use his or her left hemisphere should perform better.

An individual's characteristic tendency to engage a particular hemisphere can be inferred from directly observable behaviors. The task used in this study asks an individual to determine which of two chimeric faces looks happier to him or her. This person's characteristic tendency to engage a particular hemisphere is inferred by the percentage of faces chosen as looking happier based on the smiling side of the chosen face in a series of pairs of faces composing the 'facebook' (Levy, Heller, Banich & Burton, 1983a). The score on this chimeric face task predicts the performance pattern on various tachistoscopic tasks. Thus, a person who shows greater than average left hemisphere participation on the chimeric face task also will show greater than average left hemisphere participation on other lateralized tasks (Levine, Banich & Koch-Weser, 1984; Levine, Banich & Koch-Weser, 1988; Levine, Banich & Kim, 1987; Levy, Heller, Banich & Burton, 1983b)

The Macintosh computer incorporates the mouse to position the cursor and pull down the menus for the commands while the systems used by Gomez et al. and Sebrechts et al. access the commands through a more verbal means, for example, typing the command in on a command line. Hence, it is possible that spatial abilities combined with motoric abilities will play a more important role in the Macintosh system than in systems similar to the ones used by Gomez et al. and Sebrechts et al. In addition, a spatial task which involves more movement (e.g. the Block Design Task) should have a higher correlation with performance than one that does not because of the movement required to perform each of the commands. Further, reading comprehension, as assessed by the Nelson-Denny Reading Test, is predicted to have the highest correlation with performance among the verbal tasks.

Method

Subjects

The subjects consisted of 40 right handed undergraduates (26 women and 14 men) who participated for credit in an introductory psychology course at the University of Illinois. None knew how to use the Macintosh computer, although some had had limited experience with other personal computers.

Materials

Spatial tasks

Block Design. This is one of the performance subtests from the Wechsler Adult Intelligence Scale (WAIS-R)(Wechsler, 1981). The task is to rotate red and white colored blocks to match a square pattern as quickly as possible. The task is scored by awarding points for both successfully completing the pattern and for how quickly the pattern was completed. In addition to its spatial component, Block Design has a motoric manipulation component, a sequencing or configurational component (Lezak, 1983), and has a high correlation with other indices of General Intelligence (g)(Chastain & Joe, 1987). Damage to the right parietal lobe of the brain drastically impairs performance on this task (Warrington, James & Maciejewski, 1986)

Flags. Thurstone, the creator of this test, called it a 'test of spatial thinking' (Thurstone & Jeffrey, 1959). The task is to match several rotated flags to a target flag, and determine whether they are the same or mirror images of each other. A person's score is a factor of both how accurately and quickly the test is completed. Inherent in this task is the ability to visualize different orientations of an object.

Design Fluency. The object of this task is to create as many novel designs as possible using four lines in four minutes. Factors involved in this task include creativity, spontaneity and motoric activity. Lesions in the right frontal lobe of the brain cause a large drop in the number of different drawings produced (Jones-Gotman & Milner, 1977).

Verbal Tasks

Reading Comprehension. Reading comprehension was assessed using the Nelson-Denny reading comprehension subtest (Form E) (Brown, Bennett, & Hanna, 1981). This task presented the subject with several passages to read. After each passage were multiple choice questions concerning the content of that passage. The participants in this study were given ten minutes to read and answer as many questions as they could.

Reading Rate. Reading Rate was measured during the first passage of the reading comprehension test (Brown et al., 1981). After thirty seconds of reading, the subject was asked to read a number next to the line they were currently reading. This number gave the experimenter an approximation of how many words per a minute the subject reads.

Word Fluency. For this test, subjects were asked to write down as many words beginning with the letter 's' as they could in two minutes. As with design fluency, two components of this task are creativity and spontaneity. Vocabulary is another component. Deficits in performance can occur because of lesions in the left orbital frontal regions of the brain and to a lesser degree, lesions to the right orbital frontal region (Milner, 1974).

Background Information

Typing. This typing test was composed of 50 five letter words presented one at a time on the computer screen. Basic components to this task are sequencing, manual dexterity, and a spelling skill.

Background Questionnaire. This questionnaire asked for the respondent's age, gender, and ACT composite, mathematics and English scores.

Computer Attitude Questionnaire. Developed by the University of Illinois Housing Department (Palmer, C. & Harnisch, D., 1988), this questionnaire has four categories: desire to use computers (desire), previous experience with computers (skill), perception of how important computers are (importance), and computer anxiety (anxiety). The items for each category are intermixed throughout the questionnaire and are answered using a seven point Likert scale. A high score on a scale indicates that that person has a high degree of that characteristic. For this experiment, the questionnaire was scored as follows: the desire scale is composed of six items, so the highest obtainable score is 42. The skill scale also has six items, but the low point is zero, so the highest level of skill is 36. The importance scale has ten items for a high score of 50. Lastly, the anxiety scale has eight items, so the highest obtainable score is 56.

Free-Vision Chimeric Face Task. This task was developed as an index of functional cerebral asymmetry for processing facial characteristics, and is used in this experiment to assess each person's preferred hemisphere for processing information. It is composed of 36 test items, one to a page. Each test item is composed of a pair of chimeric faces- one on the top of the page and one on the bottom. Each pair has a face which is smiling on the right half and has a neutral expression on the left half. The other member of the pair is its mirror image. A person's score is determined by taking the number of times the person chose the face which had the smile on the right minus the number of times the person chose the face which had the smile on the left divided by the number of pairs (36). Since the median score of the participants in this experiment was -.320, a score in the range of -1.0 to -.320 is taken to mean that the person has a greater than average tendency to use the right hemisphere for processing information, while a score greater than -.320 infers that the person prefers to use the left hemisphere to a greater than average degree.

Training

Participants were trained to use a Macintosh personal computer (Mac). The training consisted of two parts both on the 'Guided Tour to the Mac' disk provided with each Macintosh sold. The first part instructs the participant the basics on how to use the mouse: pointing, clicking and dragging. The next part titled 'Getting Down to Work' teaches the participant how to use a word processing program. The emphasis here is demonstrating how the pull down menus work to open, close and save documents, and how to move, add, remove and change the style of the text. Both parts were designed to give the trainee hands on experience on moving the mouse and doing each command. If something was done incorrectly, the program gave step by step directions on how to complete the command. See Table 1 for a description of each of the commands.

Insert Table 1 about here

Computer Test

For the test, the participants had to apply what they learned from the training session to two one-page documents. They were presented with a list of commands to perform on one document and after completing those, they were given the list of commands for the other. Performance was assessed by timing how long it took to complete each command. Thus, in order to facilitate the timing, each command on the list was covered until the preceding one had been completed. A time limit of two minutes per command was imposed because of time constraints on the length of the experiment. If a person was unable to do a command, it was only completed for them by the experimenter if it was necessary for the next command to be performed. For instance, for moving text, if the person was unable to 'cut' text from the document, it was 'cut' for them so that it could be 'pasted' in its new location as directed by the next command.

Procedure

Each participant came in once to the laboratory on an individual basis for approximately two hours. At the beginning of the experiment, the participants were given the free-vision chimeric face task, and then the computer attitude questionnaire. Next, they were given the training session before which they were advised that they would be tested on the commands at the end of the experiment. Following the training session were the spatial and verbal tasks, typing test, and the background questionnaire. The order of the tasks in this middle block was counterbalanced across subjects. Finally, the participants were given the computer test. Here, the order of presentation of the two documents was counterbalanced across subjects.

Other than the training and the computer test, the only other task administered on the computer was the typing test. Except the free-vision chimeric face task and the computer attitudes questionnaire, the tasks were always given in the middle of the experiment to allow for a break between between the training and the computer test.

Results

Performance was calculated as the average of the z-scores for the amount of the time it took to complete each of the 35 commands performed on the two documents during the computer test. Please note that a low score on the performance measure corresponds to an individual who completed the computer test faster than someone else, and, therefore, is someone who did well in learning to use a word processor.

Pearson product-moment correlations were performed between all of the characteristics and the performance measure. A significant correlation between the performance measure and the self-reported amount of skill an individual had ($r= -.411$, $p < .025$, two-tailed, df=38) was found. Thus, those individuals who reported a higher degree of skill than their counterparts completed the computer test faster. Further analysis on this dataset would yield unmeaningful results in terms of the present hypotheses concerning naive users because of this correlation between amount of computer skills and performance. To see if the effect of skill could be removed, a histogram of the skill variable was examined. This histogram revealed a break in the distribution, showing that the majority of participants had a self-reported skill level of 11 or below while a few participants had scores of 13 and above. Consequently, a subgroup on which to do further analysis was created consisting of the 33 most naive participants. A Pearson product-moment correlation between amount of self-reported skill and the performance measure for this subgroup was not significant ($r= -.152$, $p > .15$, two-tailed, df=31).

Hence, Pearson product-moment correlations between the performance measure and the characteristics of the smaller group were performed. These revealed significant correlations between the Block Design task and the performance measure ($r= -.486$, $p < .005$, one-tailed, df=31), and ACT score and the performance measure ($r = -.378$,

$p < .025$, one-tailed, df=31). Thus, the better the person is at the block design task and the more academic achievement obtained, the better tha[illegible]son is at the computer test. These results give clear support for the hypothesis that the Block Design task is the best predictor of performance among the spatial abilities. Table 2 contains the correlations between all the variables and the performance measure.

Insert Table 2 about here

Since the Block Design task correlated significantly with the ACT score ($r= .378$, $p < .025$, one-tailed, df=31), further analysis was needed to support the idea that some unique ability assessed by the Block Design task is important for text-editing - not just intelligence or academic achievement. If the correlation between the Block Design task and the performance measure occurred solely because the Block Design task was a good measure of general intelligence, the results would only give us the uninteresting finding that smart people will learn to word process faster than not so smart people. Consequently, partial correlations between the characteristics and the performance measure were calculated with the effect of the ACT score removed. As shown in Table 3, the Block Design task remained significantly correlated with performance ($r = -.40$, $p < .05$, two-tailed, df=31). This supports the hypothesis that a component specific to the Block Design task other than intelligence or academic achievement is important for text-editing.

Insert Table 3 about here

Although the correlation was not significant, the results also support the hypothesis that the Nelson-Denny Reading Comprehension subtest is the best predictor of performance among the verbal tasks (r = -.202, p > .10, one-tailed, df = 31). In fact, as shown by Table 2, none of the verbal tasks approached significance with the performance measure. In addition, the hypothesis that spatial abilities are more important than verbal abilities can not be conclusively supported because only one of the spatial tasks significantly correlated with performance.

Since neither the verbal nor the spatial abilities as two distinct groups enhanced performance, it was expected that neither the left hemisphere people nor the right hemisphere people as determined by the free-vision chimeric face task would perform better on the computer test. A t-test was performed to test this hypothesis. No difference was found on the performance measure between the left hemisphere group (M = .015) and the right hemisphere group (M = .132), t(31) = .984, p > .15.

T-tests were performed on all the cognitive variables to determine whether the two groups differed on any of them. The right hemisphere group (M = 24.6) did marginally significantly better on the design fluency task than the left hemisphere group did (M = 18.9), t(31) = 1.713, p < .10, replicating previous findings (Banich, Elledge & Stolar, 1988). A trend existed for the left hemisphere group (M = 38.4) to perform better on the Block Design task than the right hemisphere group (M = 33.9), t(31) = 1.615, p < .12. The two groups did not significantly differ on any of the other cognitive tasks or on any of the computer questionnaire scales (e.g. skill, or desire to use a computer).

Because the Block Design task was the best predictor of performance and the left hemisphere group had a trend to perform better on this task than the right hemisphere group while there was no difference between the two groups on overall performance measure, a post-hoc analysis was done. Since the Block Design task and the pull-down menus both require motor sequencing and spatial placement abilities, the commands were divided into two categories based upon whether or not the command used the pull-down menus or not (refer to Table 1 for the categorization). While no difference was found between the left ($\underline{M} = .013$) and right hemisphere groups ($\underline{M} = .121$), $\underline{t}(31) = .754$, $\underline{p} > .45$ for the average standardized scores for non-menu commands, a trend was found for the left hemisphere group ($\underline{M} = .132$) to complete the menu commands faster than the right hemisphere group ($\underline{M} = .185$), $\underline{t}(31) = 1.492$, $\underline{p} = .15$. In addition, a comparison between the cut and paste commands versus the delete and insert commands was done. Both sets of commands are methods of inserting and removing text. However, the cut and paste commands require the use the pull-down menus while the delete and insert commands use the keyboard. The left ($\underline{M} = .001$) and right hemisphere groups ($\underline{M} = .127$), $\underline{t}(31) = .537$, $\underline{p} > .6$ did not differ on the delete and insert commands. However, the left hemisphere group ($\underline{M} = -.25$) completed the cut and paste commands, which require the use of pull-down menus, significantly faster than the right hemisphere group ($\underline{M} = .377$), $\underline{t}(31) = 2.793$, $\underline{p} < .01$.

Discussion

As expected, the Block Design task was the best predictor of performance. Thus, the spatial abilities, as compared to the verbal abilities, played a greater role in determining who learns to use a word processor most quickly. In fact, none of the verbal abilities correlated with performance. What can explain these results?

Several reasons can account for why the Nelson-Denny reading comprehension test did not correlate with performance as it did in Gomez et al.'s (1986) study and Sebrechts et al.'s (1984) study. First, the tutorial in this experiment used only the computer and required very little reading whereas the tutorials in the other two experiments involved reading directions from a manual. Second, the test situations for Gomez et al.'s (1986) study and Sebrechts et al.'s (1984) study presented the participants with a copy of a document several pages in length with the changes handwritten on it, whereas the present experiment listed the modifications to be made in the form of specific commands and had documents no longer than what would fit on the computer screen at one time. Third, the computer system used in this study required remembering the location of the commands while the computer systems used by the previous two studies required more of a verbal recall of what the commands were. Fourth, the previous two experiments also included the vocabulary subtest of the Nelson-Denny reading test which was not a part of this experiment. Consequently, the vocabulary subtest may be a good predictor of performance while the comprehension subtest is not, or the Nelson-Denny test as a whole may be a reflection of general intelligence.

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Since the design fluency task and the flags task did not correlate with performance, it can not be assumed that any spatial task will predict performance, or that someone good at any spatial ability will have an easier time learning how to word process than someone who has no spatial ability whatsoever. Rather, it appears to be some factor specific to the Block Design task, the Building Memory test, and the format checking and sequence recognition tasks. It is plausible that these tasks all reflect an ability to sequence or order items in a spatial arrangement which is necessary to accurately perform the commands to modify the text. This view is supported by Sebrechts et al.'s (1984) finding that the Building Memory test is correlated with the format checking exercise. Further support can be found in a study by Linde and Labov (1975) (cited in Byme, 1982) in which participants, when asked to give the spatial arrangement of their apartment, gave sequential 'tours' of the rooms in their apartments rather than a 'bird's eye view' description. It is probable that a similar strategy is followed for completing the Building Memory task in that participants do not randomly recall the placement of the buildings, but create a specific sequence or road to follow in order to recall the locations of the buildings. The Block Design task also is thought to have a sequencing component when subjects put the relations between the blocks into verbal statements (e.g. the red block is to the right of the white block). Lezak (1983) interpreted this strategy as one used by the left hemisphere. Additional support for this concept comes from Kosslyn, Barrett, Cave & Tang (1986)(cited in Kosslyn, 1987) whose experiment demonstrated that the left hemisphere is faster than the right hemisphere at judging whether a plus sign is to the left or right of a minus sign (ordering) while the right hemisphere is faster than the left hemisphere at judging whether the signs are more or less than an inch apart from each other (distance). The fact that the left hemisphere group performed better on the commands requiring a more accurate sequencing of actions (cut/paste) than the right hemisphere group while the two groups did not differ on the equivalent commands which do not require as accurate or as much sequencing of actions (delete/insert) supports this conclusion also.

Conclusions

As expected, the Block Design task was the best overall predictor of performance on the computer test, accounting for 24 percent of the variance. In addition, the Nelson-Denny reading comprehension test was the best predictor of performance among the verbal abilities assessed, although the correlation was not significant. The predictive value of the Block Design task was attributed to both the sequencing ability involved in the task, and to the task's correlation with general intelligence. The nonsignificant correlation between the Nelson-Denny reading comprehension test and the performance measure was attributed to the fact that this experiment required less reading in both the training session and testing situation than the two previous experiments did (Gomez et al., 1986; Sebrechts et al., 1984).

Far more research needs to explore the cognitive abilities that affect how quickly and easily individuals learn how to use a word processor. It is quite probable that the ability to sequence or order items in a spatial arrangement, and reading comprehension are two cognitive abilities important to the ability to word process, but that the predictive value of each will vary across the computer systems used.

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Table 1

Word Processing Command Descriptions

Command Name-	Description	Uses Pull-Down Menus?
File Commands		
Open-	to bring a document up on to the screen so it can be edited	Yes
Close-	to remove a document from the screen and editing function	Yes
Save-	to save a document to the disk	Yes
Quit-	to quit from an application (program)	Yes
Edit Commands		
Insert-	to add text by using the keyboard to type it	No
Delete-	to remove text by using the 'delete' key on the keyboard	No
Cut-	to remove text by using the 'Cut' command in the Edit menu	Yes
Paste-	to add the text which was removed using the 'Cut' command by using the 'Paste' command in the Edit menu	Yes
Style-	to change the size or style (e.g. italics) of text using the various commands in the 'Style' menu	Yes
Spell-	to correct the spelling of a word accomplished usually by deleting the incorrect word then typing it correctly	No

Table 2

Pearson Correlations between the Performance Measure and the Other Variables for the Subgroup

Characteristic	Correlation Coefficient
Facebook	-.110
Block Design	-.486**
Flags	.037
Typing Speed	-.182
Reading Comprehension	-.202
Reading Rate	-.028
Design Fluency	.142
Word Fluency	.129
ACT Score	-.378*
Desire to Use a Computer	.207
Computer Skill	-.152
Importance of Computers	.271
Computer Anxiety	.253

* $p < .025$, one-tailed **$p < .005$, one-tailed

Table 3

Partial Correlations between the Performance Measure and the Other Variables with the Effect of ACT Removed

Characteristic	Correlation Coefficient
Facebook	-.061
Block Design	-.400*
Flags	.052
Typing Speed	-.091
Reading Comprehension	-.173
Reading Rate	.010
Design Fluency	.151
Word Fluency	.148
Desire to Use a Computer	.205
Computer Skill	-.031
Importance of Computers	.228
Computer Anxiety	.115

* $p < .05$, two-tailed