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ABSTRACT

This paper presents an information processing model of test anxiety in an attempt to explain the mechanism of test anxiety's effect on working memory within the framework of the American College Testing Program Assessment (ACT). The model suggests that the construct of test anxiety, both worry and emotionality, is represented in the declarative knowledge network as forms of cognitive units. The activation of test relevant and irrelevant information competes within the limited working memory capacity and causes poor performance in highly anxious subjects. About 70 college students of high and low test anxiety, determined through the Test Anxiety Inventory, participated in a series of verbal and visual tasks, and speed and accuracy were determined. Results supported the prediction that test anxiety affected information processing on the verbal analogy tasks, demanding a high load of working memory. The studies demonstrated that the responses of highly anxious subjects may vary according to their perceptions of the situation. Some seemingly contradictory results with regard to homophony judgment tasks are discussed. (Contains three figures, two tables, and five references.) (SLD)

Information processing model of test anxiety and its effect on the speed-accuracy tradeoff (ACT* or the spreading activation explanation)

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I. Information processing model of test anxiety within the framework of ACT*

Research on test anxiety suggests that performance decrements associated with test anxiety can be explained by the extent to which individuals are able to use their working memory capacity (Darke,1988a,b; Eysenck, 1979, 1982, 1985). Highly anxious people would have less available working memory capacity for task solution than their low anxious counterparts, because some portion of the processing capacity must be occupied by the representation of test anxiety (e.g., worry) or overloaded by defective study skills or test taking skills (Eysenck, 1982; Tobias, 1982).

Research about the effect of test anxiety on working memory capacity, however, does not clearly explain how and why test anxiety affects cognitive processing of the working memory system. This paper presents the information processing of test anxiety in an attempt to explain the mechanism of test anxiety's effect on working memory within the framework of the ACT* model. This approach is similar with that of clinical and social psychology which have been adapted associative network theory and tried explain cognitive processes in specific domains of personality disorders, such as depression (Ingram, 1984), anxiety disorders (Lang, 1985).

The present information model of test anxiety suggest that the construct of test anxiety, both worry and emotionality are represented in the declarative knowledge network as forms of cognitive units (Anderson, 1983; Anderson & Pirolli,1984). The propositions (concepts) of worry and emotionality may construct two different associative network structures of their own containing relevant information of each, such as autonomic reactions, expressive behaviors, poor self-concept of vulnerability of failure and descriptions of stimuli of cues eliciting test anxiety (Bower, 1981; Lang, 1985). The whole mechanism of worry and emotionality's activation processes can be described by the condition-action matching process of the ACT* model. Testing cue stimuli and the information of affective or cognitive network in long term memory can be matched within the working memory system. Then the activation is emitted from the cue stimuli and spread among the test anxiety network with a certain level of strength (Anderson, 1983).

The associative network of worry can be triggered by the activation of emotionality or primed by worry relevant information in testing situations. Research of mood effect on memory have revealed that the activation of emotion nodes may provoke the activation of the related associated cognitive network (Bower, 1981, 1987; Blaney, 1987). Studies show that the activation of emotionality decays as tests progress (Morris, Davis & Hutchings, 1981), but the activation of worry is maintained during the whole testing period as highly anxious individuals pay continuous attention into test irrelevant cues (Wine, 1978, 1982). Thus, the activation of test relevant and irrelevant information compete within the limited working memory capacity during the exams and cause poor performances of highly anxious subjects.

II.The effect of test anxiety on the speed-accuracy tradeoff.

The present model assumes that highly test anxious individual's node strength may be relatively strong and the nodes structure can be richly elaborated by repetitive experiences of failures or self derogatory thought during the tests . Thus highly anxious may have higher degrees of activation of test anxiety than their low anxious counterparts (Anderson, 1983a,b). Anxious patients show evidence of their attention is being diverted, without awareness, toward threatening cues when there is a mixture of threatening and nonthreatening cues in the environment (Broadbent & Broadbent, 1988). Highly trait anxious individuals are more likely attend to threatening stimuli without awareness in stressful situations (Mathew & Macleod, 1988, Wine, 1979, 1981), recall anxious-content information (Ingram et al., 1987) and negative self-related information (Mayo, 1989).

The speed-accuracy tradeoff model can test the differences of nodes structures and activation processes of test anxiety between high and low test anxious subjects. "Speed-accuracy tradeoff" refers to the fact that subjects can trade increases in speed for decreases in accuracy (and vice versa) over a substantial range (Lohman, 1989). By mapping two dimensions in information processing, speed-accuracy, the speed-accuracy tradeoff curve can show different degrees of the disruptive effect of test anxiety on working memory performances. The figure 1 shows the typical speed-accuracy curve.

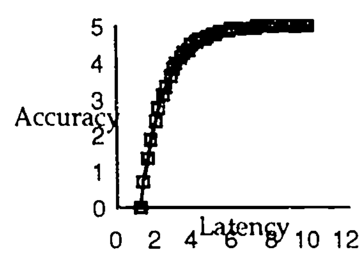


Figure 1. Speed-Accuracy Curve

The curve has three important features, intercept, curvature and asymptote which build a mathematical formula, an exponential equation, representing accuracy as following:

$$AC = \lambda[1 - e^{-\beta(t - \delta)}], \quad t > 0.$$

Where AC is accuracy at processing unit, λ is asymptote, d is intercept and β is curvature (Lohman, 1989). In the present study, I employ the cascade model which is the best known model in the speed-accuracy study. The cascade model suggests the contingent-parallel processing in which information is processed at several subprocesses or processing levels. Information in each level are continuously activating and the output of a level reflect the quantities of information of its input (McClelland, 1979). The continuous activation process can be explained by the cascade model's continuous flow of activation at each subprocess. The degrees of activation emitted by the source in working memory which can be regarded as input values in a processing unit, determine the level of activation in the long term memory network which is the output value in the cascade model (McCelland, 1979).

III. The overall predications of the model on performance.

On the basis of the present information processing model of test anxiety and the cascade model, the following three prototypic possibilities of the speed-accuracy curve can be suggested.

As figure 2a) shows, anxiety robs th. total activation level, thereby resulting in lower asymptotic level for highly anxious individuals. Figure 2b) shows that possibility that anxiety could restrict the total processing capacity, thereby resulting in a shallower curvature for highly anxious subjects. Figure 2c) presents the possibility that anxiety could produce a general slow-down in cognition, thereby increasing the intercept.

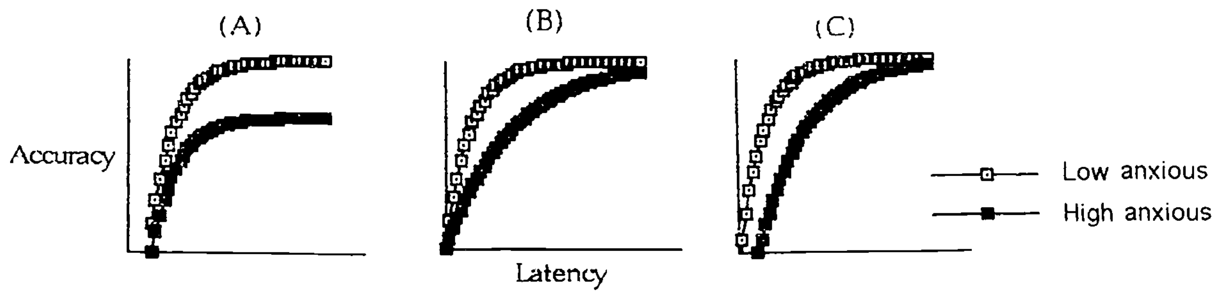


Figure 2 Three prototipic possibilities; The effect of test anxiety on the SAT Curve

Based on three prototypic possibilities, two research questions under different conditions of task difficulty and time limits can be considered.

1. Will the effect of test anxiety on the speed-accuracy tradeoff be varied as the demand of working memory capacity increases in verbal and visual-spatial tasks?

A. Verbal tasks; Studies show that the performances of highly anxious subjects in the verbal tasks are slow or less accurate than those of low anxious people in both simple digit task and the task demanding the working memory capacity (Dark, 1988a,b; Eysenck, 1985, 1991; Calovo, Ramos & Extevez, 1991; Goolkasian, 1982).The prediction for the first research question is that test anxiety would influence all three parameters of the curves .

B. Visual -spatial tasks

ACT* model assumes that knowledge representation of spatial images have the same hierarchical structure and the same activation process of condition matching as temporal strings and abstract propositions (Anderson, 1983). Studies show that highly anxious subjects performed faster but made more errors than did less anxious subjects in geometric analogy tasks under the time-constrained condition (Leon & Reville, 1985), spent longer solution time in abstract reasoning task (Mandler & Sarason, 1952). Based on the findings, I predicted that the slopes and intercepts and asymptotes of high and low anxious subjects' performances in visual-spatial tasks would be different under time limited conditions. The performance differences will be increased as the visual-spatial tasks get difficult.

2. Will the effect of test anxiety be different on the performances of tasks requiring "inner-voice" and "inner ear " of an articulatory loop?

Research have revealed that concurrent speech activity of the articulatory suppression interferes with the performances on visually presented materials, but the effect can not be found when tasks are presented auditory (Baddeley, Lewis & Vallar, 1984). The findings led Baddeley put forward a model in which the articulatory loop component of working memory is divided into two components; a subvocal rehearsal process which is assumed to maintain speech-coded material by means of subvocal rehearsal (inner voice), and a phonological storage system (inner ear) that assumed to involve some form of acoustic image and phonological representation from long term memory (Baddeley & Lewis, 1981; Baddeley, 1986). Research on test anxiety and working memory shows that the verbal processes of test anxiety may have similar effect with the articulatory suppression on the performances of tasks requiring phonological recording. The disruptive effect of test anxiety appears when digit span tasks are presented *visually* (Darke, 1988) but the effect is not shown when the tasks are presented *auditory* (Markham & Darke, 1991). Series of studies have reported that the articulatory suppression impairs the performances of rhyming judgment only, but not the performances of homophony judgment in the printed materials (e.g., Besner et al., 1981, 1987; Besner & Davelaar, 1982; Brown, 1987; Richardson, 1987). The research indicates that rhyming judgment tasks involve post-assembly phonemic segmentation and deletion processes that make demands upon the component interfered with by suppression (Besner, 1987), but the processes are not required for the judgment of homophony, which need phonological lexical decision (Besner, 1987; Richardson, 1987). According to the research evidence, I predicted that test anxiety would disrupt the performances on rhyming judgment tasks only processed in the "inner voice" of the loop. But there would be no effect of test anxiety on the performances of homophony judgment tasks, which would be processed in the phonological storage system of "inner ear" without subvocal rehearsal processes.

IV. Methods

Subjects

Approximately seventy students enrolled in "Educational Psychology and Measurement" were recruited. They were selected from a larger group of the classes on the basis of extreme scores on the Test Anxiety Inventory (TAI; Spielberger, 1980). High anxiety and low anxiety subjects were de ned as those representing approximately the upper and lower 20 % of a large sample of over 170 subjects administered the TAI at the beginning of the semester.

Materials

1. Verbal tasks: a) Test anxiety effect on an articulatory loop: Two different task, ryhming and homophony judgment tasks were used for this purpose. Total sixty pairs of rhyming or non-rhyming words, homophony and non-homophony words were presented on the computer screen in six different time conditions. The time limits for exposure were based on the pilot study's result. The subjects in the pilot study responded to the tasks without time limits. The subjects' median latencies in each tasks are divided by four, then six exposures are defined as 1,2,3,4,5 or 6 times this time.

Subjects responded to each trials by pressing the key of 1(yes) or 2 (no) button. In order to avoid the subjects' biases responding "yes" or "no", subjects will be asked about the certainty of their answers on a three point scale with the value of 3 (I am positive), 2 (I have some doubt), 1 (I was guessing) after they respond yes or no.

b) Test anxiety effect on the task performances requiring heavy demanding of working memory (i.e., a central executive system): For this purpose, I used the verbal analogy tasks. Verbal analogies have been regarded as prototypic reasoning problems (Spearman, 1927) and have high correlation (.88) with the tasks taxing the working memory capacity (Kyllonen & Christal, 1990). In the present study, the subjects have to choose the correct answers among three alternatives to the A: B:: ?: ? type of verbal analogy tasks.

2. Visual - Spatial task. a) Symbol rotation tasks. The symbol rotation tasks represents the visualization ability. Research suggests that the difficulty level of the task increases as a range of rotation increases in symbol rotation tasks (i.e., Irvine, Dann & Anderson, 1990).According to the findings, I set two difficulty levels of tasks. Three pairs of symbol were shown on the computer screen in a trial. One of symbol in a pair rotateded to 60 or 165 degrees. If a symbol in a pair just rotated, two symbols in the pair have the same shape. If a symbol in a pair is flipped and rotated, then the symbol cannot be matched with the other symbol in the pair. Subjects had to count the numbers of pairs have the same shape on their screens. The symbols are pooled from 20 non-letter symbols of "Chicago tests of primary mental abilities"(Thurstone, 1943).

b) Paper form board tests: This task can measure the spatial relationship abilities (Lohman, 1986). Items from Minnesota Paper Form Board -Revised (Likert & Quasha, 1948) was used. In the test subjects have to select the figures in which all small scattered figures in the questionnaires are fitted together.

V.Procedure

Each tasks were presented on Macintosh screens. At the beginning of the task trials, the subjects were told to respond as quickly as possible. Before the subjects began the task, they saw the ego-threatening instruction on their screens: the ability being tested would be a component of intelligence and that their performance would be posted on our division office. There were six different time limits conditions for each task. In each time condition, 10 stimuli were exposed. Subjects had to respond by pressing the key in the computer within the time limits. Otherwise, their answers were treated as wrong by the computer.

VI. Design and Data Analyses

For the research question 1, first, each subject's average score in each levels of exposure were calculated by the rescaling method (see table 1).

Table 1: Rescaling method (*1: I was guessing, *2: I have some doubt, * 3: I am positive)

	Wrong			Right		
subject's answer	3*	2*	1*	1*	2*	3*
Score	1	2	3	4	5	6

Second, In order to fit the exponential curves for low and high test anxiety subjects, data for subjects whose performance was not reasonably well described by an exponential curve need to be eliminated. Subjects whose R-squares are less than .60 were therefore dropped.

Third, speed-accuracy curves were drawn by fitting exponential function. Parameters of asymptote, intercept and curvature were estimated by the method of least squares, using the Marquardt method in SAS program. Based on the mean accuracy scores of high and low test anxious people at each of six (or eight) levels of exposure time, the speed-accuracy curves at each task were drawn. In order to see the performance differences of high and Low test anxious subjects, three parameters of each curve at each tasks were compared by t-test.

Also the performances of the high and low anxiety groups were compared by a repeated measure of 2 (sex) by 2(anxiety) by 6 or 8 (conditions) ANOVA, where sex and ar .ty were between subjcts variables and conditions were within subjects variables. The ANOVA was compueted for each task.

For the research question 2, a 2(anxiety) by 2(sex) by 6(exposure) ANOVA, anxiety and sex as between subjects variable, exposure levels as within subject variables was carried out.

V. Results

Research Question 1: The Effect of Test Anxiety on the Performances of Easy and Hard Task Both in the Verbal and Visual Tasks

Exponential curves for each task, separately for low and high test anxiety subjects were fitted to six or eight data points based on the mean accuracy scores. As Figure 3 show, the curves show the predicted patterns of performances for low and high anxious group.

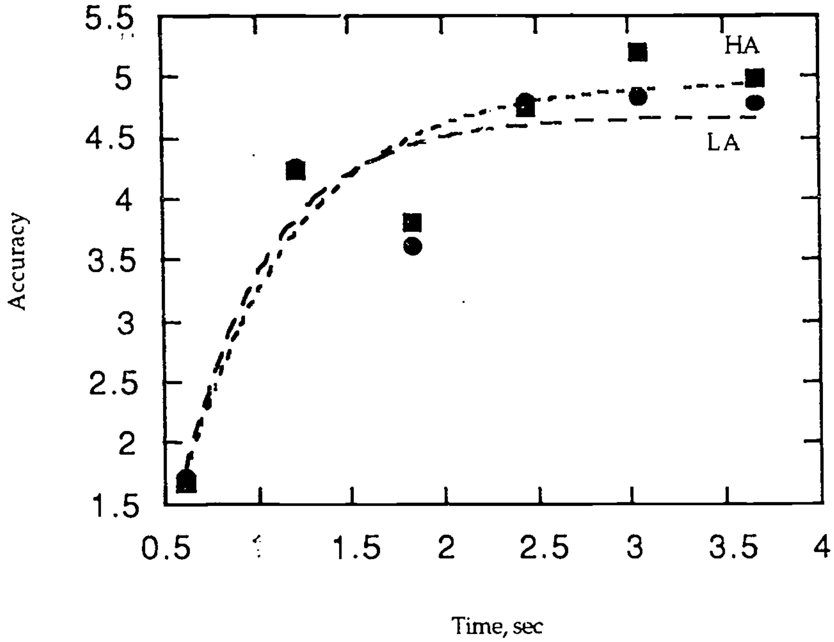
Before the three parameters of the curves for low and high test anxiety groups were compared, repeated measures ANOVAs for retained subjects were carried out. A 2 (sex) by 2 (anxiety) by 8 (exposure conditions) ANOVA for the verbal analogy task and a 2 (sex) by 2 (anxiety) by 6 (exposure conditions) ANOVA for the other tasks were carried out. Sex and anxiety were between subjects variables and exposure conditions were within subject variable.

The results indicate that significant performance differences between low and high anxious groups appeared only in the verbal analogy tasks. When the ANOVA was carried out for each task for the total subjects, the results were the same. In the verbal analogy task, there was a main effect of anxiety. Low anxious subjects performed better than highly anxious subjects ($F [1,51] = 4.21$, $MS_e=1.63$, $p < 0.05$). Also Separate 2(anxiety) x 8 (exposure condition) ANOVAS for males and females in the verbal analogy task show that there is a significant anxiety by condition interaction effect in the female group ($F [7,266] = 3.07$, $MS_e=.38$, $p < 0.05$) and a main effect of anxiety in the male group ($F [1,13]=5.12$, $MS_e=.58$, $p < 0.01$).

Because the ANOVA results of the verbal analogy task showed significant performance differences between high and low test anxiety subjects, the three parameters of the exponential curves for the two groups were compared by t-tests.

As Table 2 (a) indicates, the results showed that the asymptote of the low anxious group are significantly higher than that of the highly test anxious subjects ($t= -3.11$ df (54), $p < .004$). But there were no significant differences in other parameters for both groups of subjects. Table 2 (b) and (c) indicate that t-tests of separate analyses for males and females showed somewhat different patterns. In the case of females, the values of asymptote and intercept of low anxious subjects are significantly higher than those of highly anxious subjects. In the male subjects group, the intercepts of the highly anxious subjects are significantly higher than those of their low anxious counterparts.

a. Rhyming Judgment Task (N=20:LA, N=19:HA)



b. Homophony Judgment Task (N=30:LA, N=32:HA)

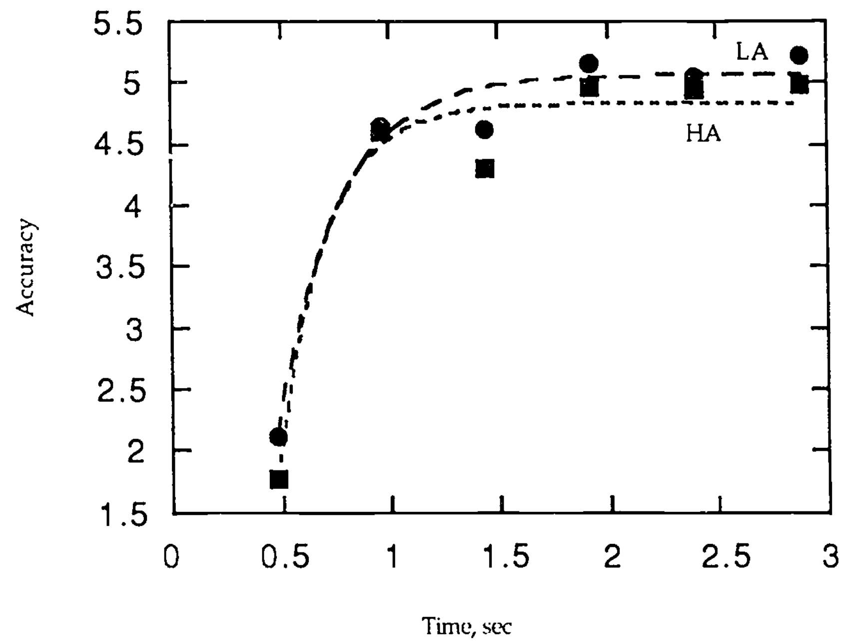
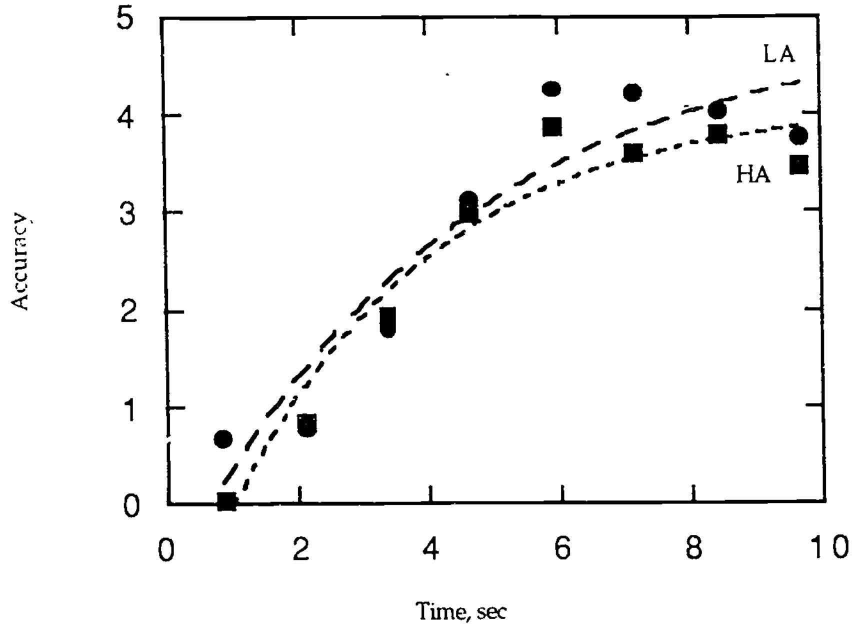
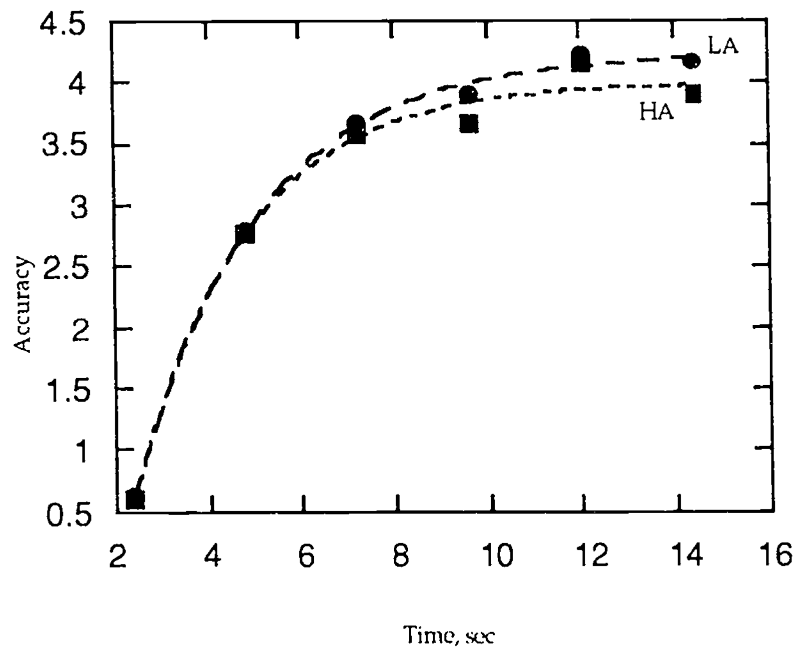


Figure 3. Exponential Curves for the Low and High Test Anxiety Groups.

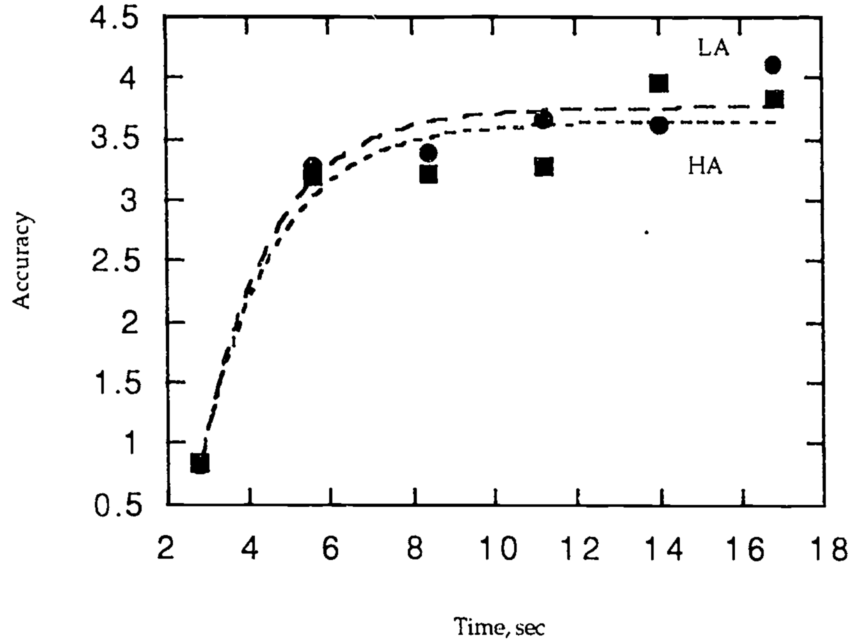
C. Verbal Analogy Task (N=27: LA, N=29;HA)



d. Symbol Rotation Task, 60°(N=32:LA, N=32:HA)



f. Symbol Rotation Task, 165° (N=30:LA, N=28:HA)



f. Paper Form Board (N=26:LA, N=30:HA)

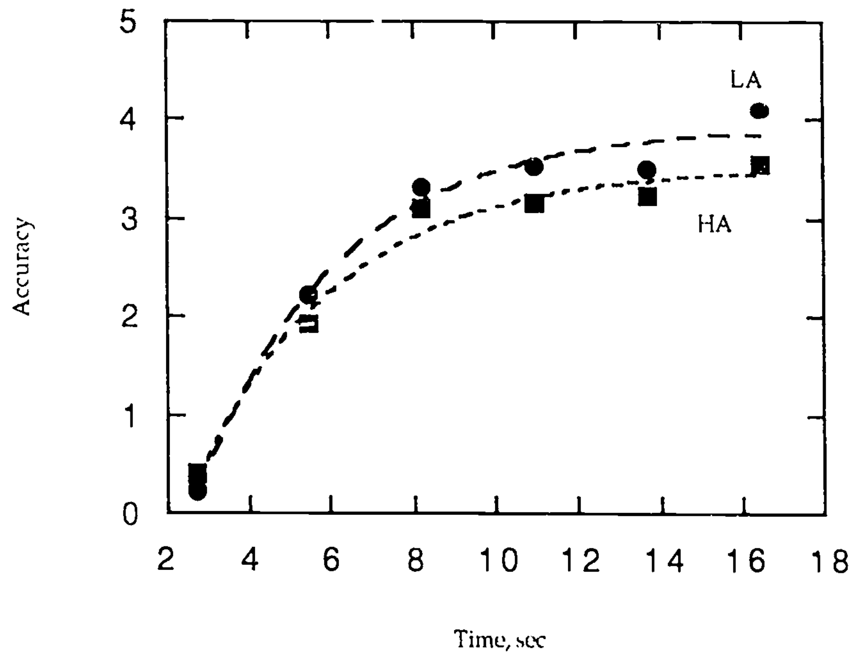


Table 2. Means and Standard Deviations of Three Parameters for the Verbal Analogy Task.

(a) High and Low Test Anxiety Groups
(b) High and low Test Anxiety Female Subjects
(c) High and Low Test Anxiety Male Subjects

a. High and Low Test Anxiety Groups

		Mean	S.D	t value (df=54)
Asymptote	HA	4.28	.760	-3.11*
	LA	5.14	1.277	
Curvature	HA	.330	.117	-.57
	LA	.362	.269	
Intercept	HA	1.05	.215	-.96
	LA	1.10	.214	

NOTE: N=29 (HA)
N=27 (LA)
*P<.05

b. High and low Test Anxiety Female Subjects

		Mean	S.D	t value (df=39)
Asymptote	HA	4.24	.611	-2.99 *
	LA	5.17	1.32	
Curvature	HA	.350	.124	.05
	LA	.347	.241	
Intercept	HA	.979	.162	--2.70*
	LA	1.140	.218	

NOTE: N=22 (HA)
N=19(LA)
*P<.05

c. High and Low Test Anxiety Male Subjects

		Mean	S.D	t value (df=13)
Asymptote	HA	4.40	1.168	-1.05
	LA	5.06	1.254	
Curvature	HA	.268	.066	-.99
	LA	.398	.342	
Intercept	HA	1.265	.229	2.30*
	LA	1.017	.189	

NOTE: N=7, HA
N=8, LA
*p< .04

Research Question 2: Differential Effect of Test Anxiety on the Performances in an Articulatory Loop

There were no significant differences between high and low anxious subjects' performances on the rhyming and homophony judgment task. The results indicate that my prediction that test anxiety interrupts the "inner voice" (rhyming judgment tasks) only, but not "inner ear" (homophony judgment tasks) was not supported.

VI. Discussion

Research Question 1

Task Performances on the Verbal Tasks

The results of the present study confirmed the prediction that test anxiety affects the information processing of test anxiety on the verbal analogy tasks, demanding a high load of working memory. As expected, the asymptote of low anxious subjects is higher than that of highly anxious subjects. The differences in the asymptote levels between high and low test anxiety subjects indicate that test anxiety influence the strength or total activation level of highly anxious subjects' performances on the verbal analogy tasks (Lohman, 1989).

In the ACT* model, the total activation level is the sum of the activation of the subsets supported by all sources and has its own limit (Anderson & Piroli, 1984). In the case of highly anxious subjects, the overall activation is emitted from two different sources, test relevant and test-irrelevant information. When the activation is propagated from the two different sources, the production execution of cognitive worry competes with the execution for the task relevant information (Anderson 1992). During the task trials, the activation of cognitive worry of highly anxious subjects may restrict the strength or level of activation for the task -relevant information processing in the limited working memory system. Thus the total activation levels of highly anxious subjects for the task can be lower than that of low anxious subjects.

Unexpectedly, there was no effect of test anxiety on the rate -limiting factor, the curvature measures . The results imply that the executing or production matching rate of task information is not affected by adverse effect of test anxiety, regardless of different levels of asymptotes. The cascade model assumes that the rate constants of all of the units at the same processing level are equal and dynamics and asymptotic of the curve does not have to be correlated (McClleland, 1979). Several studies of speed-accuracy trade- off demonstrated the effect in semantic judgment task, sentence recognition (McClleland, 1979) and semantic memory task (Lohman, 1991). For instance, asymptotic recognition accuracy for sentences varied wtih the type of task, but the tasks did not have an effect on the rate of the speed-accuracy curve (Dosher, 1976). Similar to these studies' results, the result of the present study indicates that the information processing rate for high and low anxious subjects are not significantly different.

Contrary to the prediction, highly anxious subjects responded to the tasks a little bit faster than low anxious subjects but the differences did not reach statistical significant levels. When the data were analyzed separately for both sexes, the highly anxious female group responded significantly faster than the low anxious female group, but the reverse is true for the male subjects.

Two different responding patterns of highly test anxious subjects have been found. Highly anxious subjects are slower than low anxious subjects on the performances of verbal tasks (Calvo, Ramos & Extevez, 1991; Darke, 1988 b; Eysenck, 1985). On the other hand, highly anxious subjects also tend to be directed toward escaping the test situation, therefore are more likely to respond to tasks faster (Mandler and Sarason;1952).

Highly anxious subjects' seemingly conflicting responding patterns of behaviors, that is slow or fast reaction in the task performance situations have been demonstrated in Geen's study (1987). Geen (1987) observed that when subjects perceived that constraints against escaping from an aversive test situations were weak, highly anxious subjects left more quickly than low anxious subjects. But when subjects perceive that constraints against escaping from an aversive test situations were strong, those high in test anxiety were slower and more cautious in performing the task than those low in test anxiety.

As the studies demonstrated, highly anxious subjects' responding patterns may vary according to their own perception of test situations, or several environmental factors involved with eliciting test anxiety. In the present study, only highly anxious male subjects showed slower responding patterns than their low anxious counterparts, but the reverse pattern appears in the case of female subjects. Generally, test anxiety scores for highly anxious females are higher than those for low test anxious males (Hembree, 1988). This might be because highly anxious females may more likely be sensitive under stressful situations and disrupted by test anxiety than males.

Presumably, highly anxious female subjects in the present study may be more likely to feel pressure under time constrained and ego-threatening instruction condition and want to escape the situation as quickly as possible. Whereas highly anxious male subjects did not have this tendency, therefore their reaction were slower than that of their low anxious counterparts. An interesting finding from the results is that highly anxious female's performances on the verbal analogy task were better that those of highly anxious males. The results indicate that the female subjects tended to respond faster but did not sacrifice their accuracy as much as highly anxious male subjects did.

Until now, there are almost no studies conducted for different responding tendencies or perception of situations under time-limits conditions for both sexes. Further studies about underlying mechanisms for the differences between the sexes are required.

Task Performances on the Visual-Spatial Tasks

In the ACT* theory, spatial images are represented as spatial configurations but not in absolute size. Spatial images have the same capacity limitations as temporal strings, also image units are stored and retrieved in the same manner as string phrases (Anderson, 1983). According to theory, I expected similar activation mechanisms in processing the visual-spatial tasks in the working memory system and that task processing would be influenced in the same way as verbal processes are affected by test anxiety.

The results, however, showed that there was no significant test anxiety effects on the three different visual-spatial tasks. As Figure 4 show, the asymptotic levels and mean accuracy scores of low anxious subjects are a little bit higher than highly anxious subjects, but the differences did not reach statistically significant level.

The results are consistent with other studies' findings about the nature of test anxiety. The cognitive worry is purely subvocal rehearsal processes and primarily dependent upon the articulatory loop (Darke, 1988a; Mark & Darke, 1991). As Baddelely's subcomponential model of working memory and related research indicate, the verbal processes of test anxiety served as secondary verbal task and do not affect the visual-spatial task performances which are primarily dependent upon the visual-spatial buffer storage of the working memory system (Mark & Darke, 1991).

Anderson claims that spatial images encode the relative positions of objects in multidimensional space but strings do not (1983). A study demonstrated that subjects encode and retrieve the same structures of spatial images and words in different ways (Anderson, 1983) . In the present study, the activation processes for the visual-spatial stimuli might be processed in different dimension or separately with the verbal processes of test anxiety and thus the performances are not influenced by cognitive worry processes.

Research Question 2

Research findings suggest that cognitive worry is verbally processed and would have similar functions with articulartory suppression effect on the visually presented materials (Darke, 1988; Markham & Darke, 1991). Also numerous research findings have shown consistent suppression effects on the accuracy or response time of rhyming judgment only, not on the homophony judgment tasks. (e.g., Besner et al 1981: Besner 1987; Brown, 1987; Johnston & Mcdermott, 1986; Richardson, 1987; Widing & White, 1985). But as the ANOVAs of the rhyming and homophony judgement tasks indicate, the results do not confirm the prediction for the research question two.

In the present study, the same material used in Brown's (1987) study were employed. The study demonstrated articulatory suppression effect on the error rates and response times of the rhyming judgment tasks, but no such effect on the response latency of homophony word and nonword were found. Pairs of rhyming words in each of the six the levels of exposure conditions, pairs of homophony words in the first four levels of exposure conditions, and pairs of homophony non-words in the last two exposure conditions were used. Based on the research findings described above, there should be a test anxiety effect on the rhyming or on the homophony non-words judgment (Brown 1987, Sun, 1994). But no such expected effects did occur in the present study.

Also in Brown's study (1987) there were significant interaction effects of response time and error rate by lexicality in the homophony judgment task. Subjects need more time to respond and make more errors in the performances on the homophony non-words than on the homopony words trials. Similarly negative correlations between test anxiety and homophony non-words were found in a previous study (Sun, 1994). But the present study does not show any differences between high and low test anxious subjects in the performances of homophony non-word judgment tasks.

The results of the present study show that the reliabilities estimated with Cronbach's coefficient alpha for each judgment task are quite high, and the number of subjects who participated in the study was large enough to have enough power. The results suggest that, if the measurement of subjects' responses and scoring methods were made in valid ways and the predictions had been supported by evident research findings, then it would be reasonable to assume that there must be other factors involved in the subjects' judgment on the tasks.

One possibility may be that subjects' involvement with subvocal rehearsal processes of the rhyming word pairs may inhibit anxiety provoking thought processes and thus facilitate the performances of highly anxious subjects. In order to make judgment whether the pairs of words are rhymed or not, subjects must pronounce, in other words, articulate the words (Besner, 1981; Brown 1987). By pronouncing the words, the subjects' attention can be more likely focused on the task itself rather than test irrelevant thought processes or self verbalization procedures of test anxiety. If this would be the case, the subvocalization of rhyming pairs of word would facilitate their attending to the task itself and inhibit task-irrelevant thought processes of test anxiety. Thus the performances of highly anxious subjects may become comparable with those of their own low anxious counterparts.

In fact, numerous intervention programs for test anxiety have demonstrated that highly test anxious subjects' negative inner thought processes can be prevented by encouraging subjects to make incompatible self talk, such as " calm" , "keep control", "stop" or self instructions accompanying the treatments of coping emotional arousal (Burk, Randolph & Probst, 1985; Deck & Russell, 1981;Meichenbaum, 1972; Meichenbaum et al., 1971; Russell et al, 1974, 1975; Sud & Sharma, 1990;). The main focus of these treatment methods, referred to as "cue-controlled relaxation" or "cognitive modification program", is to draw subjects' attention away from anxiety provoking thoughts by training subjects to produce incompatible self statements, such as cue words or positive self generated instructions for themselves during the tests performances (Meichenbaum, 1972; Russell et al., 1974, 1975).

The research has demonstrated that the cue-controlled relaxation or attentional training skills in cognitive modification programs have been successful in significant reduction of worry component as measured by subjects' self report of anxiety immediately after the treatment and during one to three month follow- up period. After the treatment, subjects showed significant increases in the performances of anagram tasks and academic performances (e.g., Decker & Russell, 1981; Meichenbaum. 1972; Russell et al., 1974; Sud & Sharma, 1990).

Several studies of cognitive modification treatment have revealed that a cognitive -only treatment is more effective than a relaxation treatment and a combination cognitive -relaxation approach (e.g., Anup & Sagar, 1990; Holroyd, 1976; Kaplan et al., 1979). For instance. Kaplan et al's, (1979) use of Meichenbaum's (1972) cognitive tr ament only, made test anxious subjects aware of their anxiety provoking thoughts and develop their own positive self - statement and self-instructions to replace subjects' anxious negative thought. The result showed that the combined treatment and desensitization were less effecitve than the cognitive-only treatment on a variety of test anxiety and self-rating measures.

The attentional training component in the cognitive modification program in which subjects concentrate in practicing the use of incompatible self -instructions and behaviors is more likely to be important than insight training which allow subject to explore only anxiety engendering thought processes in evaluative situations (Meichenbaum, 1972, Wine, 1970). A study showed that the attentional self-instruction training group improved significantly relative to an insight group (Wine, 1970), implying that insight procedures alone without subjects' use of incompatible self-talk procedure is ineffective in reducing test anxiety (Meichenbaum, 1972).

If highly anxious subjects' attention can be drawn away from the negative self verbalization or thoughts in their use of incompatible self statement, similar processes can be occurred in the present study. Probably, the subvocalization procedure of the rhyming word pairs make subject to attend to the task itself and prohibit highly anxious subjects' involvement with test irrelevant self talk procedures.

The nonsignificant test anxiety effect on the judgment of homophony non-words can be understood in similar ways as the processes involved with the rhyming judgment. The judgment processes which may need the pronunciation of the words due to its lack of phonological overlap draw subjects' attention to the task itself, and were not interfered by worrisome thought (Humphreys, Evett & Taylor, 1982; Brown, 1987; Sun, 1994).

But the performances on the homophony word judgments task does not have to be affected by the subvocalization of the task or test anxiety, because the homophony judgment is processed via a lexical route on the phonological basis.

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