CHILDREN'S PHONEMIC DISCRIMINATION IN

ISOLATION AND CONTEXT WITH BACKGROUND NOISE

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ABSTRACT

The purpose of this study was to determine whether there was a difference in performance on tests of discrimination among phonemes in isolation and context with background noise and whether age affected performance in the contextual test.

Four and seven year old children were administered twenty items from the Noise Subtest of the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (1970) and a twenty item contextual test. Subjects were given a training procedure and listened to recorded versions of the tests.

Results indicated a significant difference between performance on the tests of discrimination in isolation and context. There was not a significant correlation between performance on the two tests. Finally, there was a relation between age and performance on the test of discrimination in context.

Chapter 1

INTRODUCTION TO PROBLEM

Auditory discrimination is an integral part of the communication process. In order to acquire a spoken language, a child must be able to discriminate among phonemes. In addition, real-life situations require the child to discriminate among phonemes with background noise. Therefore, the evaluation of auditory discrimination should include tasks which evaluate this ability in ways which simulate the actual situations in which it is required.

The importance of assessing auditory discrimination has been demonstrated in various studies which related the process of auditory discrimination to other processes. The results of a study by Zigmond (1969) indicated a positive correlation between auditory discrimination skills and auditory-visual integration and word-attack skills in reading. Relations between deficits in phoneme discrimination and sequencing were found in learning disabled children by Aten and Davis (1968). Psycholinguistic ability and spelling ability were linked to auditory discrimination in studies by Cole (1964) and Rechner and Wilson (1967). Marslen-Wilson (1975) found that a deficit in auditory discrimination could affect the other processes involved when speech is encoded. Aram and Nation (1975) found that the phonological, syntactic, and semantic levels of lang-

uage are hierarchial; therefore, a deficit in any level may affect the other levels. Aram and Nation (1975) suggested that the assessment of auditory discrimination should be included in a differential diagnosis of language disabilities because of the relationship between the levels of language comprehension, formulation, and repetition. Wiig and Semel (1976) stressed the need for in-depth assessment of auditory discrimination in children with language and learning disabilities. However, the current tests of auditory discrimination such as the Goldman-Fristoe-Woodcock Test of Auditory Discrimination (G-F-W) (1970), assess discrimination in isolation. In real-life, the individual discriminates among phonemes in context. Moreover, these discriminations are made against a background of competing noise. Although the G-F-W assesses discrimination in words against a background in noise, none of the contextual tests which are currently available include background noise.

Thus, the extant auditory discrimination tools do not provide for in-depth assessment in the many contexts in which discrimination occurs. This apparent deficit seems unusual since the evaluation of phoneme production includes tools for testing this ability in many different contexts. McDonald (1964) developed the Deep Test of Articulation to evaluate production of phonemes in a variety of phonetic contexts. The McDonald test consists of pairs of pictures or written sentences which elicit the production of phonemes in the different contexts in which they occur. Other articulation tests which evaluate phoneme production different contexts include the Basic Data

Sheet Test (Milisen, 1968) and a series of picture and sentence
tests developed by Templin and Darley (1957).

The emphasis on evaluating phoneme production in many
different contexts serves to point out the lack of correspond-
ing measures in auditory discrimination for assessing this
skill in all the situations in which it occurs. There are
currently no formal tests of discrimination of phonemes in
context with background noise. The majority of tests such as
the Picture Discrimination Test (Mecham, Jex, and Jones, 1962)
and the Children's Auditory Discrimination Inventory (Stern,
1969), assess discrimination in isolation. There is no data
currently available indicating whether there is a difference
in performance on tests of discrimination among phonemes in
isolation and context with noise. Moreover, there is no data
currently available on the relation between age and discrimin-
ation among phonemes in context. In order to answer the pre-
ceeding questions, the present study sought to compare the
performance of children on tests of discrimination among phonemes
in isolation and context with background noise and assess the
affect of age upon performance in context.

The delimitation of the problem. In order to delimit
the problem, normal children from a representative sample of
preschool and primary grades served as the subjects. Children
with known deficits were excluded since the present study
sought data from a normal population. Only children aged
four and seven were chosen to assess the factor of age.

Definitions.

1. Auditory discrimination. The ability to make auditory distinctions among the different phonemes (Templin, 1957).

2. Discrimination in isolation. The ability to discriminate among phonemes in words.

3. Discrimination in context. The ability to discriminate among phonemes in phrases or sentences.

4. Phoneme. Basic discernible segment in sound patterns of a language. Speech sounds(Muma, 1978).

5. Background noise. The competing sounds which occur during the discrimination among phonemes in real-life situations.

Assumptions. It was assumed that the preschool subjects would not have receptively acquired all of the phonemes which were tested (Templin, 1957). It was assumed that the subjects that were tested had normal intelligence since they were selected from regular classrooms. As a result, mental ability should not have had an affect on performance. Since the words (Table 1, page 7) used in isolation and context were taken from lists appropriate for the ages tested, and since a training session was used to familiarize subjects with stimulus materials, vocabulary knowledge should not have affected performance (Goldman, Fristoe, Woodcock, 1970).

The hypotheses. Two null hypotheses were tested:
first, that there was no significant relationship between per-
formance on tests of discrimination among phonemes in isolation
and context with background noise, and second, that there was
no significant relationship between age and performance on dis-
crimination among phonemes in context with noise.

METHODS

Subjects. The population consisted of two groups of
four and seven year old children with twenty-five in each group.
The subjects were selected from a representative sample from
primary grades and day care centers in North Carolina. None
of the subjects had shown any deficits in communication skills.

Tests selected for the study. The Noise Subtest of
the G-F-W (1970) was chosen to assess discrimination among
phonemes in isolation with background noise. This test was
chosen because it included the factor of background noise and
also eliminated the affect of vocabulary on performance by
using a training procedure and words appropriate for the ages
tested. The G-F-W also eliminated administrator influence by
using a recorded test. In addition, the simple line drawings
used for the target word and three foils were easily matched
by children.

Since there were no tests of discrimination among
phonemes in context with background noise, it was necessary
to develop such a test. Twenty target words were selected

from the thirty in the G-F-W Noise Subtest. These words could easily be placed in sentences while using the line drawings which accompanied each target. Table 1, shows the words included in each test.

The sentences for the contextual test of discrimination were recorded with a signal to noise ratio of 10 in a cafeteria when noise was at a peak. The recording was made on a 3M Wollensak Model 6020 AV reel-to-reel recorder at 3 3/4 speed for the G-F-W and 7 1/2 speed for the contextual test.

PROCEDURES

Training sessions. Before the administration of each test, a training procedure was used to assure that the subject was familiar with the vocabulary. The picture foils which were on an easel were turned towards the subject. The administrator pointed to every picture and said, "What is this?" If the subject responded correctly, the administrator moved to the next picture. If the subject did not respond correctly, the administrator told the child what the picture was and again asked the child, "What is this?" After going through the four pictures on each page, the administrator again asked about the missed pictures. With each series, the administrator gave explanations of a picture such as, "This ia a ball. You can throw a ball. A ball is round. A ball bounces."

Table 1

THE TEST OF DISCRIMINATION OF PHONEMES IN ISOLATION WITH NOISE

Target	Picture Choices
1. cash	cash calf catch cap
2. catch	cap cab cat catch
3. fair	pear fair chair hair
4. cat	cab cap cat catch
5. tack	pack tack sack shack
6. jack	tack pack jack back
7. vine	vine sign line shine
8. cone	core coal comb cone
9. pail	tail sail pail whale
10. cap	catch cap calf cash
11. bear	tear pear chair bear
12. sign	sign line shine vine
13. coal	comb core cone coal
14. mail	mail nail veil rail
15. pack	pat pack path patch
16. sail	whale tail pail sail
17. bee	key tea pea bee
18. shack	sack shack pack tack
19. back	tack pack jack back
20. hair	chair hair fair pear

THE TEST OF DISCRIMINATION OF PHONEMES IN CONTEXT WITH NOISE

Target	Picture Choices
1. Did you see the cash?	cash calf catch cap
2. Look at his catch.	cap cab cat catch
3. Find the fair.	fair pear chair hair
4. Look at his cat.	cab cat cap catch
5. We walked by the tack.	pack tack sack shack
6. He saw the jack.	tack pack jack back
7. Look at the vine.	sign vine line shine
8. I threw away the cone.	core coal comb cone
9. The pail is gray.	tail sail pail whale
10. Did you see the cap?	catch cap calf cash
11. There was a big bear.	tear pear chair bear
12. What's on the sign?	line sign shine vine
13. I threw the coal.	comb core cone coal
14. I see the mail.	mail nail veil rail
15. Which picture shows pack?	pat pack path patch
16. The sail is wet.	whale tail pail sail
17. The bee is here.	key tea pea bee
18. We found the shack.	sack pack shack tack
19. We saw the back.	tack pack back jack
20. Find the hair.	chair hair fair pear

Administration of the G-F-W Noise Subtest. The fifty
subjects were administered the twenty items from the G-F-W
in a quiet room. A 3M Wollensak reel to reel recorder was
used to administer the recorded test. Following the training
procedures, the subjects listened to the following recorded
instructions: "You will heal some words. Point to the picture
of the word you hear. Listen carefully. Ready?" Then, three
sample words were used. The subject listened to the words and
pointed to one of four pictures which were on an easel facing
the subject. After the subject responded, the administrator
recorded the response and turned the plate. The easel was
positioned to allow the administrator to observe the responses
easily. An example of a target word was, "Cash." The subject
was not given any additional clues and had to discriminate
among phonemes in isolated words with a signal to noise ratio
of 9. The words were one syllable and consonant-vowel-conson-
ant or consonant-vowel. The entire test lasted $7\frac{1}{2}$ minutes.

Administration of the test of discrimination among
phonemes in context with noise. The contextual test was ad-
ministered in a quiet room on a recorder on the day after the
administration of the G-F-W. The target words within the
sentences were the same as those used for the test of discrim-
ination among phonemes in isolation with background noise.
Again, administration followed the training procedure. The
easel with pictures was positioned to allow the administrator
to observe responses. The subject listened to the following

recorded instructions: "You are going to hear some sentences. There will be noise so listen carefully. Point to the picture which matches one of the words in the sentence. Ready?" Then the subject was given three trial sentences such as: "The cap is here." The subject was required to match the word cap to one of four pictures including cap, cab, cat, and catch. Then the subject listened to the twenty sentences and matched targets to pictures. The administrator recorded each response. The test lasted $7\frac{1}{2}$ minutes.

The results of the performance of subjects on the two tests were compared to obtain information needed to test the hypotheses.

Chapter 2

SURVEY OF THE RELATED LITERATURE

The survey of the related literature suggested that
methods of evaluating auditory discrimination include one or
more of the following tasks: 1) indicating whether two stimu-
li are alike or different, 2) matching a verbal stimulus to an
appropriate picture, 3) matching a verbal stimulus to one pro-
duced by the test subject, 4) indication by subject as to wheth-
er his own production is correct, 5) matching a verbal stimulus
with background noise to an appropriate picture. The stimulus
items are presented in isolation or context. Examples of the
tasks are given later in this chapter.

Tests which require indicating alike or different. The
Travis-Rasmus Speech Sound Discrimination Test (1931) con-
sisted of three hundred pairs of consonants and sixty-six
pairs of vowels which were presented to a subject who indicated
whether a pair was alike or different. A disadvantage of the
same-different task is its irrelevance in the communication
process because in speech, individuals do not match two ex-
ternally produced sounds in isolation, but instead monitor
their own speech production (Sanders, 1972). The Travis-Rasmus
discrimination test served as a model for other auditory dis-
crimination tests that followed. The test required a minimum

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of thirty five to forty minutes to administer and was criticized for its length.

Mildred Templin (1943) constructed auditory discrimination tests which required either the matching of a picture to a target word or indicating whether pairs of nonsense syllables were alike or different. The nonsense syllables were constructed in a discrimination test for use with children six to eight years, and the picture test using word pairs was developed for use with younger children from three to five years old. The study which was used to develop the discrimination tests employed a test population selected according to age, intelligence, sex, family background, bilingualism, twinning, and hearing impairments (Templin, 1957).

The results of the Templin (1957) study indicated that speech sound discrimination ability in isolation increased with age, and in addition, there was no statistical difference in the performance by boys and girls. Subjects from higher socio-economic levels scored higher than those from lower socio-economic levels.

A chief criticism of the Templin study was the dependence of the picture sound discrimination test on the child's vocabulary. Poor performance could have been a result of a deficit in vocabulary. Similarly, poor performance on the test which used pairs of nonsense syllables could have been due to a deficit in the abstract concept of same or different.

Haroian (1951) readministered the Mansur test of auditory discrimination to 199 children in kindergarten, first

grade and a remedial reading group. Haroian found that the test was reliable but stressed the need for further revision of test materials because the arrangement of the pictures affected the results. Haroian also recommended more stimulus items so more sounds would be tested.

Matching a verbal stimulus to an appropriate picture. Pronovost and Dumbleton (1953) took the results of the Mansur and Haroian studies to construct the Boston University Speech Sound Discrimination Test. The test was a revision of the previous studies and was standardized after administration to middle class children in Boston. The test included a training session to ensure that the child understood the task.

Mecham, Jex, and Jones (1962) developed the Picture Discrimination Test which consists of words from the Thorndike list and requires a picture matching response. Mecham, Jex, and Jones later developed the Test of Listening Accuracy in Children which is a taped version of the previous task and eliminates administrator influence on the performance.

Stern (1969) constructed the Children's Auditory Discrimination Inventory (CADI) which attempts to minimize the effects of vocabulary and task-demands on performance. The CADI consists of 38 pairs of pictures which the child must point to after discriminating between a word pair. The words represent familiar objects and nonsense objects. The real words were pretested and were within the vocabulary of the population for whom the test was designed.

Matching a verbal stimulus to one produced by the test
subject and indicating whether his own production is correct.
R. L. Schiefelbusch and Mary Jeanne Lindsey (1958) constructed
a test of phonemic discrimination which assesses discrimina-
tion among phonemes as children hear them produced by others
(interpersonal), as they produce them themselves (intrapersonal),
and as they evaluate them silently. The discrimination test
consists of words selected from the Dolch word list and Rins-
land's basic vocabulary list which were on the level of the
test subjects. During the test, the child is instructed to
indicate which picture matches a target word, then the child
names the pictures and indicates whether his own production
is correct. Finally, the child names three similar pictures
and identifies the two pictures which are alike. This dis-
crimination test was administered to normal and defective
speakers with results indicating significant differences in
performance by the two groups.

The Ohio Tests of Articulation and Perception of
Sounds (1967) contains subtests of interpersonal and intra-
personal discrimination of phonemes. These auditory tasks
indicate whether the client is able to monitor external speech
and his own speech. There are at present no formal tests de-
voted entirely to intrapersonal discrimination. Failure to
match an internally produced sound with an internal criterion
would suggest that the subject cannot evaluate his own speech
production (Sanders, 1970).

Matching a verbal stimulus with background noise to
the appropriate picture. The Goldman-Fristoe-Woodcock Test
of Auditory Discrimination (1970) was selected for use in the
present study to test discrimination among phonemes in isola-
tion because it was constructed to minimize factors such as
vocabulary, familiarity with test materials, and administrator
influence on results. One or more of these factors affected
the performance of subjects on the previously mentioned tests.
In addition, none of the tests used background noise to sim-
ulate actual listening situations as does the G-F-W.

The G-F-W consists of three parts: 1) training pro-
cedures, 2) Quiet Subtest, and 3) Noise Subtest. Reliability
was .87 for the Quiet Subtest and .68 for the Noise Subtest.
Test-retest reliability was .87 for the Quiet Subtest and
.72 for the Noise Subtest.

The testing procedure for both subtests of the G-F-W
includes a target word which is matched to one of four pictures.
The authors of the test suggest that although most discrimin-
ation tests focus on preschool and primary age children, many
use the same-different concept which is too abstract for child-
ren to understand.

Despite its attempts to alleviate factors which affect
performance, the G-F-W does not assess discrimination in con-
text which is a major shortcoming of all diagnostic tools in
the area of discrimination.

Tests of discrimination in context. The gap in con-
textual evaluation methods for auditory discrimination was
evidenced by the lack of research in the area. Only two
studies used contextual type tests, but the thrust of these
tests was toward determining difference in performance by
normal and defective speakers. Hall (1938) constructed a
contextual test of discrimination for use in his study as
did Mase (1946). However, the use of contextual tests was
incidental to these studies so there was no data relative to
the present study.

The Kent State University Test (1977) consists of
thirteen sentences with five word foils. The examiner chooses
one of five words to use in the sentence and asks the subject
which word was used (Berber, 1977).

None of the contextual tests assesses ability to dis-
criminate among phonemes in context with background noise.
Thus, a contextual test of discrimination was designed for e-
valuation in the present study.

A survey of the related literature suggested that dis-
crimination of phonemes in context with noise has been virtually
ignores. Instead, tests were developed to assess discrimination
in isolation in a quiet environment. However, children and
adults are faced with the task of discriminating among phonemes
in context with background noise in everyday situations.

The importance of assessing auditory discrimination is
apparent since many tests include subtests for discrimination
including the Durrell Analysis of Reading Difficulty (1955),

the Clymer-Barrett Pre-Reading Battery (1967), and the Stanford Diagnostic Reading Test (1966), among others. Therefore, the development of a contextual test of discrimination in the present study was necessary in order to evaluate discrimination ability in all the situations in which it occurs.

The present study attempted to investigate the question of the ability of children to discriminate among phonemes in isolation and context with background noise and the affect of age upon performance in context. This was a new area of research with no formal tests fitting all the requirements necessary to assess discrimination among phonemes in context with background noise. However, the survey did suggest that the most appropriate tool to assess discrimination among phonemes in isolation with noise was the Noise Subtest of the G-F-W.

The perceptual funtions, including auditory discrimination are difficult to evaluate since a wide range of abilities are involved. Nevertheless, the concentration of past research on discrimination among phonemes in isolation without noise left a major question unanswered. Is there a difference in the ability of children to discriminate among phonemes in context and isolation with background noise? Is age a factor in the ability to discriminate among phonemes in context? The present study investigated these questions.

Chapter 3

RESULTS

Table 2 shows the raw scores of subjects on the two tests of discrimination. Table 3 reports the raw score range, mean, median and standard deviation for subjects on each test. These results were used to test the hypotheses in two-tailed t-tests for correlated and uncorrelated data at the .01 level of significance (Downie & Heath, 1974). Table 4 shows the results of both t-tests which resulted in the rejection of both null hypotheses. A Spearman Rank Order Correlation was used to determine whether there was a significant relation between performance on the two tests(Downie & Heath, 1974).

The results of a two-tailed t-test for correlated data on the significance of the difference in mean performance between the subjects on the test of discrimination among phonemes in isolation and context with background noise resulted in rejection of the null hypothesis ($t=4.76$; $df=48$; $p<0.01$).

The results of a two-tailed t-test of uncorrelated data on the significance of the difference in mean performance by the two age groups on the contextual test resulted in rejection of the null hypothesis ($t=4.04$; $df=49$; $p<0.01$).

The Spearman Rank Order Correlation (rho) indicated no significant relationship between performance on both tests by four year olds(rho=-0) and seven year olds(rho=.15).

Table 2

RAW SCORES (NUMBER CORRECT) OF SUBJECTS ON TESTS OF DISCRIMINATION

IN ISOLATION AND CONTEXT

Group 1: Four year olds							
Subject	Score:	Isolation	Context	Subject	Score:	Isol.	& Cont.
1.		9	16	14.		12	15
2.		9	15	15.		13	14
3.		10	14	16.		10	14
4.		10	14	17.		8	14
5.		9	13	18.		8	15
6.		7	13	19.		7	12
7.		7	15	20.		9	12
8.		14	13	21.		8	14
9.		9	13	22.		6	15
10.		10	13	23.		7	14
11.		12	14	24.		6	13
12.		9	14	25.		9	14
13.		10	15				

Group 2: Seven year olds							
Subject	Score:	Isolation	Context	Subject	Score:	Isol.	& Cont.
1.		16	18	14.		15	20
2.		16	14	15.		14	19
3.		17	17	16.		15	19
4.		14	17	17.		15	17
5.		17	19	18.		17	19
6.		16	19	19.		14	18
7.		16	20	20.		16	18
8.		16	18	21.		15	19
9.		14	19	22.		16	18
10.		16	20	23.		18	20
11.		15	19	24.		17	19
12.		15	19	25.		9	19
13.		17	18				

Table 3

SUMMARY STATISTICS

Test	Age	N	Raw Score Range	X	s	median
CONTEXT	4	25	9-18	15.44	1.69	16
CONTEXT	7	25	14-20	18.45	1.29	19
ISOLATION	4	25	6-14	9.12	2.00	9
ISOLATION	7	25	12-16	13.92	.97	14

Table 4

Results of t-tests				
	N	Age	t	p
Performance on both tests	50	4&7	4.67	<.01
Performance on contextual test	25	4&7	4.04	<.01

ANALYSIS OF RESULTS

The results of the present study demonstrated a difference in performance on tests of discrimination in isolation and context with noise. This difference in performance suggests that there is a difference in ability in discrimination among phonemes in different situations.

Further evidence demonstrated no significant correlation between the performance of subjects on both tests, suggesting that the performance by subjects on either test could not be used to predict performance on the other. This is an important finding because the need to assess discrimination in all situations is not currently stressed. If there had been a significant correlation between performance on both tests by subjects, there would be no need to assess discrimination in more than one area. However, the present study clearly demonstrates that tests of discrimination in a single situation do not completely assess the ability. If a child easily discriminates among phonemes in one situation, he may still demonstrate an auditory perceptual problem in another situation. Auditory discrimination must be assessed in all situations in which it occurs in order to eliminate the possibility of a problem.

Another finding was the difference in performance by four and seven year olds on the contextual test. This difference in performance coincided with the findings of Templin (1957) and Wepman (1958) which demonstrated that discrimination increases with age.

<u>Item amalysis of the contextual test</u>. Table 5 reports
the item difficulty for each of the twenty items on the test of
discrimination among phonemes in context. Item difficulty was
determined by the proportion of subjects who answered an item
correctly (Downie & Heath, 1974). Subjects had difficulty
discriminating between /m/ and /n/, /t/ and /tʃ/, /p/ and /f/,
and /p/ and /b/.

Table 5

Difficulty of Items on the Contextual Test

of Discrimination

Difficulty		Difficulty	
Item		Item	
1.	.60	11.	.48
2.	..60	12.	.90
3.	.90	13.	.90
4.	.80	14.	.66
5.	.80	15.	.80
6.	.90	16.	.90
7.	1.00	17.	.80
8.	.40	18.	.80
9.	.90	19.	.90
10.	.40	20.	1.00

Item difficulty was determined by the proportion of subjects
who answered an item correctly.

Chapter 4

CONSLUSIONS AND IMPLICATIONS

The problem. The present study attempted to determine
whether there was a difference in the ability of four and
seven year old children to discriminate among phonemes in is-
olation and context with background noise and whether there
was a relation between age and discrimination in context. It
was suggested that present assessment tools for auditory dis-
crimination do not test this ability in all situations in which
it occurs.

Two null hypotheses were tested: 1) There was no sig-
nificant difference between performance on tests of discrim-
ination among phonemes in isolation and context with noise,
and 2) There was no significant relationship between age and
performance on a contextual test with noise.

Methods and procedures. A representative sample of
twenty-five four year olds and twenty-five seven year olds
were selected from primary grades and day care centers. Each
group was given the Noise Subtest of the G-F-W and a context-
ual test with noise. Subjects were aided with a training session
and listened to recorded tests and matched targets to pictures.

Major findings. A two-tailed t-test for the signif-
icance in performance between subjects on the tests of dis-

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crimination among phonemes in context and isolation with noise resulted in rejection of the null hypothesis (Table 4). In addition, the null hypothesis of no difference in performance by the two age groups on the contextual test was rejected (Table 4). There was no significant correlation between performance on both tests by either group.

Implications. The findings in the present study demonstrated the need for continued research into discrimination in all the situations in which the ability is required. The present study was a step in the direction of assessing discrimination in a real-life situation; however, further research must determine which types of tasks most accurately assess discrimination ability. The tasks which are most important in auditory discrimination should be developed and placed in new tests for this ability.

Research should study the performance of speech and language disordered children on tests of discrimination in context with noise. The findings should be compared to those in the present study to determine whether performance can be predicted by a test with only one task.

Findings in the present study slearly demonstrate the need for research into the development of in-depth assessment tools for auditory discrimination. Future investigations must consider which situations should be tested to accurately determine whether a problem is present. The present study has been the basis for future research.

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