

**ADVANCES
IN
TEST ANXIETY RESEARCH**

VOLUME 5

EDITED BY

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**PUBLISHED FOR THE INTERNATIONAL SOCIETY FOR
TEST ANXIETY RESEARCH**

STAR

**SWETS NORTH AMERICA INC./ BERWYN
SWETS & ZEITLINGER B.V. I LISSE
1987**

THE INFLUENCE OF ANXIETY ON ACCURACY AND SPEED OF READING PERFORMANCE

by

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A Causal Hypothesis

The major purpose of the present study was to test the three-construct causal model often suggested in the context of Drive Theory and Trait-State Anxiety Theory that trait anxiety is indirectly related to performance through state anxiety (Heinrich, 1979; Hodapp, 1982; King, Heinrich, Stephenson & Spielberger, 1976). Trait anxiety is assumed to affect elevations in state anxiety. Since state anxiety is logically considered closer to drive than trait anxiety (Spielberger, O'Neill & Hansen, 1972), state anxiety is expected to affect performance more directly than trait anxiety. This model seems to have been variably supported in research on academic achievement (Heinrich, 1979; Hodapp, 1982; King et al., 1976).

A reason for the alternating support may be related to the type and number of anxiety parameters operating in the testing situation. This model assumes that anxiety in the actual testing situation is mainly accounted for by the concept of state anxiety, emphasizing the emotional aspect of anxiety. Prior research has indicated, however, the importance of cognitive self-oriented irrelevant thinking or worry to account for performance variance in the testing situations (Morris, Davis & Hutchings, 1981). In situations where worry has been activated but not measured and consequently not included in the causal model, a direct effect from trait anxiety to performance may occur. A direct effect in the causal model however, will logically imply either that trait anxiety is directly affecting performance or that a relevant intermediate factor is not included in the model. Dependent upon how variables were inserted in the causal models, Hodapp (1982) reported either a comparatively strong correlation between trait anxiety and worry, or that the effect of trait anxiety on performance was of an indirect nature mainly mediated through the worry construct. The last type of finding has been consistently replicated in five samples by Hagtvet (1984, 1985b), where a measure of fear of failure was used to assess the subjects' proneness for evaluative stress. Such evidence indicates that state anxiety may be one among other intermediate factors to be included in the causal model. However, the importance of the type of intermediate anxiety parameters may be quite situationally dependent. Common sense thinking suggests that the occurrence of worry cognitions may be a function to which the subject has any possibility to get involved in self-preoccupation. Such test conditions seem to be characterized by letting the subjects work more or less on their own as in ordinary exams. Thus, commonly designed test situations may--from an anxiety point of view--be construed in terms of cognitive- and affective oriented parameters like worry, state anxiety or emotionality. In contrast, test situations may be highly structured in the

sense that subjects are guided every point in time like in short-speed tests in which the time allowing for worrying may be present to a comparatively small extent. The anxiety experience may still be present in terms of emotional aspects of anxiety. We believe that the latter type of situations would be adequate for testing the three-construct causal model referred to above. Research on this model has usually treated performance as a unidimensional phenomenon in correspondence with the majority of studies on anxiety and complex performance. In these studies complex performance has often been global sum scores derived from different varieties of so-called timed-power tests (Nunnally, 1967). When time limits are imposed, however, the accuracy will be more or less confounded with speed variance--a phenomenon which has been well-known in ability and achievement testing for decades (Carroll, 1976; Davidson & Carroll, 1945; Mollenkopf, 1960; Nunnally, 1967; Verster, 1983). In the ability-testing tradition the distinction between speed and accuracy has been treated as an issue relating to psychological theory of cognitive functioning and as a problem relating to methodology of measurement. In the present study this distinction has been taken into account in aiming at a comprehensive understanding of the relation between anxiety and reading performance in particular. This distinction is also of relevance to recent research in reading performance where the notion of considering reading ability in terms of multiple component processes of which speed as one variable of information processing seems to be a salient aspect (Hunstad, 1985; Jackson, 1980; Jackson & McClelland, 1979; Samuels, 1983). In the Trait-State Anxiety Theory, on the other hand, accuracy, in terms of drive-activated error tendencies are evoked by intrinsic features of the task (Spielberger, Anton & Bedell, 1976). Thus, based on methodology of measurement, psycho-logical theory of cognitive functioning and, finally, anxiety theory, the distinction between speed and accuracy seems to represent important aspects in understanding the relation between the two variable domains: anxiety and cognitive performance.

From the foregoing analysis the distinction between speed and accuracy was included in the causal model briefly described above to represent aspects of reading performance. The final suggested causal model is pictured in Figure 1. Parameters resting on a clear rational basis are identified with solid lines in the figure. The model states that trait anxiety exerts a direct effect on state anxiety, which in turn exerts a direct effect on accuracy by eliciting task-related error tendencies.

A critical aspect of the model is the assumption of no direct path from trait anxiety to the different constructs of reading performance. The parameters represented by the dotted lines indicate alternative causal paths initiated by state anxiety in exerting influence on the reading components. These features of the suggested model open for a reasonable combination of confirmatory and exploratory aspects of data analysis reflecting the different rational status of the parameters. This causal model will be treated by means of

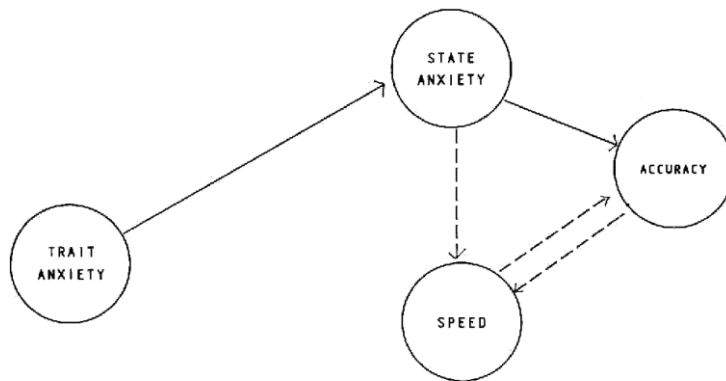


Figure 1: Hypothesized effects of Trait and State anxiety on reading speed and accuracy.

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the LISREL analytic procedure (Jöreskog & Sörbom, 1981), which contains the capacity of assessing the overall fit of the model to the data besides localizing the lack of fit of the model. Furthermore, the LISREL method may also test the existence of individual parameters that may represent competing hypotheses, which is of central importance for the present research purpose.

Assessing Anxiety in Elementary School children

The three-construct causal hypothesis, assuming a unidimensional performance concept, seems to have been mainly tested college students. The present study will test the suggested model on elementary school children. The importance of anxiety in the process of reading in elementary school children was already brought forward by S.B.Sarason, Davidson, Lighthall, Waite and Roe-bush (1960). They discovered that tests which required a high degree of reading ability were more highly associated with anxiety than tests which required little or no reading ability. However, in spite of the fact that the importance of emotional factors are clearly recognized in the field of reading, such factors do not seem to have received proper consideration in particular in pre schoolers and elementary school children, apparently due to anticipated problems of measuring anxiety in these age groups (DeHirsch, Feldman & Roswell, 1972). S.B. Sarason (1966) suggested that his own anxiety scale, the Test Anxiety Scale for Children, did not measure anxiety in terms of the affective experience as hypothesized. Prior and later internal domain studies of this scale have not provided support for its construct validity (Hagtvet) 1983, 1985a; Nicholls, 1976). For research based on the present constructs of anxiety, a children's form of the State-Trait Anxiety Inventory (STAIC) has been developed by Spielberger (1973). There are currently no Norwegian scales available for the *assessment* of these anxiety constructs in elementary school children. In order to test the suggested causal model the STAIC was adapted to the Norwegian language context by the present authors. Supportive factor studies on the distinction between trait and state in elementary school children have been reported by Dorr (1981) and Hedi and Papsy (1982). Gaudry and Poole (1975) reported a rather complex factor structure with the Australian version of this scale administered to children in Grade 8. Supportive evidence for the construct validity of

the STAIC used with normal children has been reported by Finch and Kendall (1979), while their evidence from corresponding studies with emotionally disturbed children was considered contraindicative.

Due to the necessary requirement of developing a new scale, this paper will report the development and findings of the Norwegian STAIC as Study 1, while the findings of the causal modeling study are represented as Study 2.

STUDY 1

The Development of a Norwegian Adaptation of the STAIC Subjects

The subjects consisted of 70 children (40 girls and 30 boys) in three school classes of Grades 3 and 4 located in one school belonging to the basic school system in Norway. The means and standard deviations (in parentheses) of the ages of the boys and girls were 10.10 years (.65) and 10.08 years (.68), respectively.

Procedure and Psychometric Properties

The STAIC is designed with the same format as the adult form, with the exception that only the State-Anxiety scale has its items phrased both as anxiety absent and anxiety present, while items in the Trait Anxiety scale are all unidirectional in terms of anxiety present. A salient feature of this scale is its simple format and brief item formulations. For each item in the American version one Norwegian equivalent item was formulated. Clinical tryouts of the 40 items suggested a 4-point rating scale for each item instead of a 3-point scale as used in the American version.

The Trait-Anxiety scale was first administered by one of the present authors to the pupils in groups of 23-24 during regular classroom periods. Prior to the administration of the scale, the children were instructed on how to respond to the items. The standard procedure for administering the Trait-Anxiety scale was followed (Spielberger, 1973), where the introductory instructions of the scale were read aloud while the pupils read them silently. The pupils worked on their own through the entire scale. The examiner answered questions from few pupils in agreement with standard instructions. The pupils were not informed about the State-Anxiety scale to be administered two weeks later.

The present administration of the State-Anxiety scale took advantage of the fact that the applied reading test, to be described below (cf. Study 2), consisted of two equivalent forms which were administered one after the other. Between the two reading test forms the pupils responded individually to the State-Anxiety scale with the situational reference to how they feel "right now." This procedure was applied to move close to an ideal testing condition in order to assess the pupils anxiety experience within the reading test situation.

To examine the psychometric properties of the two anxiety sub-scales, item-remainder correlations were calculated for the entire group to reach a sizable number of observations allowing fairly stable estimates. For the State-Anxiety scale these correlations varied from .21 to .53 (mean = .36), and the alpha reliability was equal to .77. All items were considered acceptable. The itemremainder correlations of the 20 trait anxiety items varied from .10 to .54 (mean .36), while the alpha coefficient was .80. However, three of these items were deleted due to low item-remainder

correlations and negative correlations with other items. These items were the Norwegian equivalents to Items 1, 3 and 16 in the American version of the Trait-Anxiety scale: "I worry about making mistakes," "I feel unhappy," and "My hands get sweaty," respectively (Spielberger, 1973). The Norwegian Item 1 may have been associated with making mistakes in a particular school context. If so, this item may be highly situationally specific. Item 3 may carry depressive content rather than anxiety. Finally, Item 16 may implicitly carry connotations to a specific situational context which bears loose correspondence to how the child feels in general. The item-remainder correlations of the 17 items varied from .21 to .54. Even though three items of the Trait-Anxiety scale were not acceptable, we considered the obtained reliabilities of each of the sum scores, as reflected in the alpha coefficients, as quite promising.

The means and standard deviations for the two sexes on each anxiety scale are reported in Table 1.

Table 1: Means (\bar{x}) and Standard Deviations (s) of the Trait-Anxiety and State-Anxiety Scales for the Norwegian Version of the STAIC

		<u>Trait</u>	<u>State</u>
Boys	x	30.93	31.30
	s	6.88	5.66
	N	30	30
Girls	x	30,05	29.00
	s	5.83	6.10
	N	40	40

Study 2

Assessment of the Causal Model

The empirical test of the causal model presented in Figure 1 was based on the same subjects as those described in Study 1.

Measures

Besides the measures of trait and state anxiety described in Study I measures of speed and accuracy of reading were obtained by administering two equivalent forms of the same reading test. The two reading test forms were made equivalent according to principles in Dansk LIX (Readability Index), 1970. (For detailed information see Hunstad and Hagtvet, 1984.) Each form consists of five one-phrase items. Each item is an imperative statement which is presented in the "window" of a simple tachistoscope. The following are sample items: "Get up and go to the door," "Show me how you drink a glass of water," "Put your left hand on your right knee," etc. The test was administered individually and all subjects responded to both forms.

Before starting on the test, each individual was explicitly instructed to read aloud as fast as she/he could, yet gaining complete comprehension of the text. The pupil was then told that the reading speed and the occurrence of reading errors would be recorded. Immediately after reading each item the subject was encouraged to enact what she/he had read to assure that the content was properly understood. The speed in seconds was recorded by a stopwatch which was started at the moment the phrase was displayed in the window, and was stopped when the last word was pronounced. Only one phrase at a time was shown in the window. The speed score was constructed by converting the reading time in seconds into words per minute.

Even though the present reading test was primarily designed to measure the speed of reading with less or no influence of reading comprehension, a reading error score was derived. If the item-phrase pronounced by the pupil differed in any way from the written item-phrase, an error was recorded. A reading percentage error score, indicating degree of accuracy of reading, was calculated by forming the ratio between the number of reading errors to the total number of letters multiplied by 100.

The present research effort was an integrated part of another study to assess the equivalence of the two reading test forms. For this purpose the 70 children were randomly assigned to two groups which were given the two test versions in opposite order. Analyses of speed scores provided clear support for the equivalence of the two test forms in terms of mean values, standard deviations, alpha reliabilities and factor structure. These psychometric properties were unaffected by the order of administration (Hunstad & Hagtvet, 1984; Hagtvet & Hunstad, 1984).

Procedure

The administration of the anxiety and reading scales followed a fixed schedule for each group. The Trait-Anxiety scale was first administered to all children in groups (cf. Study 1). Two weeks later the State-Anxiety scale and the two reading test forms were given to the two randomized groups in the following way: The one test form was individually administered. Then the State-Anxiety scale was immediately filled out individually. Finally, the second test form was individually administered. The two groups differed only with respect to the order in which they received the reading forms. Thus all the pupils responded to the State-Anxiety scale embedded in the reading test situation.

Designing the Constructs of the Causal Model

By using the LISREL analytic procedure the researcher is enabled to work with latent variables as approximations to the constructs of the suggested model. In doing so, an

appropriate set of observed indicators for each construct is required. The 17 remaining items of the Trait-Anxiety scale and the 20 items of the State-Anxiety scale were in principle considered to be equivalent indicators for the two anxiety constructs, respectively. However, to give some justification to the assumption of interval-scaled indicators, the trait anxiety factor was operationalized by means of one 3-, two 5-, and one 4-item composites labelled T₁, T₂, T₃, and T₄, respectively (see Footnote 1). Likewise, the State-Anxiety factor was defined by the following four 5-item composites: S₁, S₂, S₃ and S₄ (see Footnote 2). For each reading test form, a latent factor was defined by three indicators consisting of one, two and two items, respectively. They were labelled Sp₁, Sp₂, and Sp₃. The corresponding error or accuracy variables had to be treated as observed variables.

RESULTS AND DISCUSSION

Based on the pupils' enactments as part of their responding to each reading test item, reading comprehension was a constant in accordance with the rationale behind the reading test in this study. Thus it was assumed that the reading performance was then assessed in terms of reading speed and its associated error with no influence of reading comprehension.

A central feature of using the LISREL method is not unconditionally to obtain the best possible fit between the model and the observed data. The danger of overfitting the model is always present. The critical problem is rather deciding when to stop fitting the model (cf. Jøreskog, 1978). The present writers' contention is that the fitting procedure should be primarily guided by substantive considerations. Thus the final model should represent a reasonable fit between the model and the data and should be psychologically meaningful. In this study two estimated LISREL models seemed to meet these requirements satisfactorily. The models differed with respect to the version used to measure reading speed and reading error. However, since the two estimated models were highly similar and supported the same conclusion, only one of the models is pictured in Figure 2, including its most salient parameters.

The assessment of the fit of the final model is given by the following goodness-of-fit measures: chi-square (51) = 52.47; $p = .417$; GFI = .84. The parameters reflecting the direct effect of the trait anxiety factor on reading speed and reading error assessed by a chisquare difference test did not improve the fit of the model. The Bentler and

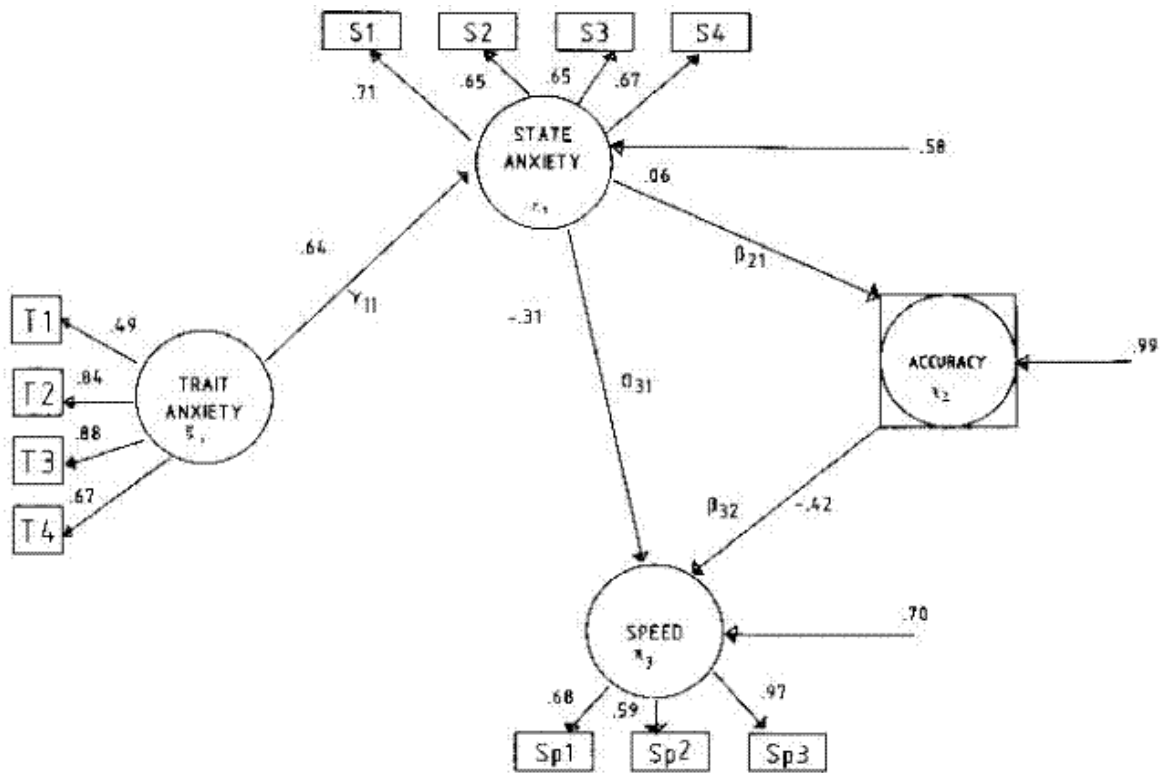


Figure 2. Visual reading speed at the first, third, sixth, and ninth day of visual word recognition training.

Bonett (1980) incremental fit indices) rho and delta, of the reported model were .99 and .85.

Alternative effects representing the relations between state anxiety, reading accuracy and reading speed were tested. The reciprocal relationship between reading accuracy and reading speed, omitting the relation between state anxiety and reading speed) provided estimates out of range, indicating lack of fit. Testing the fit of a 'circle' model representing the influence of state anxiety on accuracy, the effect of accuracy on speed, which in turn influences state anxiety, clearly did not indicate any improvement beyond the final model. An identical model to the one reported in Figure 2 with the exception that speed is exerting an effect on accuracy fitted the data equally well.

Thus, the obtained model clearly supported the main feature of the causal hypothesis by displaying an indirect causal effect of trait anxiety through state anxiety on reading speed. However, the model indicated no significant causal effect of state anxiety on the reading accuracy variable. The unknown reliability of this performance variable might represent a rival hypothesis for the zero relationship. On the other hand, since the LISREL analysis is exclusively mapping the linear component of relationships and occasionally trends of curvilinearity between anxiety and performance are reported in the literature (Hemrich & spielberger, 1982; Lens, 1984), the scatter diagram showing the relationship between state anxiety and reading error was inspected. For this purpose the sum score of the reading errors across both test versions was used to measure the reading accuracy variable. In fact, the scatterplot revealed a trend of curvilinearity. The trend was tested by inserting a quadratic term beyond the linear component in a hierarchical ordinary least square regression (Cohen & Cohen, 1983). The significant quadratic contribution ($F(1,67) = 5.73, p < .02$) explained uniquely 7.8% of the

variance of the reading accuracy variable. The curvilinearity reflected a U-curve) which is consistent with the well-known Yerkes-Dodson Law. Both low- and high-anxious subjects made more errors than the medium-anxious subjects. Thus, the present data supported the notion that anxiety as an emotional state exerts different effects on the error and speed components of reading aloud performance; state anxiety is negatively and linearly related to reading speed while it may be related by a U-function to accuracy of reading. A U-relation between state anxiety and reading errors may be interpreted as supporting the Drive Theory if the reading performance in question could be considered of intermediate difficulty (Heinrich & Spielberger, 1982). However, the obtained curvilinear trend should be considered exploratory in nature. An estimate of the internal consistency reliability of the sum score of the two reading error scores was .46. This finding may reflect the problem of constructing a test which measures reading speed and reading accuracy equally well. A closer inspection of the types of error made, however, seems to shed some light on the operation of this variable. The errors could be a posteriori classified into five categories. The error frequency distribution indicated that the "Addition of words or letters" represented 42%, "Deletion of words or letters" 25%, "Repetition" 13%, "Confusion of words or letters" 12%, and, finally, "Change of suffix of words" 8%.

The occurrence of the categories of reading errors suggested at least three hypotheses: (a) When the amount of deletion errors increases, reading speed is also expected to increase; (b) when the amount of insertion errors increases, reading speed is expected to decrease; and, finally, (c) a corresponding negative correlation between repetition errors and reading speed is expected. Thus, by suggesting a multidimensional concept of error, the relation between speed, accuracy, and state anxiety would seem to be highly differentiated. Based on the present findings a future empirical test of the obtained relationships between state anxiety and the reading performance components may require a more elaborated rationale for measuring the error construct. The clear support of the main feature of the causal hypothesis inspires some considerations about why this hypothesis was so clearly supported. This study is characterized by its reading test situation being highly structured in the sense that the pupils are constantly receiving instructions about what to do. Obviously the subject has to respond to the ongoing instructions of reading brief phrases as fast as she/he can. This structure seems to differ substantially from test situations, leaving the students more on their own. However, the construct of worry should be included in a retest of the present findings to assess the influence of self-preoccupation also in this situational context. The present findings supported the construct validity of the present version of the STAIC. Thus, this inventory may be taken into account to achieve a better understanding of differences between good and poor readers and, furthermore, to assess the relative importance between emotional and non-emotional factors in the reading process. This suggestion may even more apply to groups suffering from disabilities as for instance severe loss of visual reading ability. Hunstad (1984, 1985) has provided evidence in groups of blind subjects having extreme low residual vision (light projection only) to significantly use their visual reading potential by means of an electron-optical device. However, being in the initial process of gaining visual reading ability, most subjects often display extensive anxiety symptoms which may interfere with their anticipated improvement. Due to its ease of administration, the STAIC may be a promising device in further inquiry into the interrelationship between anxiety and reading performance in different groups of elementary school children.

CONCLUSION

The present study provided support for an indirect causal effect of trait anxiety through state anxiety on reading speed. Additional analyses indicated a curvilinear relationship between state anxiety and reading error. Further inspection of the error variable suggested an a posteriori classification of reading errors, which led to formulating three hypotheses on the relationship between reading errors and reading speed. The classification of errors inspired a more elaborated rationale for measuring the reading error variable. The present findings also provided support for the construct validity of the Norwegian version of the STAIC.

FOOTNOTES

- 1) The composition of the indicators in terms of scale items may be obtained from the writer.
- 2) Both solutions are available on request.

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