The Next Generation of Tactile Symbols: 3D-Printed Blissymbolics

ABSTRACT

In this article we introduce you to a new generation of tactile symbols that are perfect for use with non-speaking individuals who are blind, deaf/blind, or visually impaired, as well as students with complex communication needs. The symbols benefit from two different technologies: 3D-printing and Blissymbolics. 3D-printing makes it inexpensive to create these rugged tactile symbols with fidelity. Blissymbolics provides a rich, conceptual language for the development of communication skills with modest cognitive and tactile requirements. This article highlights the experiences shared by teachers of students with visual impairments (TVIs) and speech-language pathologists (SLPs) – how they collaborate and use these tactile symbols with their students. Along the way, we tell you how the public can get free access to these tactile symbols and supporting materials.

This article begins by establishing a baseline understanding of visual impairment and of traditional tactile or tangible symbols. Then, we credit the Project Core team from the University of North Carolina for their creative insight, before going into some depth regarding how their effort falls short of an optimal tactile symbol system.

On the other hand, we believe we have created an optimal system based on Blissymbolics, so we spend some time introducing you to the language of Blissymbols and to our Bliss Tactile Symbols. We've built an entire ecosystem around our tactile symbols, and we want you to know how you can obtain these free resources for your own use.

Note that we are describing more than just ideas in this article, so we share our experiences using these tactile symbols in the classroom.

Finally, we describe a special DIY device that gives our tactile symbols a voice, called the Voice It, as well as some 3rd-party tools and services for managing our symbols in the classroom.

KEN HACKBARTH, is the president of Volksswitch.org – an organization devoted to the democratization of assistive technology by leveraging the power and promise of 3D printing. Prior to his current position he worked for almost three decades as a systems architect for AT&T Bell Laboratories and its subsequent divestitures. He has Master of Science degrees in both Evolutionary Biology and Systems Engineering from the University of Arizona and a Master of Education in Special Education, with a concentration in assistive technology, from Bowling Green State University.

ANITHA MUTHUKUMARAN, is a teacher of students with visual impairments (TVI) working in the Douglas County School District in Colorado. She is in her 11th year of teaching and prior to this career, was a software engineer working in a large bank in the Midwest. She's also a 5th year special education doctoral student completing her dissertation at the University of Northern Colorado. Her main area of research interest is exploring how technology plays a role in implementing an inclusive classroom for children with visual impairments and/or blindness.

SHANNON PAIGE, is a US Navy veteran, a speech language pathologist, and a member of the QIAT leadership team. She is currently the Education Project Manager of the Texas Technology Access Program through the Texas Center for Disability Studies at the University of Texas. She has worked in rehabilitation, public schools, private practice, and as an education service center specialist. She has over 20 years of experience supporting assistive technology with an emphasis in the area of augmentative and alternative communication (AAC).

HEATHER WILLIAMS, is an Education Specialist and Assistive Technology and AAC Specialist. She has been teaching life skills, total communication, and advocacy to transition age students with Multiple Disabilities for twelve years. Heather began her career working with disabled people as a community support facilitator in Scotland in 2000. As a Transition Skills Education Specialist Heather teaches young adults and their families through practical application and collaboration that advocacy and communication are basic human rights and are the foundations of a safe and successful life, lived as independently as possible.

BACK TO CONTENTS

INTRODUCTION

Students with visual impairments and additional disabilities often need a communication system using concrete or abstract symbols. Tactile symbols of core vocabulary words are often used for students with cognitive, motor, or speech impairments. Teachers of students with visual impairments can create 3D-printed Tactile Symbols unique to their students' communicative abilities.

As shown in Figure 1, according to the Office of Special Education Program (2022), of all students, ages six through 21, who received special education services under the Individuals with Disabilities Education Act in the school year 2019-2020, 0.4 percent received services under the category of visual impairments or blindness. Note that in Figure 1, "Other disabilities combined" include deaf-blindness (less than 0.05 percent), developmental delay (2.6 percent), hearing impairment (1.1 percent), multiple disabilities (2.0 percent), orthopedic impairment (0.6 percent), traumatic brain injury (0.4 percent), and visual impairment (0.4 percent).

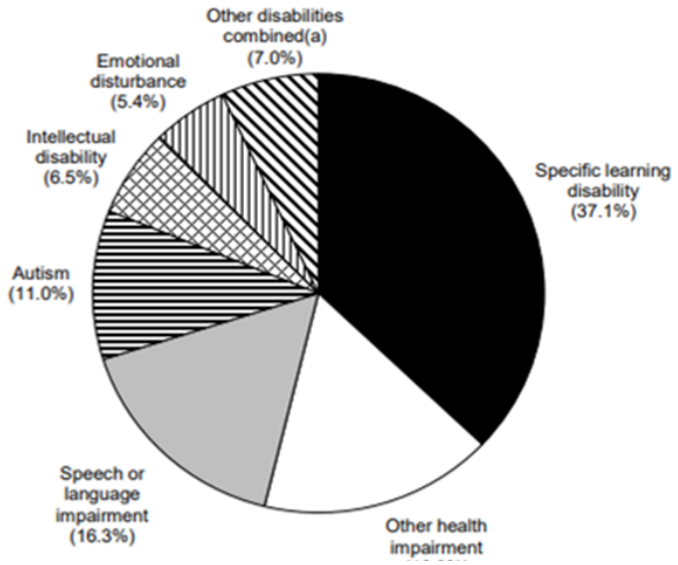

Figure 1 - Percentages of Students Receiving Special Education Services.

The term Visual Impairments includes both low vision and severe visual impairment which ranges from partial to total blindness. Students with visual impairments receiving special education services vary in how they access their learning materials. As depicted in Figure 2, according to the annual quota census by American Printing House (2020) in the year 2019, approximately 8.2% were braille readers, 33.3% were print readers, 10% were auditory readers, 30.4% were non-readers, and 18.1% are pre-readers. Symbolic readers are students who do not currently demonstrate traditional print or braille reading potential. Non-reading students are either students not working on or toward a readiness level or students who do not fall into any of

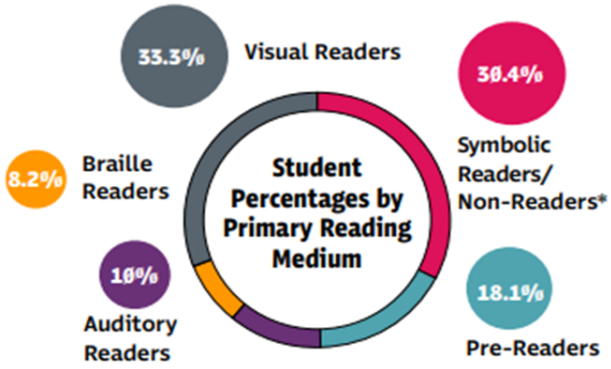

Figure 2 - Divergent Access Needs of Students with Visual Impairments.

Figure 3 - Blissymbols for Symbolic Readers.

the above categories. Based on the above statistics, even within the category of visual impairments or blindness, students differ in how they access their learning content through braille, print, symbolic, or auditory modalities. Considering the divergent access needs of students with visual impairments, when materials are presented in more than one sensory modality (visual, tactile, and auditory), they open up the world for these students to more communication and access.

As shown in Figure 3, when instructional materials are presented in multiple formats, ALL learners can access those materials seamlessly. The idea is for our Bliss Tactile Symbols to be accessible to not only low vision, tactile and auditory learners but to ALL symbolic readers with or without visual impairments. Symbolic readers can access Blissymbols visually (students with low vision), via tactile means (students with significant vision loss), or auditorily (students with physical disabilities who cannot access through vision or tactile means).

TRADITIONAL TACTILE SYMBOLS

You've all seen Tactile Symbols before – even if just in pictures. They're used by individuals who are blind or visually im-

BACK TO CONTENTS

paired and can help them express their needs and desires, as well as gather information about the world around them. They can also be useful when working with individuals who need help with executive functioning, have autism, or don't respond to traditional systems.

The symbol can incorporate a physical object like a ribbon or simply have a unique tactile profile. Figure 4 shows two examples of traditional Tactile Symbols. The first is a plastic starfish glued to a card with the word "star" printed on the front. The second is seven raised dots on a card labeled "snow".

Traditional Tactile Symbols are typically constructed by gluing a physical object to a rigid backing. The physical object may be closely associated with the symbol's referent. For example, Figure 5 shows a plastic spoon glued to a piece of cardboard to represent the concept "to eat".

It's much more difficult to create effective symbols for concepts that are less tangible. Figure 6 shows a tactile symbol with a raised circle as a representation of the concept "yes". Less tangible concepts tend to be modeled very differently by different tactile symbol designers.

Physically large concepts tend to be modeled by choosing a small component of the larger concept even if that small component is unrepresentative of the overall concept. For example, how should a tree be represented? By a leaf? By a piece of bark? Similarly, complex or multi-component concepts are often modeled by selecting a single component of the concept. Figure 7 shows a traditional tactile symbol incorporating half of a tennis ball and labeled "gym" – but is a tennis ball really the best representation of gym class?

Traditional tactile symbol sets rarely represent more than one hundred concepts. When a symbol set is assembled for a small number of concepts, there is little or no motivation to base the design choices on a set of rules. Without rules, there's little conceptual carryover from one symbol to another. Such symbols must, by definition, be learned through rote memorization.

Probably the most revealing aspect of traditional Tactile Symbols (just like popular graphic image sets) is the fact that they always include a text label. Ostensibly the text is there to help communication partners – because without the text, it's unlikely that anyone would connect the symbol to the concept. Only by first reading the label, can someone "back into" the referent – sometimes not even then. Figure 8 shows a card with a piece of string glued horizontally onto it. Why would you intuit that this shape represents the concept "to want"?

Figure 9 shows eleven traditional Tactile Symbols from two different, popular, symbol sets. Some symbols are relatively intuitive – for example, using an arrow for the concept "to go". But why would a beaded triangle represent the concept "more"? We're sure you can rationalize a cross representing "help" – especially a red cross (though this cross appears to be made of brown sandpaper). Consider how much cultural knowledge you have to have amassed in order to make the connection between a

Figure 4 - Traditional Tactile Symbols.

Figure 5 - A Symbol for a Tangible Concept.

Figure 6 - A Symbol for a Less Tangible Concept.

Figure 7 - A Symbol for a Complex Concept.

BACK TO CONTENTS

Figure 8 - An Inscrutable Symbol.

cross and the concept "to help"?

The symbols on the right are, at least, internally consistent. They appear to use a small piece of rope to represent the concept of "now". But where do you go next if you want to extend the set to represent a new concept like "to want"? The consistent theme is immediately lost. Imagine trying to intuit the meanings of these symbols without their text labels. Then remember that the individual relying on the tactile shape can't take advantage of the partner text.

PROJECT CORE'S 3D-PRINTED TACTILE SYMBOLS

Let's now look at a breakthrough in the creation of Tactile Symbols. Project Core is a program of the Center for Literacy and Disability Studies at the University of North Carolina-Chapel Hill. They have established a Universal Core Vocabulary as part of their Universal Core Communication System. In support of their Universal Core Vocabulary, Project Core developed a set of thirty-six, 3D-printable Tactile Symbols. This was a brilliant idea!

Figure 10 shows an early example of their symbol for the concept "to go". It has a raised arrow from left to right, the word "GO" engraved, and braille bumps for the letters: "g" and "o". All these features are located on the face of the symbol.

Figure 10 - Project Core "to go" Symbol.

Project Core makes these symbols freely available to the public as STL files. An STL file is a common input to the 3D-printing process. Because the symbols are 3D printed it's easy to produce exact copies of their designs. Though printed from plastic, they're very robust and sturdy.

Unfortunately, there are several issues associated with the approach taken by Project Core:

- The STL files cannot, reasonably, be modified, if desired.
- There is no support for extending the set, if needed. There are thirty-six, and only thirty-six, universal core words and 3D symbols.
- Including braille and engraved text along with the raised shape, unnecessarily complicates tactile processing of the symbol. The braille, in particular, is very scratchy and off-putting.
- If you look at the complete set of symbols, there are no obvious features that tie together related concepts, other than their word class. Learning one symbol provides no advantage in learning the next or a related symbol.
- Often, there's no obvious relationship between the raised shape and the symbol's referent. Figure 11 shows an image

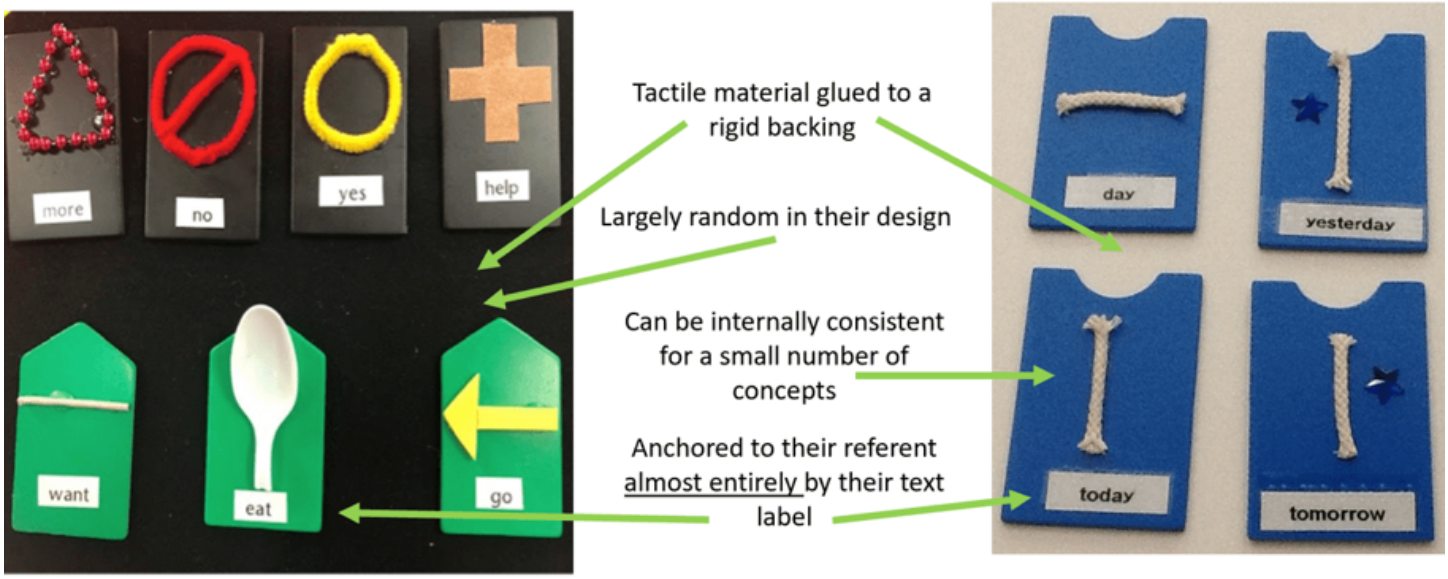

Figure 9 - Two Popular Tactile Symbol Sets.

Figure 11 - Project Core "more" Symbol.

of their current symbol for the concept "more". What is the connection between three raised bumps and the concept "more"?

- Without clear tactile relationships and carry-over, these symbols must also be learned through rote memorization.

WHAT WOULD AN OPTIMAL TACTILE SYMBOL SYSTEM LOOK LIKE?

If the previous tactile symbol systems are non-optimal, what would an optimal tactile symbol system look like?

1. The symbol system would utilize a conceptual language. As a result, there would be no required intermediate conceptual transformations like tactile shape to sign language to concept, or tactile shape to Braille letter to English word to concept.
2. It would be made of simple elements – thereby lowering the tactile and cognitive load (just a few lines and curves, basically 2-dimensional).
3. It would be extensible – with a generative language, you can easily create new symbols from existing ones.
4. The tactile symbol design itself would be flexible – you and your student would be in control of the amount of complexity. Yet, creating exact copies of your design would be as simple as 3D-printing them.
5. There would be a governing body to validate and ground construction of the language and specification of symbols.
    a. The governing body would establish a set of rules to direct the design of new symbols.
    b. The rules would be enforced to ensure consistency as well as carry-over of learning from symbol to symbol.
    c. The governing body would be multicultural and multilingual, thereby ensuring that the symbols would be independent of culture – in other words, cultural knowledge would not be a prerequisite for their use.

Video 1 - An Introduction to Blissymbolics
YouTube link - https://www.youtube.com/watch?v=oAAt-5Mulig

BLISSYMBOLICS

With those characteristics in mind, take five minutes to watch Video 1 about the basics of Blissymbolics.

Blissymbols are unlike any other graphic symbol set. They are curated by a multicultural, multi-language, non-proprietary governing body – Blissymbolics Communication International (BCI for short). When a new symbol needs to be added to the language, a collection of individuals ensures that the symbol adheres to the rules of symbol design and leverages the rest of the language. What process do you think is followed when they need to add a new symbol to PCS or SymbolStix?

In 1971, Shirley McNaughton (a recent president of the board of directors for BCI) as a part of the Ontario Crippled Children's Centre's (OCCC) Symbol Communication Project, came across and utilized the precursor to the current Blissymbolics and used the system to create and publish *The Handbook of Blissymbolics for Instructors, Users, Parents and Administrators* in 1978. The system took off around the world.

In 2015, Isaacson and Lloyd saw something special in Blissymbolics that had them wondering about its applicability to the tactile domain (Isaacson and Lloyd, 2015).

In particular, they thought:

"Due to their simplicity, edges, outlines, and kinesthetic feedback are optimized in raised-line renderings of Blissymbols, which may facilitate recognition of tactile Blissymbols. In short, the conformational characteristics of Blissymbols results in stimuli that have minimal complexity (or low potential cognitive load) and when rendered as raised lines have characteristics that may increase the efficiency of perceptual/cognitive processes involved in communication with Tactile Symbols."

BACK TO CONTENTS

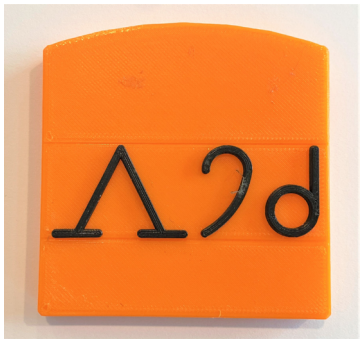

Figure 12 - Music Therapy Blissymbol.

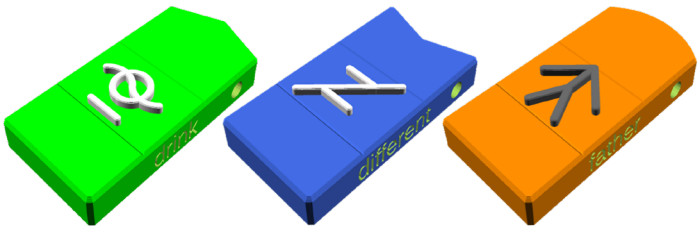

Figure 13 - Three Bliss Tactile Symbols: to drink, different, and father.

There are many functional applications of Blissymbolics in the classroom. The simple and consistent shape-based Blissymbols can be used by students to convey complex information. For example, Figure 12 shows an image of the Bliss Tactile Symbol for music therapy. Blissymbols can be used for all curriculum subjects and extracurricular activities, as well as for communication, by combining the shapes already established in Blissymbolics. Due to their ability to be adapted across multiple subjects and situations, Blissymbols allow for a more organic language experience for students with intellectual disabilities and vision impairments compared to other traditional tactile systems. Students who use Blissymbols may have the means to be more interactive in their lessons and therefore build a stronger understanding of concepts presented, since they would have the means to answer questions with premade Bliss Tactile Symbols relevant to the lesson (similar to how sighted students have word walls and vocabulary banks). This also allows for expanding student vocabulary as the student learns symbols specific to each lesson by using tactile Blissymbols that are created easily, and 3D-printed in a few hours.

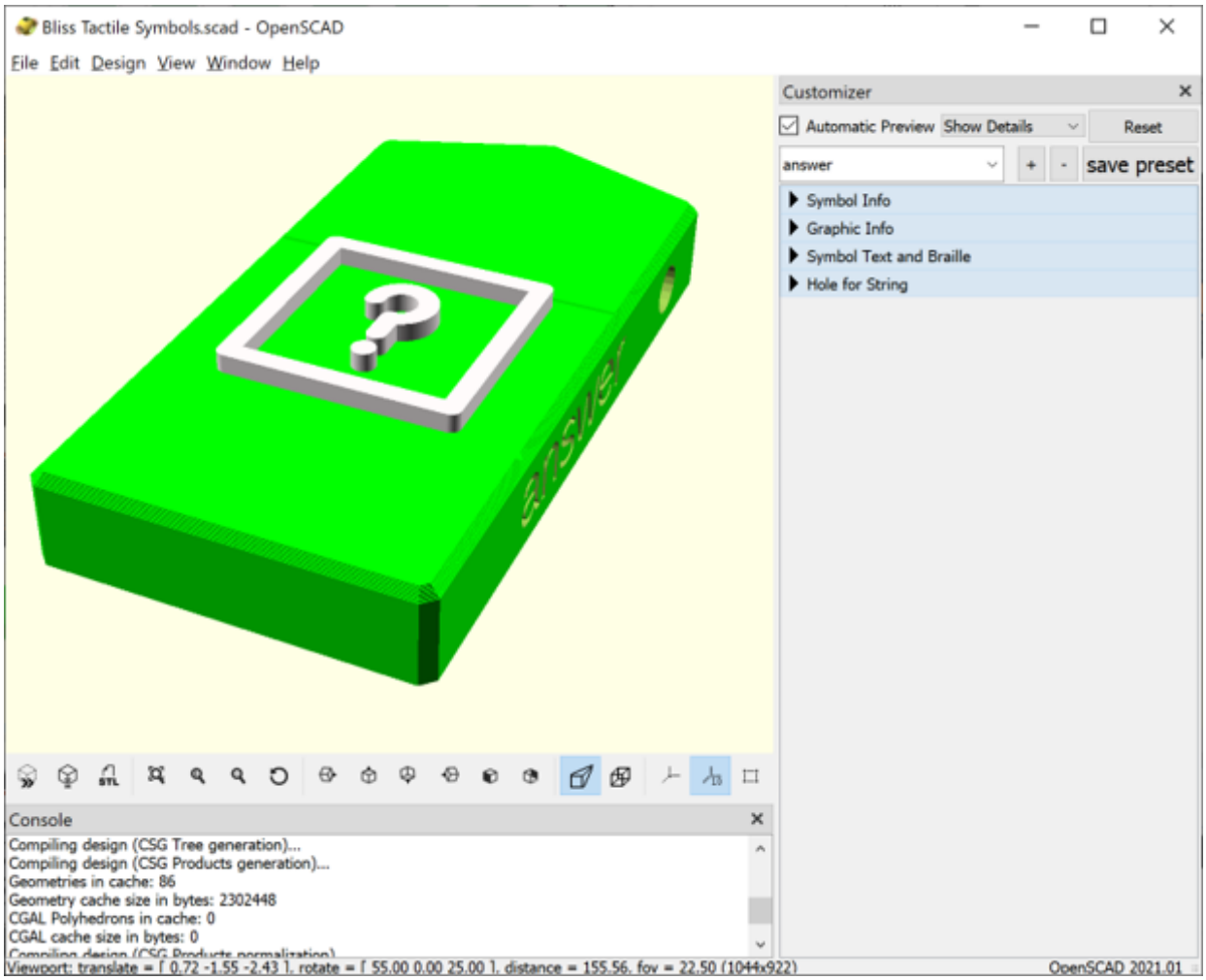

Figure 14 - Tactile Symbol Designer User Interface.

OUR BLISS TACTILE SYMBOLS AND SUPPORTING MATERIALS

As mentioned in the abstract, we've constructed an entire ecosystem around our Bliss Tactile Symbols. This takes the form of a rich set of ready-to-3D-print symbols, a symbol designer for modifying and creating new symbols, a collection of sample 3D-printable motivational and remedial tools along with a designer for creating your own, and an introductory library of explicit teaching plans to aid you in getting started using these Tactile Symbols in the classroom.

Figure 13 shows images of three of our Bliss Tactile Symbols - to drink, different, and father.

We've made 242 of our symbols free for you to download and 3D-print via the Volksswitch website. They span the 36 Universal Core Words from Project Core as well as Gail Van Tatenhove's "Core Vocabulary List for Students with Intellectual Disabilities".

TACTILE SYMBOL DESIGNER

We also provide a free tactile symbol designer that you can use to modify our initial symbol set, as well as to create new symbols based on the free graphics from BCI. Figure 14 shows an image of the tactile symbol designer's user interface. Modifying an existing design or creating an entirely new one is as simple as choosing options from pulldown lists and typing some text.

BLISS PUZZLES, EXPLORERS, AND CHALLENGE TILES

You can take advantage of the pictographic nature of Blissymbols to construct motivational tools like our Bliss Puzzles – which are also 3D-printable. Figure 15 shows an example Bliss "Head" Puzzle in both assembled and disassembled form.

3D-printed Explorers and Challenge Tiles can provide scaffolding for children who need to build their skills from simple tactile shapes to more complex ones. Figure 16 shows an example explorer and an example challenge tile set. The challenge tile set illustrates building the symbol for father from the symbols for protection and man. We provide a free, easy-to-use designer to create these tools and the Bliss Puzzles, for yourself, based on your student's needs.

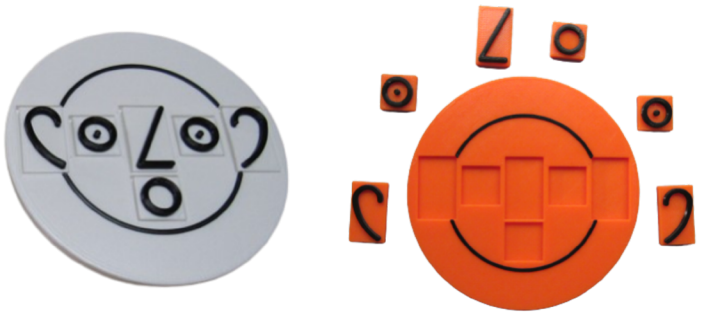

Figure 15 - Example 3D-Printed Bliss Puzzle.

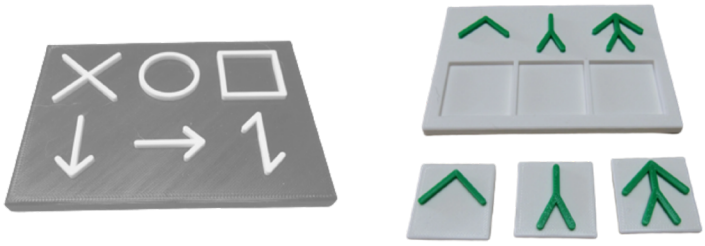

Figure 16 - Example 3D-Printed Explorer and Challenge Tile Set.

EXPLICIT TEACHING PLANS & SUPPLEMENTAL MATERIALS

You can incorporate our Tactile Symbols into your classrooms in the same way that you've previously incorporated traditional Tactile Symbols. But we've taken the extra step of developing a few, simple, explicit teaching plans and supplemental materials to help you get started. Figure 17 shows an image of a documented teaching plan and the Bliss Tactile Symbols and Bliss Head Explorer used to support that plan. Our set of teaching plans is admittedly small at this point. We'd love your help in extending the set based on your own learning and experience.

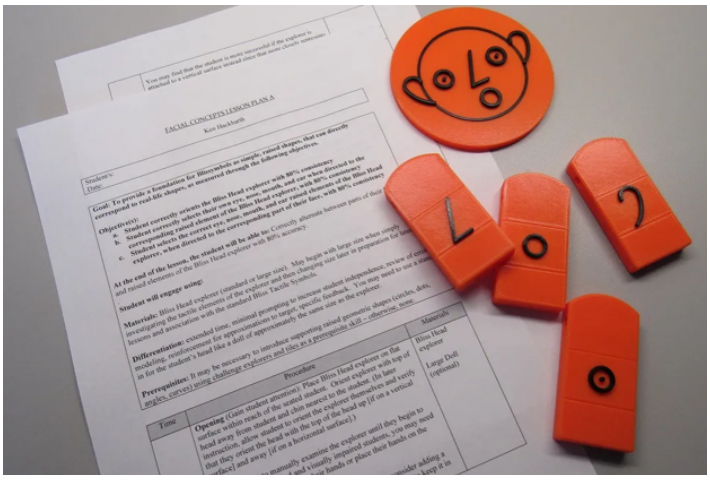

Figure 17 - Example Explicit Teaching Plan and Supplemental Materials.

DIY AND 3RD-PARTY PRODUCTS AND DEVICES

In this section, we present a collection of DIY devices and commercial offers that you might want to take advantage of to facilitate your use of our Bliss Tactile Symbols in the classroom. To be clear, we are not financially connected to any of the companies.

THE BLISS TACTILE SYMBOL CARRIER

The company, Augmentative Resources, makes several products for the management and display of communication symbols. Figure 18 shows their Bliss Tactile Symbol Carrier ($64.00) that they created specifically for the display, management, and transport of our Tactile Symbols carrier. The carrier is shown in both closed and expanded configurations.

The carrier has a rigid spine and a padded separator that

BACK TO CONTENTS

Figure 18 - Bliss Tactile Symbol Carrier.

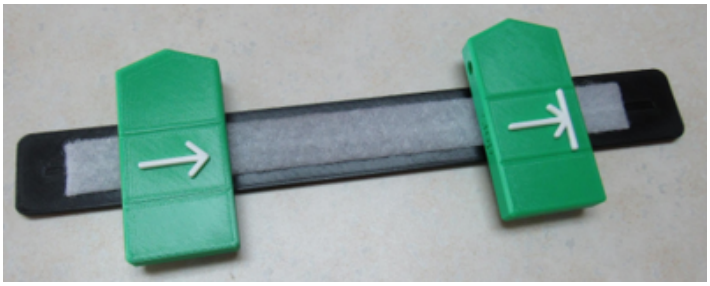

Figure 19 - 3D-Printed Message Builder with Go and Stop Bliss Tactile Symbols Attached.

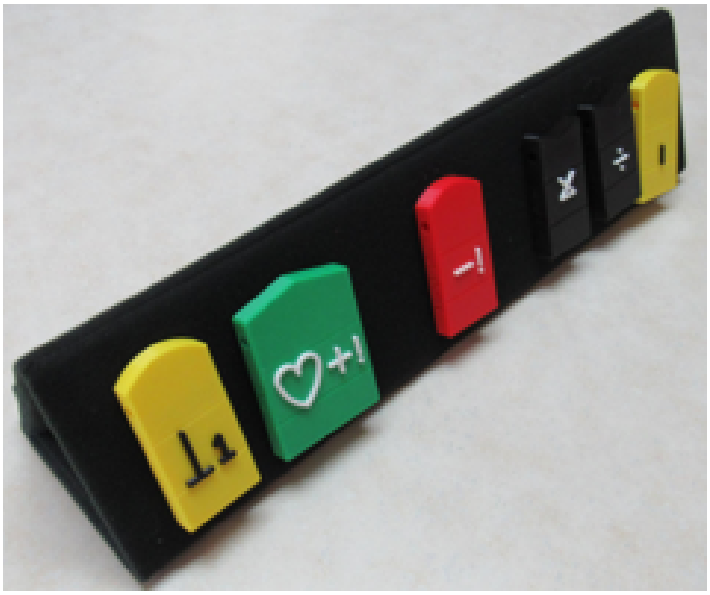

Figure 20 - Trifold Choice Board with Several Bliss Tactile Symbols Attached.

keeps the symbols carrier from clacking against each other during transport. In the picture, we've used the space of the rigid spine to attach a 3D-printed "Message Builder". Figure 19 shows an enlarged picture of a Message Builder with the symbols for "go" and "stop" attached. You can download the free, 3D-printable Message Builder STL file from the Printables website. Figure 20 shows their trifold choice board ($45.61) with six Bliss Tactile Symbols attached.

PURCHASING PRE-PRINTED BLISS TACTILE SYMBOLS

The people at the 3D Learning Shop on Etsy have already made a business of 3D-printing and selling the Project Core, 3D-printed Universal Core words (approx. $6 per symbol). You may be more comfortable purchasing 3D-printed devices and symbols rather than making them yourself. For that reason, we contacted the 3D Learning Shop about printing and selling our Bliss Tactile Symbols (approx. $5 per symbol) as well as Voice It boxes (offer in the planning stage at this time) – and they agreed.

CREATING CONSISTENT USER-INTERFACES ON AAC DEVICES

If your favorite AAC software will allow you to place your own graphic images on one or more buttons, you can take advantage of Blissymbolics to create a consistent interface for your students. We support that effort by making the symbols for all 242 concepts in our collection accessible via a webpage. Figure 21 includes screenshots of both TD Snap and Proloquo2Go. In both instances, the default button images have been replaced with their Blissymbol equivalents.

THE VOICE IT

The Voice It can be used with our Tactile Symbols to provide a multi-sensory experience. The Voice It is a simple, DIY device that reads an RFID tag and then plays a recording associated with the word or words it finds on the tag. You can build a Voice It in less than 45 minutes using about $130 in off-the-shelf parts and a screwdriver. RFID tags can be purchased online for anywhere from 15 to 30 cents each.

We provide free voice files for all 242 of our concepts in both English and Spanish - and adding a new concept or even a new language is a simple matter. It's also simple to extend the recordings to give a voice to just about anything from a plush toy to a children's book. Figure 22 contains a picture of an assembled Voice It box surrounded by a few Bliss Tactile Symbols.

A VIEW FROM THE CLASSROOM

Jazmin is 20 years old. Since 2019, she's attended a small, special education, public school in Woodland, CA. For the past four years Jazmin has been enrolled in the Transition Skills class, which serves students diagnosed with multiple disabilities ages 17 to 22.

She was born legally blind and has a diagnosis of intellectual disability. Her right eye is absent (anophthalmia), and her left eye is underdeveloped, small (microphthalmia), and has a coloboma (cleft in the iris, the colored part of the eye). She also has retinal dysplasia, a congenital defect of the eye that occurs when the layers of the retina do not form and attach properly during fetal development. Jazmin is bilingual – understanding concrete statements in both Spanish and English.

When Jazmin came to the class, she relied on others to provide a timed transition between lessons and activities. People did not talk with her other than to tell her what to do and to tell

BACK TO CONTENTS

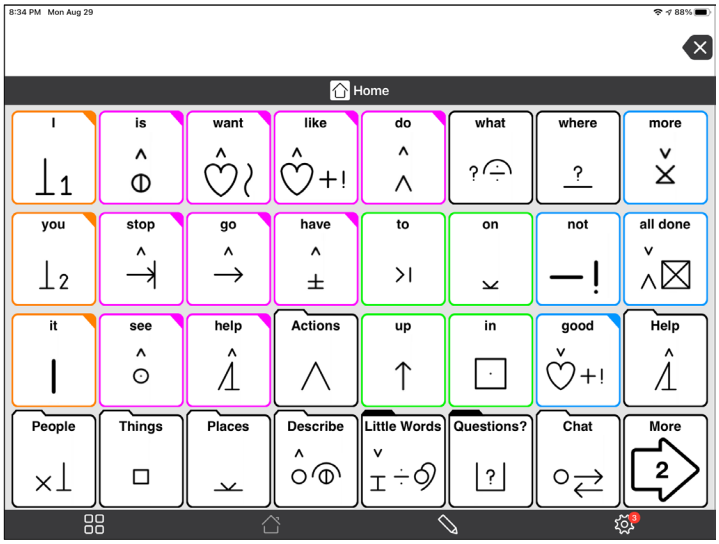

Figure 21 - Two AAC Apps with Blissymbol Button Graphics.

Figure 22 - The Voice It.

her that the timer had gone off to transition to another activity. Jazmin does not like to transition from one thing to another. In class, she rejected timers and refused to transition to a new scheduled lesson during the school day – often screaming, crying, and banging her cane on the floor for as long as 30 minutes. The VI specialist showed the classroom staff, and Jazmin's family, traditional Tactile Symbols and how they could be used as a tactile schedule to help her to anticipate transitions throughout the day.

After two weeks, Jazmin demonstrated to the staff that she really liked the tactile schedule. She would ask for activities to put on her schedule; independently go to the place in the classroom where she kept her schedule; and carry it in her backpack when out shopping.

While she was getting used to her new system she would pull the pieces off their backing, bend them, and bite them. When she was bored or upset, she would fidget with them, pick at them, and bite them. Occasionally, the staff would accidentally take one home and wash it – thereby, destroying it in the process. Other students were interested in the symbols and would explore them, lose them, and pull off pieces. The staff had to recreate the same Tactile Symbols for Jazmin every single week for two and a half years. If the symbols could not be replaced by the next day she would cry, scream, strike out at people, and attempt to bite. She made it clear to the staff that she greatly valued her schedule but she needed a more durable solution.

A few months ago, Jazmin was introduced to the 3D-printed Bliss Tactile Symbols as a tactile schedule. By introducing these new symbols in a familiar setting, she understood how they could help her anticipate her environment and schedule, just as before. Once Jazmin learned to use the Bliss Tactile Symbols as a tactile schedule, the classroom staff taught her that she can use the Blissymbols to help control her day.

Video 2 shows Jazmin sitting at a table with two Blissymbols ("more" and "all done") in front of her. When she starts to vocalize that she is frustrated, the Bliss Tactile Symbols are placed in front of her and she is prompted to tell the staff how she wants to proceed. If she gives the staff member the "more" symbol she is given the option to continue the work she was doing before she became frustrated. If she continues to be frustrated after providing the "more" symbol, she is immediately handed the "all done" symbol and assured that the staff understands that she is finished with her work. She's also given time to process her frustration.

If Jazmin gives "all done" symbol first, she is provided with a confirmation that she is finished with her current work. She is then be prompted to choose a different neutral activity – something she doesn't mind doing – and advised that once she completes the neutral activity she can play piano – a favorite free time choice. In the video, she tells staff that she first wants to work, then play piano.

By knowing what is expected of her, and being able to anticipate future activities, Jazmin has gained significant control of her day.

BACK TO CONTENTS

Video 2 - Jazmin Beginning to Communicate with Bliss Tactile Symbols in the Classroom.
YouTube link - https://www.youtube.com/shorts/TttY69iumyY

Figure 23 - Six Blissymbols Jazmin has learned to use.

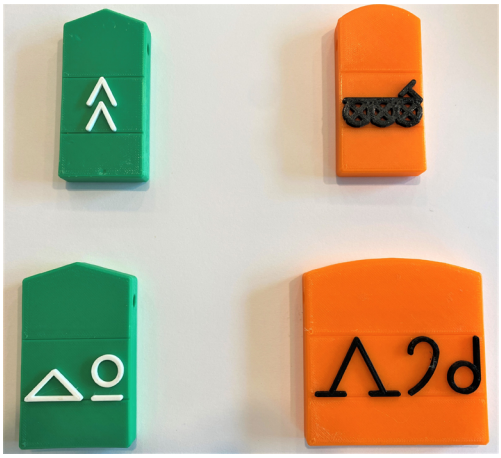

Figure 24 - Four Blissymbols Jazmin has learned to use.

Even after three months, her Bliss Tactile Symbols have not needed to be replaced due to breakage. They cannot be bitten through or ripped, and they are durable enough to go through the washing machine and the dryer. Currently, Jazmin has mastered eleven Blissymbols that she uses to manage her daily schedule. She also uses the symbols to help her focus on transitions using first/then strategies.

The eleven Bliss Tactile Symbols that Jasmin currently uses are: Snack, More, Stop, Lunch, Piano, Walk, Work, Bus, Go, Cooking, and Music Therapy - all but Go are pictured in Figures 23 and 24.

She is not yet interested in learning which symbols are nouns, verbs, or adjectives, but she actively seeks to use this language to help her navigate her school day. Her classroom team keeps encouraging her to expand her knowledge, and she shows them when she is ready to learn more. The staff plans to introduce Jazmin to literacy skills by using the Bliss Tactile Symbols to help her answer questions about audiobooks and class lessons.

In Figure 25, Jazmin is using the premade, explicit teaching plan from Volksswitch.org to learn parts of her face. She is sitting at a table with a 3D-printed Bliss Head explorer and the associated Tactile Symbols.

Jazmin has learned to match the symbols to the facial elements of the explorer, and in turn, to relate the symbols to the parts of her own face. She had not shown that she knew the names for regions of the face before using the Bliss Tactile Symbols. Jazmin often becomes echolalic when stressed, frustrated, or tired. It took about six weeks for her to independently identify

Figure 25 - Jazmin during a Blissymbol lesson

regions of her face with Bliss Tactile Symbols as prompts. She enjoys matching the facial features of the explorer and to her own face – laughing when she matches correctly.

Learning the Blissymbols for facial features has made it easy for Jazmin to show others if she is in pain or discomfort – two conditions which cause her to stop communicating in a way that is easily understood. Now she will independently state a part of the face and we can focus on helping her in a more specific way. Other times, she initiates a conversation by finding a face symbol, touching her face, and saying the name of the part independently. The staff supports this by talking about that part of the face and offering more parts to talk about to practice communication skills and promote language development.

Since starting to use the Bliss Tactile Symbols in September 2022, Jazmin has increased her independent transitions between lessons, independently asks the staff if she can have a break, identifies parts of the face, initiates communication, and has increased her speaking vocabulary. She is much more confident and consistent in her communication. Jazmin has shown us that consistent, reliable communication tools such as the Bliss Tactile Symbols are a powerful way to grow one's communication, self-esteem, and independence.

FINAL THOUGHTS

The population we are targeting with our Bliss Tactile Symbols are those individuals whose current form of communication is simply not working. As a result, these individuals do not have a shared system for communication. Their caregiver or caregivers may understand certain movements, vocalizations, or simple gestures, but they may not always be around to interpret for the individual. If the current form of communication restricts future potential, then an appropriate communication system should be identified and implemented based on the individual's unique strengths and weaknesses. Despite the benefits communication systems may have for students with complex communication needs, professionals often recommend communication systems based on familiarity, past experiences, or discussions with colleagues, rather than through evidence-based practices.

A form of AAC that is often overlooked in that consideration process, and should be included, is Tactile Symbols. Until now, Tactile Symbols were created on the fly which reduced the consistency in their implementation – and they were not implemented until other communication systems and strategies had failed. The key here is to closely observe the potential communicator and look at each area to identify their unique communication profile. This can only happen via a thorough assessment to determine the individual's capabilities. This must take place before implementing a functional means of communication designed to accommodate those needs and abilities. We do not want to make the mistake of providing an emerging communicator with one type of communication system that either fails or limits their communication potential. There should often be a set of Tactile Symbols available as an option.

Tactile Symbols improve a student's access to social interactions in the community. The symbols can be used as a communication system for individuals with dual-sensory impairments, especially since tactile perception is important and leads to the development of motor skills that encourage grasp, pincer, finger isolation, bilateral hand use, finger position, tracking, and including pre-braille skills. The Bliss Tactile Symbols can function as an AAC system and also as a supplemental tool. Think about individuals with autism that may be overstimulated by auditory information even though they are verbal communicators. These symbols are perfect manipulatives to reinforce verbal instructions when these individuals are overwhelmed by their environment. You can and should allow the individual time to look at, touch, and explore them. This reduces the load on their short-term memory. The benefit of these symbols is that you can individualize the organization and presentation layout. The symbols are concrete and can be fixed in a set position and you can choose which words are needed to support communication development. They are easily reproducible with fidelity and there are an unlimited number of options for words and word combinations.

Additionally, the Bliss Tactile Symbols can be used to help learners to be more independent throughout their day. For learners who do not easily transition between classes or lessons, the Bliss Tactile Symbols can be used as a tactile schedule of the lesson or of the day – either as a sequence of events throughout the school day or presented as 'first/then', where the student focuses on each individual transition, for example 'first PE, then Reading'; 'first Reading, then Lunch'. Not only does this afford the student agency in their day by taking responsibility for their own daily routine, but it may also help the student transition more smoothly between classes or lessons and reduce potentially disruptive incidents, since students are anticipating their own schedule and have the ability to independently remind themselves of what is coming next. Autonomy within routine can help to build confidence and self-esteem, reduce frustration, and reduce dependency on others.

The meaningful application of 3D-printing technology in K-12 schools has been rare and inconsistent despite the availability of inexpensive 3D printers since 2009 (Horvath & Cameron, 2018). Although a popular use of 3D-printing technology is building tactile models for individuals with visual impairments, teachers of students with visual impairments have not yet exploited the benefits of this technology (Yue-Ting, 2014). More often than not, technology companies design products without understanding the unique needs of non-visual learners. Teachers of students with visual impairments who are experts in the pedagogical needs of students with visual impairments can use 3D-printing technology to create Tactile Symbols for their students. By using 3D-printed multimodal symbols such as the Bliss Tactile Symbols, instructions in academic and functional sub-

BACK TO CONTENTS

jects that were previously considered inaccessible by students with disabilities can become accessible.

Blissymbols are an ideal tactile communication system in the classroom because every Bliss Tactile Symbol can be recreated identical to the last, ensuring that students who use these symbols can have a ready supply of language with fidelity, akin to speech or American Sign Language. When they can be used throughout the day, in multiple settings, and with both educators and peers, Blissymbols have the potential to be incorporated naturally into the student's communication repertoire, as people interacting with the student using Tactile Symbols will become familiar with the consistent language being used in meaningful ways to convey ideas, emotions, and information.

ACKNOWLEDGEMENTS

This work represents the contributions of a team of volunteer service providers, teachers, and engineers. We'd like to acknowledge the efforts of: Andrea Newall, Angela Albrigo, Justin Wintour, Kathy Sledz, Sara Palmer, and Tim Bellis.

REFERENCES

43rd Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act, 2021. (n.d.). https://sites.ed.gov/idea/files/43rd-arc-for-idea.pdf

Bliss, C. (1965). Semantography (2nd ed.). Sydney, Australia: Semantography Publications.

Blissymbolics Communication International - Start. (n.d.). Www.blissymbolics.org. https://www.blissymbolics.org/

Clark, C. R. (1981). Learning Words Using Traditional Orthography and the Symbols of Rebus, Bliss, and Carrier. *Journal of Speech and Hearing Disorders, 46*(2), 191–196. https://doi.org/10.1044/jshd.4602.191

Dunst, C., & Lowe, L. W. (1986). From reflex to symbol: Describing, explaining, and fostering communicative competence. *Augmentative and Alternative Communication, 2*(1), 11–18. https://doi.org/10.1080/07434618612331273820

Eugene Thomas McDonald. (1980). *Teaching and Using Blissymbolics*.

Horvath, J., & Cameron, R. (2018). *Mastering 3D printing in the classroom, library, and lab* (1st ed., pp. XXI, 310) [Review of Mastering 3D printing in the classroom, library, and lab]. Apress Berkeley. https://doi.org/10.1007/978-1-4842-3501-0

Hughes, M. J. (1979). Sequencing of Visual and Auditory Stimuli in Teaching Words and Bliss Symbols to the Mentally Retarded. *Australian Journal of Mental Retardation, 5*(8), 298–302. https://doi.org/10.3109/13668257909018792

Learn Your Way Annual Report. (2020). https://www.aph.org/app/uploads/2021/02/Annual-Report-FY2020.pdf

McNaughton, S., & Kates, B. (1978). *Handbook of Blissymbolics*.

Mick D. Isaacson & Lyle L. Lloyd (2015) The potential for developing a tactile communication system based on Blissymbolics, Developmental Neurorehabilitation, 18:1, 47-58, DOI: 10.3109/17518423.2014.965798

Raghavendra, P., & Fristoe, M. (1995). "No Shoes; They Walked Away?": Effects of Enhancements on Learning and Using Blissymbols by Normal 3-Year-Old Children. *Journal of Speech, Language, and Hearing Research, 38*(1), 174–186. https://doi.org/10.1044/jshr.3801.174

Rowland, C., & Schweigert, P. (1989). Tangible symbols: symbolic communication for individuals with multisensory impairments. *Augmentative and Alternative Communication, 5*(4), 226–234. https://doi.org/10.1080/07434618912331275276

Siu, Y.-T. (2014). 3D Printing for Accessible Materials in Schools – Final Report [Review of *3D Printing for Accessible Materials in Schools – Final Report*]. In *Diagram Center*. http://diagramcenter.org/3d-printing.html ■