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# The Touch Inventory for Elementary-School-Aged Children: Test-Retest Reliability and Mother-Child Correlations

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Key Words: self-reporting forms • sensory integration • sensory integrative dysfunction

*Objective.* The Touch Inventory for Elementary-School-Aged Children (TIE) is a self-report screening assessment for tactile defensiveness. The purpose of this study was to examine test-retest reliability of the TIE and to evaluate agreement between children's TIE scores and scores that mothers gave their children on a modified version of the TIE.

*Method.* Twenty-nine children, 6 to 12 years of age, were available for the test-retest portion of the study and were assessed with the TIE with a 1-week interval between sessions. Their mothers completed a modified version of the TIE.

*Results.* Results indicated significant test-retest reliability ( $r = .91, p < .001$ ), although a more conservative Kappa indicated only moderate agreement. The correlation between mothers' ratings and children's ratings was less significant ( $r = .56, p = .001$ ), and Kappas were slight or fair, indicating considerable disagreement between mothers and children.

*Conclusion.* These results suggest that using information from both mothers and children might provide a more complete picture of tactile defensiveness, but further research is needed before using a mother's assessment when the TIE is implemented as a standard procedure.

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The tactile system is of utmost importance for human occupations, including work, play, and daily living tasks. A review of literature concerning the importance of the tactile system revealed the role of the tactile system in many performance components. For example, touch sensations are important for human survival because they can warn a person of impending danger (Ayres, 1979). The sense of touch is also important in motor planning because it helps a person organize and synthesize movements (Gilfoyle, Grady, & Moore, 1981). Even emotional and social stability are intertwined with the tactile system as a result of the system's key role in human relationships (Ayres, 1964). Because of this importance to human occupations, dysfunction of the tactile system has been an area of concern for many occupational therapists (Ayres, 1964; Bauer, 1977; Fisher & Dunn, 1983; Larson, 1982; Royeen, 1985). One such dysfunction of the tactile system is tactile defensiveness, which was first identified by Ayres in 1964. The syndrome is characterized by the avoidance of touch, aversive responses to nonnoxious touch, and atypical or irregular execution of occupations consisting of tactile components (Royeen & Fortune, 1990). Tactile defensiveness has been documented in several clinical populations, including children with mental retardation (Kinnealey, 1976), developmental delays (Larson, 1982), learning disabilities (Ayres, 1979), and autism (Ayres & Tickle, 1980).

Specific behavioral responses associated with tactile defensiveness are somewhat similar to typical fight-or-flight reactions of the nervous system (Bauer, 1977). For example, primary tactile defensive behaviors include objection, withdrawal, or negative responses to touch contact, increased stress in response to being physically close to persons, and aggression in response to light touch to the arms, face, or legs (Royeen & Lane, 1991). Other examples of primary tactile defensive behaviors include: preferring to keep one's body covered with long sleeves and pants regardless of temperature; aversion to using such materials as glue or finger paint; avoiding walking barefoot in sand; struggling when picked up, hugged, or cuddled; avoiding certain textures of clothing (e.g. scratchy or stiff); and responding aversively to certain daily living tasks, such as baths, showers, face washing, and cutting of fingernails (Larson, 1982; Royeen, 1985; Sears, 1981).

Along with these primary manifestations, a variety of secondary effects may also be observed in children with tactile defensiveness. These secondary behaviors found apart from the primary behaviors do not suggest that a child is tactile defensive; however, they are often found in conjunction with primary behaviors (Royeen & Lane, 1991). Included among the secondary manifestations are distractibility, hyperactivity, and problems interacting with peers and parents (Ayres, 1972a; Bauer, 1977; Royeen & Fortune, 1990). Tactile defensiveness might also be associated with such behaviors as becoming unex-

pectedly disruptive during crowded school programs, being unable to participate to maximum ability in closely grouped learning experiences, and striking out at other children while standing in line. In addition, some science experiments, physical education group games, and art projects may prove to be unbearable for children with tactile defensiveness (Sears, 1981). These manifestations are often mistakenly interpreted as "bad" behavior instead of adversative responses to tactile stimuli; consequently, children with tactile defensiveness are often misunderstood by their peers and mishandled by their parents (Price, 1979).

The misunderstanding of tactile defensiveness is perpetuated by the fact that its neurological basis is uncertain. Even though the behavioral characteristics of the syndrome have been clear since they were reported by Ayres in 1964, the theoretical basis has changed several times since then (Royeen & Lane, 1991).

The current view concerning the syndrome is that tactile defensiveness is one component of sensory defensiveness, which is one component of a sensory modulation disorder (Royeen & Lane, 1991). Sensory modulation disorders refer to hyporesponsivity or hyperresponsivity to sensory input due to modulation in the central nervous system, not to deficient inhibitory mechanisms. Royeen and Lane explained that the limbic system may be this center for modulation. Because of the association between the limbic system and emotion, this modulation link may explain many of the emotional behaviors associated with tactile defensiveness.

Regardless of the cause of tactile defensiveness, the syndrome does exist, and it causes problems for many children. Until Royeen (1985, 1986, 1987; Royeen & Fortune, 1990) developed a self-rating attitude scale called the Touch Inventory for Elementary-School-Aged Children (TIE), tactile defensiveness was identified through clinical observations during administration of the Southern California Sensory Integration Tests (SCSIT) (Ayres, 1972b) and through general reporting from parents, teachers, and children. As far back as 1977, the need for a more objective means of assessing tactile defensiveness was recognized (Bauer, 1977). Bauer designed the Tactile Sensitivity Behavioral Response Checklist, which consisted of 11 items and measured the frequency of defensive reactions during administration of the SCSIT. However, this checklist was still a somewhat subjective means of assessing tactile defensiveness. Royeen (1986) proposed that because tactile defensiveness produces characteristic, stereotypical responses in children, a self-rating attitude scale could be developed that would measure the traits validly and reliably. She thus developed the TIE and believed that, because it is a standardized tool, it helped provide professional credibility to the assessment of tactile defensiveness as well as a means for objective research in the area (Royeen, 1986).

Royeen performed many of the validity and reliability

studies needed to verify the effectiveness of the TIE. A list of this data can be found in Royeen & Fortune (1990). Test-retest reliability was reported as  $r = .5883, p = .001$  (Royeen, 1987). According to Benson and Clark (1982), the minimum acceptable value for test-retest reliability is  $r = .60, p < .05$ . Royeen (1987) noted several problems with her study. These problems included a small sample size ( $N = 26$ ), a test-retest interval of 2 weeks, and a limited response format (three choices) for the TIE, which may have lowered the magnitude of the coefficient. In regard to the test-retest interval problem, there is no actual research standard for the preferred amount of time between tests. However, logic dictates that the longer a researcher waits between testing, the higher the risk of confounding factors skewing the data (White, 1985). Various research protocols have used anywhere from a 10-day (Beitchman & Corradini, 1988) to a 1-year (Gordon & Mettelman, 1988) test-retest interval. A short interval between tests limits threats to external validity from history, maturation, and treatment effects (Kinnealey, 1989). To respond to Royeen's (1987) suggestion for more test-retest studies of the TIE with an interval shorter than 2 weeks, we examined test-retest reliability of the TIE with a 1-week interval.

Royeen also suggested a correlational study between children's scores on the TIE and mothers' ratings of their children on a modified version of the scale (C. B. Royeen, personal communication, September 11, 1992). Children's self-ratings have been deemed important in research and treatment for the following reasons:

1. Children have access to more samples of their behavior than do other observers. Thus, self-reports may portray more accurately the consistency of behaviors across situations (Ledingham, Younger, Schwartzman, & Bergeron, 1982).
2. Excluding children's perspectives may unnecessarily narrow the focus of interventions to observable behaviors and external contingencies (Rohrbeck, Azar, & Wagner, 1991).
3. Children may be better able to describe their internal feelings in different situations than parents or teachers can describe the children's feelings (Beitchman & Corradini, 1988).

However, there are limitations to children's self-rating tools such as the TIE. For instance, a child may have difficulty understanding items on a scale (Beitchman & Corradini, 1988), and thus the scale may need to be read and explained to the child. This process introduces a potential bias because the adult reading the scale may influence the child's response (Poznanski et al., 1984). In addition, such scales require the ability to analyze one's own feelings, and it is not yet clear if children have the maturity to rate their feelings accurately (Beitchman & Corradini, 1988). Hence, many psychologists who use self-rating scales recommend that information obtained

from self-reports be supplemented with information from other informants (Kashani, Orvaschel, Burk, & Reid, 1985; Kazdin, French, Unis, & Esveldt-Dawson, 1983). Such a multimethod assessment process is also suggested when evaluating children for attention deficit disorder with hyperactivity (Cohen, Becker, & Campbell, 1990; Gordon & Mettelman, 1988; Guevremont, DuPaul, & Barkley, 1990).

When more than one informant contributes assessment data, the consistency between responses needs to be investigated. Herjanic and Reich (1982) found that when specific questions about concrete and observable behaviors are asked of both children and their parents, the consistency between responses is high. However, children are more apt to report how they feel, whereas parents report how their children behave (Beitchman & Corradini, 1988; Kashani et al., 1985). The TIE questions are relevant to both feelings and behavior. Studies finding low agreement between informants indicate that no single rating appears to be more "right" than another; rather, it is apparent that raters who have different relationships with the subject will either view different behaviors or will view the same behaviors differently (Duncan, Gale, & Kilpatrick, 1990; Ledingham et al., 1982; Rohrbeck et al., 1991). Kashani et al. (1985) wrote, "While total agreement between different informants is hardly likely, improving agreement and better understanding the nature of disagreements will aid in the diagnostic accuracy we strive to achieve" (p. 438). Therefore, the second purpose of this study was to determine if a correlation does exist between children's TIE scores and mothers' scores of their children on a scale similar to the TIE.

The reason mothers were used for this study instead of fathers was primarily for consistency purposes, but also because research (Hulbert, Gdowski, & Lachar, 1986; Jensen, Traylor, Xenakis, & Davis, 1988) has documented that mothers observe significantly more behaviors in their children than fathers do. This finding may be because mothers tend to view their children's behavior in a greater variety of settings and situations than do fathers (Duncan et al., 1990).

## Study Purpose

The test-retest reliability of the TIE is not firmly established, and thus the first purpose of this study was to evaluate the test-retest reliability of the scale. It was hypothesized that the scale would demonstrate at least the minimum requirement for test-retest reliability ( $r = .60$ ) with a 1-week interval.

Information from a child's parents is often used in conjunction with a child's self-ratings, and the agreement (or correlation) of these different sources of information is important. The input of several sources concerning tactile defensive behaviors could enhance the likelihood that accurate conclusions about a child's dysfunction

would be reached. Thus, the second purpose of this study was to evaluate the correlation between children's TIE scores and the scores that their mothers gave them on a modified version of the TIE.

## Method

### Subjects

The subjects were children from an elementary school in a rural area of southwestern Michigan. Royeen and Fortune (1990) have listed four qualifications that a child must meet in order to be tested with the TIE, namely that the child must be 6 to 12 years of age, have a language competency of at least 6 years, have an intelligent quotient of 80 or more, and have no physical disabilities such as cerebral palsy, blindness, or spina bifida. All of the subjects in this study met the qualifications. Mothers of the children also participated in the study.

The subjects were randomly selected from eight classrooms. The teachers were instructed to send consent letters home with 15 of their students—either every other student on their class list or every other row of students in their classrooms. Modified TIE assessments (see Appendix) were sent along with assent and consent forms for mothers to complete. Of the first 120 letters sent, 30 were returned. The reason for the low return rate is unknown. Forty-eight more letters (six per classroom) were then given to other randomly selected children, and three additional forms were returned. One could not be used because the child did not meet the age requirement. Thirty of the 32 mothers completed the assessment forms, which were used to determine a correlation between their scores for the child and the child's self-score. Because of illness, only 29 of the 32 children were available during both the initial test session and the retest session.

Of the 32 children, 21 (65.6%) were girls and 11 (34.4%) were boys. The subjects ranged in age from 6 to 12 years, with a mean of 8.44 years and a standard deviation of 2.03 years (see Table 1).

### Instrument

The TIE consists of 26 questions that require one of three responses: No, A little, or A lot. (For a complete description of the assessment and the procedure for administration, see Royeen & Fortune [1990]).

The scale completed by the mothers is a modified version of the TIE, created by the first author, with questions containing the same content as Royeen's (1986, 1987; Royeen & Fortune, 1990) version of the TIE but asked in a manner that elicited a response about the child from the mother's point of view (see Appendix).

### Procedure

After obtaining the necessary signed consent and assent

**Table 1**  
**Subjects' Performance on the Touch Inventory for**  
**Elementary-School-Aged Children (TIE)**

Subject	Gender	Age (Years)	Mother's Test (%)	First Test (%)	Retest (%)
1	F	7	30	30	25
2	F	8	6 <sup>a</sup>	8	8
3	F	8	10 <sup>d</sup>	70	65
4	F	9	16 <sup>a</sup>	30	30
5	F	9	40	30	60
6	F	12	70	30	25
7	M	6	N/A	65	70
8	F	6	6 <sup>a</sup>	16	35
9	F	6	84 <sup>a</sup>	93	87
10	F	12	35	30	30
11	F	12	30 <sup>a</sup>	70	N/A
12	M	11	40	30	30
13	F	12	2 <sup>a</sup>	35	10
14	M	7	25 <sup>a</sup>	81	91
15	F	8	30	25	35
16	M	7	13 <sup>a</sup>	19	N/A
17	F	6	19 <sup>a</sup>	30	25
18	F	7	10 <sup>a</sup>	25	10
19	F	8	22 <sup>a</sup>	45	87
20	M	9	16	13	8
21	M	9	99	90	92
22	M	6	25	13	8
23	M	7	25 <sup>a</sup>	55	N/A
24	F	7	30 <sup>a</sup>	50	45
25	F	10	84 <sup>a</sup>	87	91
26	M	8	4 <sup>a</sup>	10	8
27	F	12	60	45	60
28	F	11	10 <sup>a</sup>	25	19
29	M	8	50 <sup>a</sup>	65	65
30	M	7	16 <sup>a</sup>	30	40
31	F	8	75	16	16
32	F	7	N/A	93	92

Note. M = male, F = female, N/A = data not available.

<sup>a</sup>Indicates cases where the mother underscored the child's first testing percentage in comparison to the child's self-score testing percentage.

forms and data from the modified TIE version for mothers, actual testing of the children began.

The children were assessed on the TIE according to the protocol outlined by Royeen (Royeen & Fortune, 1990). Testing sessions took place from 12:30 to 2:30 pm in a secluded, partitioned area at the end of the school hallway. Testing lasted approximately 10 min for each subject. Either the first author or one of three assistants trained in administering the TIE conducted the assessment sessions. One week later, the children were assessed again in exactly the same manner by the same test administrator.

## Results

Raw score totals on the TIE were converted to percentiles according to normative data (Royeen & Fortune, 1990). The higher the subject's percentile, the more his or her behaviors were considered to be indicative of possible tactile defensiveness.

Initially, the researcher ran scatterplots of the test-retest percentiles and the mother-to-child scores. Accord-

ing to the SPSS (1990) *Introductory Statistics Student Guide*, "It is important to examine correlation coefficients together with scatterplots since the same coefficients can result from very different underlying relationships" (p. 185). The plot for test-retest scores revealed a strong positive linear association. The plot for mother-child test score correlations also demonstrated a positive linear association, but the plot was much more scattered than was the test-retest plot. The difference relates to the fact that the mean percentages were 42.31 for the child's first testing, 43.69 for the child's second testing, and 32.73 for the mother's rating of the child. With the greater variance between percentages with the first testing and the mothers' rating, the plot is more scattered than is the plot for test and retest.

The test-retest reliability value between the children's two assessments was then calculated with the Pearson product-moment correlation ( $N = 29$ ,  $r = .91$ ,  $p < .001$ ). (Only 29 subjects were present for both testing sessions.) Ottenbacher and Tomchek (1993) have indicated concern with reliability studies that use the Pearson product-moment correlation because it "measures linear association or covariation between values, not agreement" (p. 13). However, individual questions were also analyzed to determine frequency of exact agreement of responses between the first and second testings (see Table 2). To control for chance agreement, a Kappa was used. Landis and Koch (1977) suggested that Kappa is the proper way to assess degree of agreement between two observers when the variable is categorized. The Kappa indicated that the child's test-retest score agreement was moderate.

Because the level of exact agreement for each question was generally high, the Pearson product-moment correlation was considered a valid statistic to use with the overall percentiles to determine test-retest reliability. The Pearson product-moment correlation was also used to determine the strength of the correlation between the children's first testing and the mothers' assessments of the children ( $N = 30$ ,  $r = .56$ ,  $p = .001$ ). (Although only 29 subjects were present for both testing sessions, 32 were available for the first testing session. Of those 32 children, 30 of their mothers returned the assessments.) The Kappa was used to determine the effect of chance agreement between mother and child. The results indicated only slight or fair agreement between mother and child. These results provide an example of the conservatism of Kappa. For the same data, the Pearson product-moment correlations appear to be quite large, whereas most of the Kappas for both groups were in the moderate, slight, or fair range.

## Discussion

The test-retest portion of this study provides stronger evidence beyond Royeen's (1987) findings for reliability

**Table 2**  
**Frequency of Exact Agreement of Individual Questions**  
**on the Touch Inventory for Elementary-School-Aged**  
**Children (TIE)**

Question Content	Test-Retest Agreement (%)	Mother-Child Agreement (%)
1. Going barefooted	79.3	90.0
2. Fuzzy shirts	79.3	46.7
3. Fuzzy socks	69.0	66.7
4. Turtleneck shirts	82.8	66.7
5. Having face washed	89.6	80.0
6. Having nails cut	69.0	56.7
7. Having hair combed	65.6	66.7
8. Playing on carpet	89.6	83.3
9. Scratching spot after touched	65.6	60.0
10. Rubbing spot after touched	82.8	80.0
11. Going barefoot in sand and grass	58.6	53.3
12. Getting dirty	75.9	70.0
13. Difficulty paying attention	72.4	43.3
14. When can't see who's touching	55.2	50.0
15. Fingerpainting	93.1	86.7
16. Rough bedsheets	62.1	40.0
17. Someone touches back	72.4	63.3
18. Someone comes from behind	58.6	50.0
19. Kissed other than by parents	65.6	36.7
20. Hugged or held	86.2	70.0
21. Playing games with feet	69.0	76.7
22. Someone touches face	75.9	63.3
23. Touched unexpectedly	55.2	33.3
24. Difficulty making friends	79.3	60.0
25. Standing in line	79.3	63.3
26. Someone close by	69.0	73.3

of the TIE. Royeen reported a test-retest reliability value of  $r = .5883, p = .001$ , whereas this study demonstrated a value of  $r = .91, p < .001$ . The increase in significance in our study could be due to the use of a 1-week testing interval instead of the 2-week interval used by Royeen. When using a more conservative statistic such as Kappa, the results showed moderate agreement for test-retest and only slight or fair agreement with the correlation between mothers' and children's ratings. In any case, the results of this study provide additional data for occupational therapists to determine the reliability of the TIE as a screening device for tactile defensiveness.

In terms of the mother-child correlations, the association was not as strong as the test-retest value, when

using Pearson or Kappa. The overall mean of mothers' scores was approximately 10 points lower than the children's first testing scores. Mothers were twice as likely to underscore their child than to overscore them, as compared to the child's self-score. However, several of the scores were only underscored by a few percentile points (see Table 1). Additionally, in 11 of the 26 questions, a 60% or less agreement was found between mothers and children. These results suggest that using information from both mothers and children might provide a more complete picture of tactile defensiveness in some instances but, in other instances, may provide information regarding disagreement or misunderstanding between mothers and children regarding tactile defensive behaviors. Further research in this area needs to be completed so that researchers can be sure that they are correctly interpreting a mother's TIE form.

Along with the small sample size, another limitation of this study involves the voluntary completion of the mothers' forms. The mothers who voluntarily completed forms may naturally be more involved in their children's lives than mothers who did not return any of the forms. Thus, they may be naturally more aware of their children's feelings and behaviors. The poor return rate of the questionnaires should also be considered. Perhaps giving the questionnaire to the mothers in person would have increased the return rate. Explaining the meaning of some of the questions to the mothers might also have increased the consistency of mothers' and children's perceptions of the questions. This step, in turn, might have increased mother-child score correlations.

Future research on the TIE should include a replication of this study with a larger sample size. Future studies should also focus on factors influencing answers by parents and children, such as cultural background and past experiences. Furthermore, a similar study with a sample of children already identified as tactile defensive would be beneficial. Perhaps mothers and children would show greater agreement when tactile defensiveness has already been determined. All of the studies mentioned above could further enhance the credibility and effectiveness of the TIE as an occupational therapy assessment. ▲

## Appendix

### Mother's Form for the Touch Inventory for Elementary-School-Aged Children

Mother's Signature: \_\_\_\_\_

Child's Name: \_\_\_\_\_

Date: \_\_\_\_\_

Procedure: Answer each question by checking one of the three responses: 1 = No, 2 = A little, 3 = A lot.

Response			No.	Question
1	2	3		
[ ]	[ ]	[ ]	1.	Does going barefooted bother your child?
[ ]	[ ]	[ ]	2.	Do fuzzy shirts bother your child?
[ ]	[ ]	[ ]	3.	Do fuzzy socks bother your child?
[ ]	[ ]	[ ]	4.	Do turtleneck shirts bother your child?
[ ]	[ ]	[ ]	5.	Does it bother your child to have his or her face washed?
[ ]	[ ]	[ ]	6.	Does it bother your child to have his or her nails cut?
[ ]	[ ]	[ ]	7.	Does it bother your child to have his or her hair combed by someone else?
[ ]	[ ]	[ ]	8.	Does it bother your child to play on a carpet?
[ ]	[ ]	[ ]	9.	After someone touches your child, does he or she feel like scratching that spot?
[ ]	[ ]	[ ]	10.	After someone touches your child, does he or she feel like rubbing that spot?
[ ]	[ ]	[ ]	11.	Does it bother your child to walk barefoot in the grass and sand?
[ ]	[ ]	[ ]	12.	Does getting dirty bother your child?
[ ]	[ ]	[ ]	13.	Does your child find it hard to pay attention?
[ ]	[ ]	[ ]	14.	Does it bother your child if he or she cannot see who is touching him or her?
[ ]	[ ]	[ ]	15.	Does fingerpainting bother your child?
[ ]	[ ]	[ ]	16.	Do rough bedsheets bother your child?
[ ]	[ ]	[ ]	17.	Does your child like to touch people, but appear bothered when someone touches him or her back?
[ ]	[ ]	[ ]	18.	Does it bother your child when people come from behind?
[ ]	[ ]	[ ]	19.	Does it bother your child to be kissed by someone other than you?
[ ]	[ ]	[ ]	20.	Does it bother your child to be hugged or held?
[ ]	[ ]	[ ]	21.	Does it bother your child to play games with his or her feet?
[ ]	[ ]	[ ]	22.	Does it bother your child to have his or her face touched?
[ ]	[ ]	[ ]	23.	Does it bother your child to be touched when he or she does not expect it?
[ ]	[ ]	[ ]	24.	Does your child have difficulty making friends?
[ ]	[ ]	[ ]	25.	Does it bother your child to stand in line?
[ ]	[ ]	[ ]	26.	Does it bother your child when someone is close by?

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