The Development of a Universal Tangible Symbol System

Ellen Trief, Susan M. Bruce, Paul W. Cascella, and Sarah Ivy

Tangible symbols are objects or partial objects with qualities, such as shape, texture, and consistency (Trief, 2007), that can be used to represent a person, place, object, activity, or concept. They can be handled and share a perceptual relationship with what they represent, known as the referent (Werner & Kaplan, 1988). The following terms, drawn from the literature, are synonymous with tangible symbols: object cues (Lancioni, O’Reilly, & Oliva, 2002; Westling & Fox, 2004), objects of reference (Golinkoff & Hirsh-Pasek, 2000; Park, 1997; Werner & Kaplan, 1988), anticipation cues (Joffee & Rikhye, 1991), tactile symbols (Lund & Troha, 2008), and tangible cues (Rowland & Schweigert, 1989; Vicker, 1996).

Tangible symbols are an important form of communication for children with visual and additional impairments who communicate at the presymbolic level (Rowland & Schweigert, 2000). They are appropriate for this population of children because they make fewer demands on memory and representational abilities than do more abstract symbols (Rowland & Schweigert, 2000). In addition, they support presymbolic communicators to express the children’s wants and needs, thus reducing the children’s frustrations and associated undesirable behaviors (Trief, 2007). Tangible symbols can be used in tandem with other expressive forms of communication, such as body language, gestures, vocalizations, early verbalizations, signs, and voice output devices.

Little has been done to establish a set of standardized tangible symbols. Other standardized communication systems have been developed, including sign language, line drawings (such as Mayer-Johnson), and braille. Each system provides users with a consistent and stable system of symbols that have been universally accepted. The purpose of this study was to identify a set of standardized tangible symbols from which educational teams could select the most appropriate symbols for the children they serve.

Method

A survey was developed that asked the participants to identify the tangible symbols they were already using, new activities and concepts they would like to represent in tangible symbols, and their preferences for tangible symbols for 28 referents that were identified in a pilot study (see Trief, 2007). This survey was sent to the directors of four New York City schools and additional agencies to disseminate to their teachers and speech-language pathologists. Twenty-nine teachers and speech-language pathologists who were certified in visual impairment, severe multiple disabilities, or speech and language therapy completed the survey. In addition, a 14-member advisory board, composed of 5 directors of New York City schools, 3 speech-language pathologists from the surveyed schools, the designer and manufacturer of the symbols, a representative from the Perkins School for the Blind, 3 college professors, and a graduate research assistant, was formed. This board reviewed and discussed the

Special thanks to the Lavelle Fund for funding this project and Adaptive Design Association for manufacturing the tangible symbols.

### Table 1
Results from the survey sent to four schools.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Suggested symbols</th>
<th>Number of teachers currently using the symbol (N = 29)</th>
<th>Number of teachers requesting the symbol from all four schools (N = 29)</th>
<th>Documented need for the symbol (number of teachers using or requesting the symbol (N = 29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dismissal</td>
<td>Bus, seatbelt strap</td>
<td>6</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Bathroom</td>
<td>Tile, diaper, toilet paper roll</td>
<td>17</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>Gym</td>
<td>Ball, floor</td>
<td>9</td>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td>Speech</td>
<td>Name cue for the specialist, lips</td>
<td>4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Music</td>
<td>Bells, mallet, toilet paper roll</td>
<td>17</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Classroom</td>
<td>Raised yellow strips, chair, doorknob</td>
<td>10</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Literacy</td>
<td>Book</td>
<td>15</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Circle time</td>
<td>Circle</td>
<td>15</td>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>Outside</td>
<td>Zipper, floor surface</td>
<td>2</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Occupational therapy</td>
<td>Name cue for the occupational therapist, brush, beads</td>
<td>4</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>Physical therapy</td>
<td>Name cue for the physical therapist, ball</td>
<td>3</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Snack</td>
<td>Spoon, cup</td>
<td>5</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Computer</td>
<td>Mouse, computer keys, CD</td>
<td>2</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Art</td>
<td>Paint brush</td>
<td>8</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Sensory</td>
<td>Cotton balls, lotion bottle</td>
<td>6</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Rest time</td>
<td>Blanket</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Music room</td>
<td>Maraca, shaker</td>
<td>1</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>Art room</td>
<td>Paint and paintbrush</td>
<td>—</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Nurse’s office</td>
<td>Band-Aid</td>
<td>1</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Toothbrushing</td>
<td>Toothbrush</td>
<td>6</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Cooking</td>
<td>Bowl, wooden or metal spoon</td>
<td>—</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Orientation and mobility</td>
<td>Shoe, cane</td>
<td>—</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Arrival</td>
<td>Small cubby, name cue, miniature hands</td>
<td>1</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Math</td>
<td>Cubes</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Science</td>
<td>Plants, foil paper, plant seeds</td>
<td>—</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Vision</td>
<td>Eyeglasses, flashlight, mirror</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Center time</td>
<td>Timer, material for that time</td>
<td>—</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Drink</td>
<td>Cup</td>
<td>3</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Lunchroom</td>
<td>Tray, spoon</td>
<td>3</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Break</td>
<td>Broken wooden dowel, timer</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Pet therapy</td>
<td>Fur</td>
<td>—</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Community</td>
<td>Horn, people</td>
<td>—</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Stander</td>
<td>Vinyl square</td>
<td>—</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

(continues)
results of the survey and suggested the symbols they thought were appropriate for each referent during a three-hour meeting.

**RESULTS**

The teachers and speech-language pathologists identified 48 referents for which they either already used or needed a tangible symbol, and the advisory board identified an additional 9 referents. Some of the suggested new symbols were recommended for use at home. Table 1 presents the referents for which tangible symbols were requested by the teachers and speech-language pathologists, the number of teachers and speech-language pathologists who were currently using symbols for these referents, the number who requested a symbol for these referents, and the documented need (sum of teachers and speech-language pathologists who were already using or requesting a symbol for a specific referent). The survey indicated that the following symbols were requested by teachers and speech-language pathologists at all four schools: dismissal, bathroom, gym, speech, music, classroom, literacy, circle time, outside, occupational therapy, physical therapy, snack, computer, art, sensory, and rest time, with additional symbols being requested by a varied number of teachers.

The survey, coupled with the advisory board’s discussions, resulted in the final selection of tangible symbols for each of the identified referents. The list of the final 55 referents and their associated tangible symbols is presented in Table 2.

**DISCUSSION**

The survey revealed common school activities and concepts for which teachers and speech-language pathologists (at all the

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Table 1 (cont.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Suggested symbols</th>
<th>Number of teachers currently using the symbol ((N = 29))</th>
<th>Number of teachers requesting the symbol from all four schools ((N = 29))</th>
<th>Documented need for the symbol ((number of teachers using or requesting the symbol (N = 29))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calendar</td>
<td>Piece of calendar</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Walk</td>
<td>PVC, part of a precane device</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Light box</td>
<td>Piece used with light box</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>More</td>
<td>Velvet</td>
<td>8</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>Games</td>
<td>Spinner, game piece</td>
<td>-</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Food</td>
<td>Spoon, bowl</td>
<td>10</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Lunch</td>
<td>Plate</td>
<td>9</td>
<td>-</td>
<td>9</td>
</tr>
<tr>
<td>Finished</td>
<td>Sandpaper</td>
<td>8</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Juice</td>
<td>Juice box</td>
<td>5</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Bubbles</td>
<td>Bubble wand</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Milk</td>
<td>Milk container</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Specified song symbol</td>
<td>Plastic spider, bus, foil star</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
</tbody>
</table>

schools) were either already using or requested tangible symbols. The advisory board members were able to reach a consensus on the list of symbols on the basis of the survey’s findings. It is important to note that many of the symbols, such as a cup for drinking and a toothbrush for brushing teeth, are highly iconic, but others, such as an “X” for no and an “O” for yes, are more abstract. The development of a basic set of standardized tangible symbols will provide continuity within all programs that serve children with visual and additional impairments. Commercially produced standardized symbols can reduce the need for teachers to make symbols and can ensure the uniform quality and durability of symbols. The quality and durability of symbols may make this low-tech communication system attractive to parents and may become an incentive to carry over the use of symbols to

Table 2
Results for standardized symbols.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Chosen symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Dismissal</td>
<td>Strap with a buckle</td>
</tr>
<tr>
<td>2. Bathroom</td>
<td>White tile with a black edge</td>
</tr>
<tr>
<td>3. Gym</td>
<td>Tennis ball</td>
</tr>
<tr>
<td>4. Speech</td>
<td>Mouth or lips</td>
</tr>
<tr>
<td>5. Classroom</td>
<td>Doorknob</td>
</tr>
<tr>
<td>6. Literacy</td>
<td>Small, thick book</td>
</tr>
<tr>
<td>7. Circle time</td>
<td>Wooden circle</td>
</tr>
<tr>
<td>8. Outside</td>
<td>Three stones</td>
</tr>
<tr>
<td>9. Music</td>
<td>Bells</td>
</tr>
<tr>
<td>10. Occupational therapy</td>
<td>Three beads</td>
</tr>
<tr>
<td>11. Physical therapy</td>
<td>Squishy ball</td>
</tr>
<tr>
<td>12. Snack</td>
<td>Small, empty snack bag</td>
</tr>
<tr>
<td>13. Cookie</td>
<td>Cookie</td>
</tr>
<tr>
<td>14. Computer</td>
<td>Floppy disc</td>
</tr>
<tr>
<td>15. Art</td>
<td>Paintbrush</td>
</tr>
<tr>
<td>16. Sensory</td>
<td>Small tube of lotion</td>
</tr>
<tr>
<td>17. Rest time</td>
<td>Small square of a blanket</td>
</tr>
<tr>
<td>18. Nurse’s office</td>
<td>Large Band-Aid</td>
</tr>
<tr>
<td>19. Toothbrush</td>
<td>Toothbrush</td>
</tr>
<tr>
<td>20. Cooking</td>
<td>Measuring spoons</td>
</tr>
<tr>
<td>21. Orientation</td>
<td>Tip of a long cane</td>
</tr>
<tr>
<td>and mobility</td>
<td></td>
</tr>
<tr>
<td>22. Arrival</td>
<td>Plastic hands</td>
</tr>
<tr>
<td>23. Math</td>
<td>Unifix cube</td>
</tr>
<tr>
<td>24. Science</td>
<td>Magnet</td>
</tr>
<tr>
<td>25. Vision</td>
<td>Small eyeglasses</td>
</tr>
<tr>
<td>26. Center time</td>
<td>Clothes pin</td>
</tr>
<tr>
<td>27. Drink</td>
<td>Cup</td>
</tr>
<tr>
<td>28. Lunchroom</td>
<td>Spoon</td>
</tr>
<tr>
<td>29. Break</td>
<td>Timer</td>
</tr>
<tr>
<td>30. No</td>
<td>Raised “X”</td>
</tr>
<tr>
<td>31. Community</td>
<td>Piece of a tactile map</td>
</tr>
<tr>
<td>32. Stander</td>
<td>Vinyl square</td>
</tr>
<tr>
<td>33. Orthodontics</td>
<td>A half-cup measuring cup with Velcro strip</td>
</tr>
<tr>
<td>34. Calendar</td>
<td>Piece of a calendar from American Printing House for the Blind</td>
</tr>
<tr>
<td>35. Walk</td>
<td>Shoe or sneaker</td>
</tr>
<tr>
<td>36. Light box</td>
<td>Plastic piece from light-box kit</td>
</tr>
<tr>
<td>37. More</td>
<td>Piece of red velvet</td>
</tr>
<tr>
<td>38. Games</td>
<td>Spinner</td>
</tr>
<tr>
<td>39. Food</td>
<td>Small plate</td>
</tr>
<tr>
<td>40. Finished</td>
<td>Spool on a cord</td>
</tr>
<tr>
<td>41. Juice</td>
<td>Juice box</td>
</tr>
</tbody>
</table>

(continues)
the home. The uniformity and availability of symbols throughout a program can help to instill a culture that values the use and provision of communication systems for students. The accessibility of commercially produced tangible symbols may allow teachers to implement the next phase of instruction more quickly. Commercially produced tangible symbols should not replace tangible symbols that are already being used with individual children, nor do they preclude the development of individualized tangible symbols by teachers or parents.

Limitations

The small sample of 29 teachers and speech-language pathologists and 14 advisory board members may limit the implications of the findings. Another limitation is that parents were not surveyed. Although the advisory board suggested 12 tangible symbols for use in the home, the original intent of this study was to identify symbols for use in school settings.

Future research

The tangible symbols that were identified in this study are being used with approximately 50 children with visual and additional impairments in four New York City schools in the 2008–2009 school year. The schoolchildren were pretested on their communication competencies and familiarity with the tangible symbols, followed by six months of structured intervention using the tangible symbols. Then a posttest was conducted that measured their communication competencies, including knowledge of tangible symbols. This study will help to identify if the children can learn the more abstract symbols, such as “yes,” “no,” “more,” “finished,” and the plastic hand to represent “arrival,” as well as the highly iconic symbols. The results of this research will determine which of the tangible symbols were most meaningful and effective for the children and will suggest which symbols may be most appropriate for standardization among all programs that serve this population.

REFERENCES


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**Tactile Classification of Traditional and Computerized Media in Three Adolescents Who Are Blind**

*Katia Rovira and Olivier Gapenne*

Inspired by the work of Bach-y-Rita (1972) on tactile-visual sensory substitution, over the past 10 years we have been developing a computerized platform called Tactos (Lenay, Gapenne, Hanneton, Marque, & Genouëlle, 2003). One of the main aims of this platform is to enable persons who are visually impaired (that is, those who are blind or have low vision) to read computerized two-dimensional (2-D) shapes (Gapenne, Rovira, Ali Ammar, & Lenay, 2003). The platform has been used in the context of fundamental research on perception (Sribunruangrit, Marque, Lenay, Gapenne, & Vanhoutte, 2004), and for the design of new interfaces for perception and communication (Ziat, Gapenne, Stewart, & Lenay, 2007). The fact that this platform makes it possible to read simple computerized shapes has also provided the conditions for a longitudinal study of the teaching of mathematics, particularly geometry, to a small group of high school students who are congenitally or adventitiously blind (Rovira & Gapenne, 2008).

In the setting of this longitudinal study, we have been particularly interested in the activities of categorization of shapes and the attribution of meaning to shapes. Beyond the simple perception of shapes, we wanted to evaluate the capacity of these students to categorize geometric line drawings defined by several dimensions. In addition, we wanted to study and compare the categorization strategies used by these students when they performed identical tasks either with traditional material (on thermoformed paper) or with the Tactos system.

The Tactos platform (see Figure 1) consists of a graphics tablet and its pen, a computer, and a tactile stimulator (2 standard 8-pin electronic braille cells). The participant can explore a line drawing by moving the pen on the graphic tablet. The Tactos software provides the link between the position of the pen and the stimulators: The 16 (2 x 8) pins of the braille cells are activated in an all-or-none fashion whenever the participant encounters the shape (which is represented by black pixels) being explored by means of the pen. The tactile stimulation is delivered on the free hand. It is to be noted that perception with this instrument does not involve any symbolic coding—the activation of one or several pins on the braille cells corresponds solely to contact with the virtual object—and that at any one