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ARTICLE

The Tactual Profile: Development of a procedure to assess the tactual functioning of children who are blind

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ABSTRACT The Tactual Profile assesses tactual functioning of children with severe visual impairments between 0 and 16 years of age. The Tactual Profile consists of 430 items, measuring tactile skills required for performing everyday tasks at home and in school. Items are graded according to age level and divided into three domains: tactual sensory, tactual motor and tactual perceptual. The development of the instrument is described and the psychometric properties that were studied reported. Most items had an acceptable difficulty level, and test–retest reliability proved to be good. The analyses for the construct validity showed moderately high correlations between the Tactual Profile and intelligence tests. These correlations were higher for the haptic performance subtests than for the verbal tests. High correlations with other haptic tests were found. However, these associations disappeared after factoring out intelligence, possibly because current methods for examining tactual functioning are strongly affected by intelligence. A summary of work planned in further development of the procedure is provided.

KEY WORDS *blindness, children, haptics, reliability, tactual functioning, touch*

INTRODUCTION

Until recently there has been no instrument available to assess 'passive' and 'active' touch in children with blindness and severe visual impairments. Passive touch is used to refer to the actions involved in being touched either by an object or by another person, and to touching an object without independent exploratory and manipulative use of the skin. Active touch, on the other hand, refers to touching, usually with the hands, which involves independent exploratory and manipulative use of the skin and therefore stimulation of receptor systems in the muscles, tendons and joints (McLinden and McCall, 2002).

For a number of reasons, it was felt that an assessment instrument in the area of both passive and active touch was required, to help find out how children who are blind collect information in school subjects and daily life skills through touch. Sometimes the loss of vision can be compensated by the olfactory or auditory senses, but for some types of information, touch might be the only sense that can be used to replace vision. However, the overview obtained from a glance when using sight is achieved in a different way from the one gathered by touch. As a result, subjects (including, for example, visual spatial relationships, object recognition, and analysing graphs in mathematics) will need to be taught in a different way to children with severe visual impairments than to children with normal sight. To teach the correct tactile skills to these children so that they can function as independently as possible at home and at school, it is necessary to know what prerequisites there are at school and in their everyday tasks (Gibson, 1966; Hatwell, 1978; Heller, 1991, 2000; Katz, 1989; Warren and Rossano, 1991).

To help the teachers support children in undertaking these tasks, the Tactual Profile (TP) was developed. The TP was conceived as an instrument for charting tactual functioning, and was constructed to assess the tactile skills relevant for everyday tasks at home and in the school. The term 'tactual' was used to refer to the perceptual information processing system that uses input embedded in the skin, as well as in muscles, tendons and joints. This included the exploratory actions of manipulating objects (McLinden and McCall, 2002). Tactual perception and functioning in 'near space' (i.e. at arm's length) is viewed therefore in a broader sense than reading a tactile code or understanding geographical maps or raised line pictures.

The interest in charting tactual functioning of children with visual impairments was stimulated by educational developments in the 1980s and 1990s. With an increase in the number of children with visual impairment attending mainstream education, and a consequent increase in the number of peripatetic teachers, it was realized that there was a need to ensure that the expertise that once resided in specialist settings was available for all teachers to draw upon in order to provide effective support for children.

Further, with a move towards more formal monitoring of pupil skills covering all aspects of learning of visually impaired and blind children (Grevink et al., 1994; Vervaart and Withagen, 1992), it became apparent that there was no appropriate instrument available for assessing touch, tactile functioning and haptic skills (Gillijns, 1991). Although several instruments could be used to assess tactile capacities, including the Boehm Test of Basic Concepts (Boehm, 1971), the Roughness Discrimination Test (Nolan et al., 1965) and the tests of Mommers (Mommers, 1974), no overall impression of tactual development could be derived from these instruments. Further, intelligence tests for the blind (e.g. Intelligence Test for Visually Impaired Children; Dekker, 1987) were designed to test the intellectual capacities of blind children, making use of their haptic sense; these tests did not claim to assess the tactile capacities themselves. As a result, they did not cover the field of tactual functioning and touch in general, but assessed only some distinct tactile capacities. Moreover, several tactile capacities remained wholly unassessed with the instruments mentioned above (e.g. transforming two-dimensional information into three-dimensional information, and tactual language).

In summary, prior to this study no instrument was available to assess children with visual impairment on tactual perception and functioning in general, in order to assist tactual performance in daily and educational tasks, without regard to their level of intelligence. This article describes the construction of such an instrument, the Tactual Profile, and reports the results of a study investigating the psychometric properties of this instrument.

The goals of the psychometric study were to determine basic psychometric qualities; that is, item difficulty, test–retest reliability and construct validity. Given the large number of items and the relatively small number of participants it was impossible to perform a factor analysis or do calculations on the internal consistency of the TP. The domains and categories within the TP described in this article are therefore based on

theoretical and clinical considerations. Normally one would perform an item analysis for a new instrument before trying to calculate means and (standard) scores. This procedure would require two subsequent studies with two different samples of children. Given the small population of children with blindness and the fact that 37 children with blindness were already seen in the two previous validation studies, it was decided to perform both stages in the development of a psychological instrument in one study.

DEVELOPMENT OF THE TACTUAL PROFILE

The project group consisted of a behavioural scientist with a masters degree in special education, a remedial teacher for visual and tactual functioning, an occupational therapist and several early interventionists. The group created a first item set that was based on relevant literature (e.g. Gibson, 1966; Hatwell, 1978; Heller and Schiff, 1991; Lederman and Klatzky, 1987, 1996; Millar, 1994; Schellingerhout, 1998).

An expert group of experienced psychologists and other professionals in the field of visual impairment was set up to comment on the ideas of the project group that developed the TP. In 2000 the first trial version was developed and was subsequently validated by Schellingerhout in order to assess its content validity and applicability (Withagen and Schellingerhout, 2004). Content validity concerned issues of face validity, the psychological constructs the items intended to measure, an analysis of possible missing relevant items, and item hierarchy. At the same time the applicability of the TP was studied in a process evaluation. In this evaluation the quality of the materials, the manner of administration, the times and materials needed for administration, and the satisfaction of the administrators were assessed. The main goal of this validation study was to enhance content validity of the TP by adjusting item content. The results were reported by Schellingerhout and Withagen (2002) and Withagen and Schellingerhout (2004).

Pilot studies

For the validation of the TP two series of administrations of TP were carried out. The administrators were all practitioners, professionals working with visually impaired children. The administrators received a one-day training program, in which they were instructed in the administration of TP.

In the first series of administrations, 10 children (two children in each age level) were assessed with TP. In addition to the administration, every item was rated by the administrators on a standardized evaluation form on a number of aspects. This included appropriateness of formulation, usefulness, ease of administration, difficulty and tactual domain. Beside these evaluation forms, each administrator was interviewed about his or her experience with the TP. After the first series of administrations the TP was adjusted. Some items changed in age level and information was added to clarify several items.

In a second series of trials 27 children were assessed. All the children were congenitally blind. Four of these children had light perception and 12 children had some residual vision (albeit not enough to read print). Items were evaluated in a similar way as in the first series. In addition, the items of the adjusted version were evaluated by a group of four special educationalists.

On the basis of these results, some adjustments were made to the TP. First, 10 items were removed because of insufficient item distribution. Second, the category Kinesthesia was removed, because of the overlap with the category Proprioception. Third, the age group 6–12 was split in half, because of differences found between the younger half of this group and the older half. Lastly, guide questions were added as well as a screening checklist for residual visual capacities. An important outcome of both series of trial administrations was that satisfaction with the TP was high. The administrators and special educationalists considered the TP an important and useful instrument, which helped them to get ideas for intervention.

The results of these validation studies were used to construct a second version of the TP that is reported on in this article and draws on the preliminary results reported by Janssen et al. (2005).

The final item set of TP (see Figure 1) consisted of 430 items, graded according to age level and divided into three tactual functioning domains (tactual sensory, tactual motor, and tactual perceptual), and one domain of practical skills. There were items for six different age groups: 0–2; 2–4; 4–6; 6–9; 9–12; 12–16 years. Each domain was divided into different categories but not every category had items for each age group. The categories within the domains of TP are listed in Table 1. The number of items for an assessment varied from 23 items (F-level) to 102 items (A-level).

Table 1. The Tactual Profile items

Tactual sensory functioning (106 items) Consists of the following categories of passive perception: tactual awareness, noticing, body awareness, touch sensitivity and proprioception.
Tactual motor functioning (52 items) Tactual perception items that require motor proficiency. It includes the following categories: tactual exploration, manipulating, two-handedness and middle and near space.
Tactual perceptual functioning (162 items) Items that refer to the interpretation of tactual information. It contains the following categories: recognizing, perception of detail, discrimination, constructing/reproducing, tactile–spatial perception, part–whole relationship, figure–ground perception, third and second dimension and tactual 'language'.
Practical skills (110 items) These are the skills necessary to function well in daily life. This domain contains the following categories: touch strategy, self-help skills, game-activity, linking function to object, action-sequences and dealing with variables.

METHODS

Participants

All the institutes and schools for the visually impaired in the Netherlands and Flanders were willing to participate. The inclusion criteria were: visual acuity < 5/100 from birth; attending mainstream education; between 0 and 16 years of age; understanding of the Dutch language; and no additional impairments. Based on school records, the potential sample of participants consisted of exactly 100 children. All these children were contacted, and 55 children (response rate 55%) participated. The group consisted of 27 boys and 28 girls. The distribution of age levels is shown in Table 2. It was not possible to gather information about the non-respondents.

Procedure

Three administrators, who had some experience with TP, performed the examinations. They received extra training in order to achieve standardization on presentation and scoring of all items. The procedural reliability was ensured by organizing regular meetings with the administrators to discuss and check administration and scoring of the TP. All

Figure 1. The contents of the Tactual Profile

analyses were performed according to classical test theory, which considers observed test scores as a combination of true scores and error (see e.g. McDonald, 1999; Nunnally and Bernstein, 2000).

The items in TP were divided over six age levels. Normally, each child would receive the items belonging to his or her age level. To study the possibility that items were placed in the wrong age group, each child was given the items belonging to his or her own age group, but also items belonging to the preceding and succeeding age group. This way it was possible to compute three difficulty levels for each item:

1. difficulty level young, (p-young)
2. difficulty level, (p)
3. difficulty level old, (p-old)

To assess the stability of the psychological constructs underlying TP, a test–retest reliability coefficient was calculated. Therefore, all participants

Table 2. Participants

Age level	Boys n	Girls n	Total per age n	Mean age level (months)	Some residual vision (n)
A (0–2 year)	3	3	6	16	3
B (2–4 year)	5	10	15	36	8
C (4–6 year)	6	6	12	57	3
D (6–9 year)	5	1	6	93	2
E (9–12 year)	3	6	9	124	6
F (12–16 year)	4	3	7	161	3
Total	26	29	55	81	25

received two administrations of TP by the same administrator, within a two-week interval after the first administration.

Construct validity was determined by calculating the correlation of the TP with tests that measured comparable constructs (*convergent* validity), as well as tests that measured (partly) different constructs (*divergent* validity). Developmental and intelligence tests were administered to determine divergent validity. The hypothesis was that the TP would correlate only moderately with intelligence. If the TP measures something other than intelligence then it is to be expected that verbal intelligence will correlate moderately with the instrument. However, since the TP used manual problem-solving tasks it might also be expected that performal intelligence will correlate better with TP than verbal intelligence. All children were given a developmental or intelligence test. Because there was not a single intelligence test available for the age range under study, three tests were chosen:

The Reynell–Zinkin developmental scales: 0–4 years (Reynell, 1979; Reynell and Zinkin, 1975). The Dutch age norms were used and since a study with Dutch children showed that the reliability of the scales is highest for children aged between 1.5 and 4 years the scales were not administered to the five-year-old children (Vervloed et al., 2000).

The verbal tests of the WPPSI: 4–6 years. It was not possible to administer the non-verbal tests, because they were not adapted for children with visual impairments.

The ITVIC: 6–16 years, an intelligence test for blind children (Dekker, 1987, 1993; Dekker and Koole, 1992; Dekker et al., 1991). The full

procedure consists of 13 subtests. The shortened version used in this study included the scales Perception of figures, Block Design, Exclusion of figures, Map questions, Verbal analogies, and Vocabulary.

Tests that measure aspects of tactile functioning were administered to measure convergent validity. The authors hypothesized that the TP should correlate highly but not perfectly with tests that assess haptic functioning. As with the intelligence and developmental tests, different tests were required for different ages:

Tactile Tests of Basic Concepts (TTBC): 4 –7.5 years (Caton, 1983). This test is an adaptation from the 'Boehm Test of Basic Concepts' (BTBC) for normally sighted children. The purpose of the TTBC is to appraise the mastery of concepts that are commonly found in preschool and primary grade instructional materials and that are essential for understanding oral communication with teachers and fellow pupils.

Tests of Mommers (Haptic Figure Orientation Test and Haptic Greatness Discrimination Test): 7.5–13.5 years (Mommers, 1974). In these tests the child had to decide, by touch, which figure out of a group of four figures is placed in a different orientation or which figure had a different size.

These tests for determining construct validity were always administered after the assessment of the TP. To gather data from these tests as objectively as possible, they were administered by professionals who had not been involved in administering the TP. These so-called 'naive' administrators were unaware of the goal of the study and were not familiar with the participants. All 'naive' administrators received training to administer the intelligence and haptic tests. All tests were administered within a period of four to six weeks to cancel out the confounding effect of maturation as much as possible.

RESULTS

Item analysis

The item difficulty level was computed for each age group. The distribution of the items would be correct if: p-young < p < p-old. Difficulty levels ranged between 0.25 and 1.0. Of all 430 items, there were 351 (82%) items which seemed to be in the correct age level and 79 items that were either too easy or too difficult. Of these 79 items, four items ought to be deleted from the final task due to the fact that they had a difficulty level of 1, meaning that every child passed this item.

Table 3. Correlations between first and second administration of TP

Domains and Category	Rho[1]	n[2]
Tactual sensory functioning	0.87**	50
Tactual awareness	0.55**	24
Noticing	0.46*	27
Body awareness	0.84**	50
Touch sensitivity	0.78**	50
Proprioception	0.75**	50
Tactual motor functioning	0.78**	50
Tactual exploration	0.83**	30
Manipulating	0.61**	40
Two-handedness	0.83**	50
Middle and near space	0.59**	29
Tactual perceptual functioning	0.86**	50
Recognizing	0.62**	40
Perception of detail	0.82**	50
Discrimination	0.78**	47
Constructing/reproducing	0.84**	50
Part–whole relationship	0.87**	40
Tactile–spatial perception	0.70**	46
Figure–ground perception	0.59**	50
Third and second dimension	0.75**	23
Tactual language	0.79**	45
The Tactual Profile	0.94**	50

*p < 0.05, **p < 0.01

[1] Correlations were computed with average scores (total score/number of administered items). Correlations were only calculated for the items that were observed. For this reason the domain 'Practical Skills' is not in this table, because most items were reported not observed.

[2] This number differs per category, because not every category has items for each age level. Five children did not receive a second administration with TP; that is why the n in the calculations for the test–retest reliability has a maximum of 50. For some categories the number of children assessed with an item is below 50 because the categories do not have items for all the age levels.

Test–retest reliability

The test–retest reliability was based on the results of two administrations of the TP within a two-week interval. The categories and total TP score showed moderate to strong correlations between both administrations (see Table 3), indicating that the psychological constructs measured with TP were quite stable in a two-week period. Of note is that the

Table 4. Correlations between Reynell–Zinkin scales and TP

	Rho
Social adaptation	0.55*
Sensory–motor understanding	0.51*
Exploration of the environment	0.49*
Response to sound and verbal comprehension	0.44
Vocalization and expressive language structure	0.34
Vocabulary	0.45*
Total score Reynell–Zinkin	0.58**

*p < 0.05, **p < 0.01

Table 5. Correlations between subscales of the ITVIC and TP

	Rho
Perception of figures	0.57*
Block design	0.59**
Exclusion of figures	0.68**
Map questions	0.46*
Verbal analogies	0.53*
Vocabulary	0.54*
Total score ITVIC	0.75*

*p < 0.05, **p < 0.01

categories with low test–retest correlations, such as Tactual awareness and Noticing, did not have items for all age levels.

Divergent validity

The Reynell–Zinkin scale consists of three verbal tests and three non-verbal tests (see Table 4). Although the items in the verbal scales were elicited by questions regarding manipulation of materials, only one verbal subscale (i.e. Vocabulary) correlated significantly with TP. Only the verbal subtests of the WPPSI were administered. None of the WPPSI scales correlated significantly with the Tactual Profile. Table 5 shows the correlations between the ITVIC and TP for the oldest children. Significant correlations were moderately high.

Table 6 shows the correlations of the domains and the total TP score with the scores on the developmental and intelligence tests. Three out 11 verbal subtests correlated significantly with the TP. These were the

Table 6. Correlations between TP-domains and the developmental and intelligence tests

	Correlations		
	Reynell–Zinkin[1]	Verbal IQ WPPSI[2]	Shortened version ITVIC + perception of raised line figures[2]
Tactual Sensory Functioning	0.55*	0.44	0.53*
Tactual Motor Functioning	0.59**	–0.15	0.49*
Tactual Perceptual Functioning	0.60**	0.41	0.84**
Practical Skills	0.56*	0.19	0.65**
The Tactual Profile, Total score	0.58**	0.43	0.75**

*p < 0.05, **p < 0.01

[1] Correlations were computed with average scores (total score/number of administered items) of TP and the raw score (number of mastered items) of the total Reynell–Zinkin

[2] Correlations were computed with average scores (total score/number of administered items) of TP and the standard scores of the WPSSI/ITVIC

subtests Vocabulary (Reynell), Verbal Analogies (ITVIC) and Vocabulary (ITVIC). The correlations were in the moderately strong range (0.45–0.54). The correlations with the performal/haptic subtests were somewhat stronger (range 0.49–0.68). The correlation of the shortened version of the ITVIC with TPF was high (0.84).

Convergent validity

Table 7 shows that the TTBC haptic test did not correlate significantly with TP but the tests of Mommers did (Rho = 0.80). However, after controlling for intelligence, the correlations turned out to be non-significant.

DISCUSSION

After describing the development of the Tactual Profile, the psychometric properties were determined within the framework of classical test theory. Item analysis, reliability checks, and some tests for validity were conducted by the authors. The item analysis showed that the a priori ordering of the large number of items was mainly correct. Based on the difficulty levels, the results showed that 82 per cent of the items were

Table 7. Correlations between TTBC, Mommers and TP

	Rho		
	TTBC	**Mommers**	**Mommers partial correlation**
Tactual Sensory Functioning	0.50	0.59*	0.07
Tactual Motor Functioning	0.20	0.49*	0.02
Tactual Perceptual Functioning	–0.01	0.83*	0.22
Practical Skills	0.09	0.52*	–0.21
The Tactual Profile, Total score	0.24	0.80*	0.05

*$p < 0.05$

assigned to the correct age level. There were 75 items that had to be placed into another age group. Four items were deleted because they were too easy and did not add extra information. Items that were too easy were mainly found in the youngest age group. A possible explanation could be that the A-group of participants consisted of five children of 1 year old, and only 1 child younger than 1 year. The A-items might therefore have been too easy for these 1-year-old children.

The reliability tests showed that TP was quite reliable within a two-week interval. This also meant that TP was rather stable within a two-week period. The analyses for the construct validity showed mixed results. As expected, a mild to moderate correlation was found between TP and intelligence. This correlation was strongest for the performal/haptic subtests. The absence of high correlations means that the TP measures something different from the intelligence tests, but there is also some overlap. This overlap was mainly found between the TP and the ITVIC. This is not surprising as the ITVIC is performed almost completely by touch. The correlation with the verbal tests of the WPSSI was in the desired direction; that is, low to moderate.

Despite the expectations, there was not a significant association between the TP and other tactile tests, for instance between the TTBC and TP. In contrast, the Mommers tests correlated moderately to strongly with the TP. However, after correcting for intelligence differences, the significant correlations between the TP and the Mommers disappeared.

Both the Mommers and TP correlated significantly with intelligence tests. A possible explanation could be that the haptic tests tap not only tactual functioning but also other capacities such as 'problem solving' skills. The TTBC and Mommers apparently assess different concepts and areas of tactual functioning than the TP. At the moment we cannot rule out that this association is an artefact. All items of the TP required a different instruction, whereas in the TTBC and Mommers one instruction suffices for a complete scale. As a result the TP could have been affected more by the child's verbal comprehension and short-term memory capacities. Of note, however, is that there was also a significant correlation between the tests of Mommers and the intelligence tests. Both the Mommers and the TTBC tap just a small part of haptic and tactile functioning. As a result, both these haptic tests assess different concepts and areas of tactual functioning from the TP, hence the rather low correlations between the TP and the TTBC and Mommers.

As a consequence of the results the question arises whether tactual functioning can be clearly distinguished from intelligence. A way to measure tactile skills is by offering problem-solving tasks through touch. Solving these tasks depends on both tactile skills and cognitive skills, which would explain why some significant correlations between TP and intelligence were found.

At present, however, the construct validity cannot be judged accurately as the two haptic tests available with norms for Dutch children did not show a strong correlation with the TP. Despite the high response rate (55%), the group is far too small to execute procedures for data reduction and analysis of underlying psychological constructs, such as factor analysis. The TP consists of different items for each age group, and the number of items per age group is sometimes very small. As a result, it was not possible to study the validity of the underlying constructs by means of analysing the item homogeneity of the a priori categories either. So, for the present, the validity of TP is mainly based on content validity; that is, the expert judgements that were used to develop TP.

Although the Haptic Battery, developed by Soledad Ballesteros and colleagues (2005), was not available on the market at the time of data collection, it is possible that this instrument can be used in future research to improve the content validity.

Two recent developments could also make it possible to study the validity of TP in a more appropriate way. First, the TP has been translated into English, thus considerably increasing the potential group of participants.

Future research with the English version is therefore welcomed. Second, the Dutch national science foundation awarded the first author with an extra grant to implement the TP. Part of this implementation is the construction of an online database to gather the results for future research on the instrument. The website has been online since January 2009 and we hope this will serve to complement the database.[1]

Schellingerhout and Withagen (2002) concluded in their process evaluation that, irrespective of its psychometric properties, the TP led to new ideas for intervention. In addition, TP furthered a more structured approach to the assessment of haptic and tactile development. The next step was therefore to write an activity book to assist the teacher with designing relevant interventions. This resulted in the writing of *Tast Toe* [Feel Free], an activity book containing exercises, lessons and suggestions for stimulating and training tactual functioning (Janssen et al., 2006). Anecdotal feedback suggests that the activity book *Feel Free* has been well received by professionals, who have reported that the book increased the value of an administration with TP. When certain areas of poor tactual functioning are detected during an assessment, this book provides a range of suggestions for interventions in different areas of tactual functioning. The text will be translated into English in 2009, making it available for a larger audience.

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Note

1 See http://www.tactualprofile.org

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