Visual Features That Convey Meaning in Graphic Symbols: A Comparison of PCS and Artists' Depictions

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Abstract: Research on AAC symbols has focused almost exclusively on iconicity and complexity, and thus has not established whether additional visual features are necessary for conveying meaning in graphic representations. Despite variations in individual depictions of an "apple," we understand the underlying concept due to shared consensus on the set of necessary visual elements. This initial investigation examined 25 concepts depicted in Picture Communication Symbols (PCS) in terms of a diverse set of visual features and principles. Additionally, seven artists drew the same concepts to determine whether patterns emerged across artist groups and within semantically related concepts. While visual profiles of PCS and artists' renditions differed for most concepts, they were identical for some concrete concepts. Additionally, common patterns were noted for semantically related concepts. These findings suggest that a broader set of visual features may be useful for analyzing how meaning is conveyed in existing AAC symbol sets and for developing novel symbols.

Keywords: Graphic symbols, Semantics, Visual representation

Language, spoken and written, is a shared social construct. It is because we agree on a set of common meanings that we can engage in meaningful interaction. How is this shared knowledge negotiated when interacting using graphic symbol representations? The old adage 'a picture is worth a thousand words' must be borne from the fact that we often negotiate meanings when communicating through pictures.

While spoken language is typically an arbitrary mapping between the referent and the word, communication using graphic symbols is usually tied to physical experience and embodiment. When we draw a picture to depict an action or an object, the drawing is tied to the physical world in how it appears, how it moves, its shape, its color, etc. We do not draw arbitrary and indistinguishable scribbles for each item and expect that our communication partner will understand what we mean. Although each person may produce a different drawing to convey the same concept, there must be a set of necessary visual features that convey meaning. We understand drawings produced by children, those produced by novice adults, and those produced by artists because we share common experiences with these individuals that are then communicated via drawing.

Conveying one's ideas, needs, and desires through graphic symbols is of utmost importance for individuals who are unable to communicate using speech. The clinical practice of augmentative and alternative communication (AAC) is consequently aimed at enabling these individuals to convey their intentions using means such as sign language,

gestures, and graphic symbols. The study of graphic symbols in AAC has focused primarily on an analysis of symbol learnability and complexity (Fuller & Lloyd, 1987, 1991; Soto, Cassidy, & Madanat, 1996) and categorized in terms of iconicity (Fuller, 1997; Fuller & Lloyd; Lloyd, Fuller, & Arvidson, 1997; Soto et al.; Schlosser, 1997a, b). Iconicity refers to the visual relationship of a symbol to its referent and varies along a continuum from transparent to opaque. When a symbol to referent relationship is clear and obvious, the symbol is said to be a <transparent> depiction. In contrast, if the symbol bears little or no visual resemblance to the referent, it is said to be <opaque>. Depictions that lie somewhere between transparent and opaque in terms of iconicity are considered <translucent>.

Previous work has attempted to discern the interaction between symbol iconicity and learnability. For example, Picture Communication Symbols (PCS) are thought to be easily learned due to a transparent or translucent relationship between symbol and referent (Fuller & Lloyd; Soto et al., 1996). In contrast, Blissymbols are less learnable than PCS since they combine a finite set of arbitrary visual elements which are less transparent and translucent to a layperson (Fuller & Lloyd; Huer, 2000; Mizuko, 1987; Musselwhite & Ruscello, 1984; Radhakrishnan & Fristoe, 1990).

Earlier studies have also explored the multifaceted relationship between iconicity, complexity and learnability. Symbol learnability appears to be influenced by the referent's part of speech. For example, symbols for nouns are easily learned given that they are concrete and therefore easier to depict visually. [See Fuller (1997) for results in non-impaired adults and children; see Koul and Harding (1998) for similar results with adults with global aphasia.] In contrast, verbs, which contain a high level of abstract semantic information, tend to yield symbols that appear more visually complex and less iconic (Fuller & Lloyd, 1987). In addition, verbs may be more complex to depict due to the difficulty in rendering a dynamic event using static images (Bloomberg, Karlan, & Lloyd, 1990). For example, to depict the verb "to fly" requires indicating movement perhaps using wavy lines or arrows near part of the object that is performing the flying action, while depicting the noun "bird" only requires a static rendition of the object. Attempts to enhance the concreteness and learnability of verbs by animating symbols on computer programs have not been successful with adults with aphasia (Koul & Harding). It remains unclear which visual features can adequately convey the meaning of these concepts without imposing increased processing demands on learners who may already be burdened with visual and cognitive impairments.

The interaction between visual complexity and learnability is further complicated by the finding that typically developing children seem to benefit from complex symbols (Fuller, 1997). Fuller noted that children were able to assign idiosyncratic meaning to symbols that had no visual relationship to their referents, and could map meaning onto any arbitrary symbol. In fact, the more complex a symbol, the more scaffolding it provided the child for assigning meaning to the symbol. Similarly, Raghavendra and Fristoe (1990) demonstrated that adding iconic embellishments to Blissymbols helped children without disabilities to understand and learn these symbols. While a complex, less iconic system may be appropriate for children with adequate cognitive and abstract reasoning skills, such a system may be challenging for many individuals who use AAC. In order to design graphic representations that can be easily learned, it is important to identify which visual features lead to perceived complexity.

Table 1
List of 25 Commonly Used Vocabulary Items for Which Drawings were Elicited

Again	*Feelings*	*In*	*Pain*	*That*
All	*Friend*	*Like*	*Pet*	*Thing*
Animals	*Give*	*Maybe*	*Pretty*	*This*
Better	*Hard*	*More*	*She*	*Want*
Eat	*He*	*None*	*Talk*	*Yes*

Fuller and Lloyd (1987) suggest that the processing required for comprehension and use of symbols is tied to visual elements such as the length, area or number of lines in the symbol. Thus, complex symbols may contain unnecessary visual information that clutters the communication board, taxing the learner's visual and cognitive processing. While recent software makes it convenient to modify or create new symbols and add colors to meet preferences, these modifications may impose further demands on visual processing. Although Musselwhite and Ruscello (1984) found that perceived appeal did not affect perceptions of symbol complexity, improving appeal did not enhance learnability either. Further research is warranted on identifying a broader set of visual features that can elucidate the interactions between symbol complexity, learnability, and appeal.

The design of a successful AAC symbol set must meet the demands brought on by the conflicts of "compactness, iconicity, and semantic transparency/translucency" (Carmeli & Shen, 1998, p. 181). Many symbol sets currently used in AAC have been developed on an ad hoc basis, without systematic analysis of linguistic principles or graphic representation. For example, Schlosser (1997a, b) found that convergence, a relationship between superordinate, basic, and subordinate taxonomies, was present in Blissymbols and PCS symbols. Within the PCS symbols, however, most superordinates were merely collections of several basic level symbols and most subordinates were not represented at all. Furthermore, he noted that PCS symbols lacked visuo-graphic links between subordinates within categories, indicating that convergence in PCS symbols exists only in a limited fashion and not by design. Since users of AAC must rely upon graphic symbols for concept formation, or as a primary language, further research is required for determining which visual features are most effective for depicting category concepts.

Perhaps previous work on semantic primitives can inform the study of visual primitives in graphic representations. Wierzbicka (1996, 1997) performed a thorough lexical analysis of five diverse cultures (English, Polish, German, Russian, and Japanese) in search of a finite set of concepts that encompass all basic human notions. She termed this a "universal mental language independent of the specific oral languages and underlying them all" (Wierzbicka, 1980, p. 2), and proposed a set of 55 "innate and universal semantic primitives" (Wierzbicka, 1996, p. 17) that were common to all cultures and that could be used to define any other concept. If such

core concepts exist in a mental language, how might they be represented graphically?

To broaden the study of graphic representation in AAC beyond traditional comparisons of iconicity, we turned to the study of visual arts. Horn (1998) conducted a comprehensive visual analysis of a diverse collection of Western media including comic books, maps, advertisements, computer interfaces, architectural diagrams, logos, and trademarks. He found patterns among the visual elements used to convey the underlying semantic content of graphic representations. To optimize the effectiveness of communication through graphics, Horn attempted to establish what he refers to as the linguistics of visual language. He formulated a morphology and syntax of visual elements within a set of visual principles.

The present study applied Horn's visual principles to the analysis of graphic symbol representations in AAC. This initial investigation sought to identify the set of visual features used to convey the meaning of 25 commonly used concepts as depicted in Picture Communication Symbols, a popular AAC symbol set. Additionally, seven artists drew the same 25 concepts to determine whether the visual features used in PCS extended to depictions by other artists and whether patterns emerged across semantically related concepts. The goal was to identify a set of shared visual features used to convey meaning across the artist groups.

Method

Participants

The third author, a former graphic artist, sent requests for participation via email and letters to approximately twenty artists from across the USA. This initial communication stated that the purpose of the research was to examine visual features in graphic representations. To avoid limiting the scope of the study or biasing the artist's renditions, there was no mention of the target population or of AAC symbols. Artists were simply told that they would be asked to depict a set of concepts using whatever media they preferred. They were informed that the task had to be completed independently within a time frame of six weeks. If interested in participating, they were asked to return a signed consent form and await further instruction. The group that responded consisted of seven male and female visual artists (mean age 33) from a variety of racial and ethnic backgrounds. While the artists varied in skill and style, all participants had some formal training in fine arts and/or design and were working as professionals in the capacity of teachers, designers, and/or illustrators.

Vocabulary Stimuli

A finite set of 25 commonly used vocabulary items was identified using several criteria. In order to generate a diverse set of items appropriate for users of AAC, initial vocabulary lists for young children (Bristow & Fristoe, 1984; Bruno, 1989) and a list of frequently used vocabulary items for adults (Beukelman, Yorkston, Poblete, & Naranjo, 1984) were consulted. From these sources, overlapping concepts were first selected. Next, concepts that also occurred in Wierzbicka's (1996) list of 55 semantic primitives were selected. This initial set was then used to determine whether these concepts were represented in the PCS lexicon (Johnson, 1981). To constrain the drawing task to a manageable size, the resulting list was further reduced to 25 items (Table 1) from various semantic categories that spanned the concreteness/abstractness continuum.

Visual Features and Principles

Artists' renditions and PCS illustrations were analyzed in terms of 27 visual features that

spanned five principles as defined by Horn (1998) and Fuller and Lloyd (1987). See Table 2 for a description of visual features within each visual principle. Drawings were also categorized in terms of their level of iconicity (i.e., <transparent>, <translucent> and <opaque>).

Since Horn's taxonomy of visual features includes elements from a variety of graphic representations, the present study only focused on features used for representing meaning. Specifically, drawings were analyzed in terms of the gestalt, semantic attributes, cartoon conventions, and compositional distinctions principles (Horn, 1998). The gestalt principle includes visual features of (a) <proximity>, (b) <similarity>, (c) <common regions>, and (d) <connectedness> which are used to convey the spatial grouping of elements. For example, the visual feature <common regions> may be used to convey the concept "family" as a collection of people enclosed by a circle given the tendency to perceive elements enclosed by a line as a single unit. The semantic attributes principle encompasses the features <increment>, <anthropomorphism>, <possible outcomes>, and <examples> which convey underlying meanings or metaphorical representations. The <examples> feature may be particularly relevant for depicting types of items (e.g. dog, cat, horse, etc.) within a category (e.g. animal). The cartoon conventions principle includes the visual features <emotion>, <motion>, <physical phenomena>, <speech balloons>, <embodied experience>, <cartoon metaphors>, and <arrows> which pertain to the use of simplified imagery from cartoon culture. For example, the <cartoon metaphor> of a 'heart' may be used to depict the concept "love." The compositional distinctions principle includes the visual features <symmetry>, <asymmetry>, <repetition>, <singularity>, <juxtaposition> and <exaggeration> which pertain to the graphic layout and arrangement of visual elements within an image. Thus a comparative concept such as "biggest" may be illustrated using <juxtaposition> of two or more items.

Fuller and Lloyd (1987) also argue that visual elements such as area, length, and number of lines, aid symbol comprehension and use. Horn (1998) grouped these elements within a principle called line interpretations that includes the visual features <horizontal lines>, <vertical line>, <active lines>, <converging line> and <diverging lines>. For example, the <active lines> feature may be used to convey movement in verbs such as "to fly" or to convey abstract concepts such as "busy."

Procedures

Drawing Procedures. Subsequent to receiving informed consent, an instructional letter was mailed to participating artists. Each artist received a list of 25 concepts and was instructed to "draw one picture for each of the words." The artists were not given any guidelines upon which to base their drawings, and were allowed to use any type of media. While some artists used electronic media to create their drawings, most used pen or pencil on paper. To avoid imposing the experimenters' biases on the artists, there were no explicit directions in terms of drawing size, level of detail, level of abstraction, etc. Additionally, artists were not provided with any information about the target population. They were merely asked to depict each concept as they understood it. For concepts that had multiple meanings, artists were free to decide which meaning to illustrate. Once they had completed all 25 illustrations, they were asked to return them via mail.

Table 2
Glossary of Visual Principles and Corresponding Visual Features with Definitions and Exemplar Illustrations

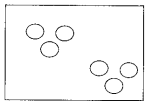
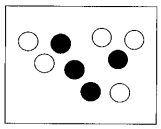
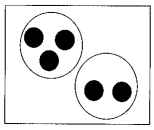
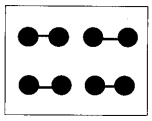
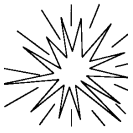
Principle	Visual Feature	Definitions	Exemplars
Gestalt	Proximity	Tendency to group elements which are closest to each other.	
	Similarity	Tendency to group elements which appear similar in size, shape, color, or darkness.	
	Common region	Tendency to perceive elements enclosed by a line as a unit.	
	Connectedness	Tendency to perceive points, lines or region as a single unit.	
Semantic Attributes	Increment	Showing progression from lowest to highest.	
	Anthropomorphism	Representing an inanimate object as human.	
	Possible outcomes	Depicting a consequence of an event or action.	
	Examples	Using token exemplars to define a conceptual category.	
Cartoon Conventions	Emotion expression	Use of facial expressions to depict human emotion.	
	Motion	Use of lines to indicate mode, direction, or intensity of movement.	
	Physical phenomena	Use of simple drawings to capture natural or physical phenomena.	

Table 2
Glossary of Visual Principles and Corresponding Visual Features with Definitions and Exemplar Illustrations (continued)

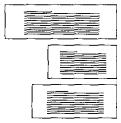
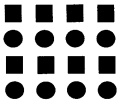
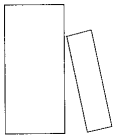
Principle	Visual Feature	Definitions	Exemplars
Cartoon Conventions (continued)	Speech balloons	Using speech balloon content, size, and form to convey emotions or ideas.	
	Embodied experience	Using the whole body or body parts for expression.	
	Cartoon metaphors	Visual expressions of metaphors used in spoken language.	
	Arrows	Use of arrows to represent direction, flow, transformation, force, or time.	
Compositional Distinctions	Symmetry	Depicting equivalence among parts of the image.	
	Asymmetry	Depicting a lack of symmetry among visual elements.	
	Repetition	Repeating all or part of an image.	
	Singularity	Depicting a unique element such that it stands alone.	
	Juxtaposition	Depicting contrast through adjacent placement of visual elements.	
	Exaggeration	Using size, shape, or color for emphasis.	

Table 2
Glossary of Visual Principles and Corresponding Visual Features with Definitions and Exemplar Illustrations (continued)

Principle	Visual Feature	Definitions	Exemplars
Line Interpretation	Horizontal lines	Use of lines extending in a horizontal plane.	
	Vertical lines	Use of lines extending in a vertical plane.	
	Active lines	Use of lines that have quick changes of direction, sharp angles, or forceful curvilinear movements.	
	Converging lines	Use of lines that meet at a point.	
	Diverging lines	Use of lines that split into different directions.	

Coding Procedures. Drawings from each artist were scanned and resized to 2" x 2" illustrations. Once all the illustrations were collected, an array of the seven artists' drawings and the representative PCS symbol was compiled for each concept. The drawings were analyzed by two raters (the first and third authors) according to a set of 30 visual features and principles outlined by Horn (1998) and Fuller and Lloyd (1991). Both coders were certified speech language pathologists. Given the subjectivity of the task, prior to analysis, the coders jointly established a reference glossary that defined each visual principle and the corresponding visual features. To ensure that both coders agreed on the interpretation of each visual feature, a representative illustration supplemented the definitions (see Table 2).

Each coder independently analyzed all illustrations using a master checklist of potential visual features. For each illustration, the coders marked whether a given visual feature was present using a binary scale (0 = not present; 1 = present). Given the breadth and diversity of the visual features studied, coders could refer to the reference glossary when making their judgments.

Measures

Post-coding, the ratings of both coders were analyzed on a concept by concept basis. Ratings of the artists' drawings were analyzed separately from the ratings for PCS. Initial inter-rater agreement was 77.9% across all concepts within PCS and the artists' depictions. Inter-rater discrepancies were most noteworthy for the following abstract concepts: "hard," "none," "pet," "pain," "pretty," "that," and "want." Specifically, the visual feature <examples> (i.e., using token exemplars to define a conceptual category) was interpreted by one coder as requiring the depiction of multiple tokens within a concept

while the other coder believed only a single exemplar was required. Within the compositional distinctions principle, coders were not always in agreement on the presence of the visual features <asymmetry>, <singularity>, and <juxtaposition>. Subsequent to agreeing upon the interpretation of the discrepant visual features (i.e. examples, asymmetry, singularity and juxtaposition), inter-rater agreement improved to 89.6% across all concepts within PCS and the artists' depictions.

In order to quantify similarities across artists, a visual feature was considered to be commonly used for a given concept if both coders indicated that it was present in 4 or more artists' drawings. Similarly, a visual feature was considered to be present in PCS drawings if both coders rated it as such. These operational definitions provided an initial metric of analysis for an inherently subjective task.

Results

The set of commonly used visual features for each concept rendered in PCS and depicted by the artists are presented in Tables 3 and 4, respectively. In the interest of brevity these results are not reiterated here. Instead, we describe general trends in the visual features used in PCS and by the artists. Additionally, we present the results in terms of common visual features shared across concepts with similar semantic functions in PCS and the artists' drawings.

Commonly Used Features Within Each Visual Principle

All four visual features within the gestalt principle were commonly used within PCS as well as in the artists' renditions. Moreover, these features were common across artists' and PCS renditions for a similar set of concepts. For example, both artist groups used gestalt features to depict the concepts, "all," "animals," "friend," "pet," "in," and "more."

Both the artists and PCS drawings used features within the semantic attributes principle with similar frequency. Only the <anthropomorphism> feature (i.e., representing an inanimate object as human) was not used in the 25 concepts depicted. This finding may be an artifact of the relatively finite set of concepts depicted herein.

PCS renditions were most noteworthy for their use of visual features from the cartoon conventions principle. In particular, the <arrows>, <emotion expression>, and <embodied experience> features were used with far greater frequency in PCS versus the artists' drawings. Both the artists and PCS, however, used all visual features within this principle except <speech balloons>.

There was little agreement among artists' drawings and within PCS in terms of the necessary features within the line interpretations principle. Interestingly, both artists and PCS depicted the concepts "pain" and "talk" using the same visual features within this principle.

With the exception of the <exaggeration> feature, all other visual features within the compositional distinctions principle were commonly used to convey meaning in the artists' drawings and in PCS. Artists and PCS used compositional distinctions to depict a similar set of concepts. In particular, "again," "all," "better," "friend," "he," "more," and "thing" were depicted using features within this principle.

In terms of iconicity, the majority of PCS and artists' renditions were found to be either <transparent> or <translucent>. The artists' renditions, however, were more varied in

Table 3
Visual Features Used to Depict the 25 Studied Concepts in Picture Communication Symbols

Concept Depicted	Visual Principles					
	Gestalt	Semantic Attributes	Cartoon Convention	Line Interpretation	Compositional Distinctions	Iconicity
Again			Arrows		Symmetry, Repetition	Translucent
All	Similarity, Common region, Proximity				Repetition	
Animals	Proximity	Examples			Juxtaposition	Transparent
Better		Increment	Arrows, Emotion expression		Asymmetry, Juxtaposition	
Eat			Embodied experience			Transparent
Feelings	Similarity	Examples	Emotion expression		Juxtaposition	Transparent
Friend	Connectedness		Emotion expression		Symmetry, Repetition	Transparent
Give		Possible outcomes	Arrows, Embodied experience, Motion		Asymmetry	Transparent
Hard			Cartoon metaphors			
He			Arrows, Embodied experience		Singularity	Transparent
In	Common region		Arrows			Transparent
Like			Emotion expression			Translucent
Maybe			Arrows, Cartoon metaphors, Motion		Repetition	Translucent
More	Proximity, Similarity	Increment	Arrows		Asymmetry, Juxtaposition	Transparent
None	Common region					Translucent
Pain		Possible outcomes	Embodied experience	Diverging lines		

Table 3
Visual Features Used to Depict the 25 Studied Concepts in Picture Communication Symbols (continued)

Concept Depicted	Visual Principles					
	Gestalt	Semantic Attributes	Cartoon Convention	Line Interpretation	Compositional Distinctions	Iconicity
Pet	Connectedness					Transparent
Pretty			Embodied experience			Translucent
She			Arrows, Embodied experience		Singularity	Transparent
Talk		Possible outcomes	Physical phenomena, Embodied experience, Cartoon metaphors	Active lines		Transparent
That			Arrows			Translucent
Thing					Singularity	
This			Arrows			
Want		Possible outcomes	Cartoon metaphors			
Yes			Emotion expression, Cartoon metaphors			Translucent

terms of iconicity. While some artists used a particular iconicity level (i.e. <transparent>, <translucent>, or <opaque>) for all concepts, others adapted the iconicity level to reflect the concept's abstractness.

Common Visual Features Across Semantically Related Concepts

In this section, we present the results in terms of the visual features shared across semantically related concepts. Rather than grouping concepts by grammatical roles, we focus on semantic relationships in order to explore whether certain visual features are associated with the underlying meaning of concepts. However, since artists were only provided with a list of words, several concepts were interpreted differently across artists. For example, "like" was depicted by some artists as a term of affection, and by others as a comparison as in alike. Similarly, "hard" was interpreted by some artists as difficult and by others as a description of material characteristics as in the hard surface. Furthermore, given the finite set of concepts depicted herein, not all concepts fell into semantically related groups. Moreover, since many concepts could play several semantic roles, the groupings presented below may not be exhaustive.

Concepts conveying animate agents such as "he" and "she" were depicted using the <embodied experience> (i.e., representations that include the whole body or body parts) and <singularity> (i.e. the use of a unique visual element to indicate that it stands alone) features in the artists' drawings and in PCS (Figure 1). Additionally, in PCS, these concepts were also depicted using <arrows> as pointers. In contrast, for the inanimate

Table 4
Visual Features Used to Depict the 25 Studied Concepts in the Artists' Renditions

Concept Depicted	Visual Principles					
	Gestalt	Semantic Attributes	Cartoon Conventions	Line Interpretation	Compositional Distinctions	Iconicity
Again			Arrows		Symmetry, Repetition	
All	Similarity, Proximity				Repetition	
Animals	Proximity	Examples			Juxtaposition	Transparent
Better					Asymmetry, Juxtaposition	
Eat			Embodied experience			
Feelings	Similarity	Examples	Emotion expression		Juxtaposition	
Friend	Similarity, connectedness				Symmetry, Repetition	
Give			Motion			
Hard						Opaque
He			Embodied experience		Singularity	Transparent
In	Common region		Arrows			Transparent
Like	Similarity				Symmetry	Translucent
Maybe			Cartoon metaphors			
More	Similarity	Increment			Asymmetry, Juxtaposition	Translucent
None			Cartoon metaphors			Translucent
Pain		Possible outcomes	Embodied experience, Cartoon metaphors	Diverging lines		

Table 4
Visual Features Used to Depict the 25 Studied Concepts in the Artists' Renditions (continued)

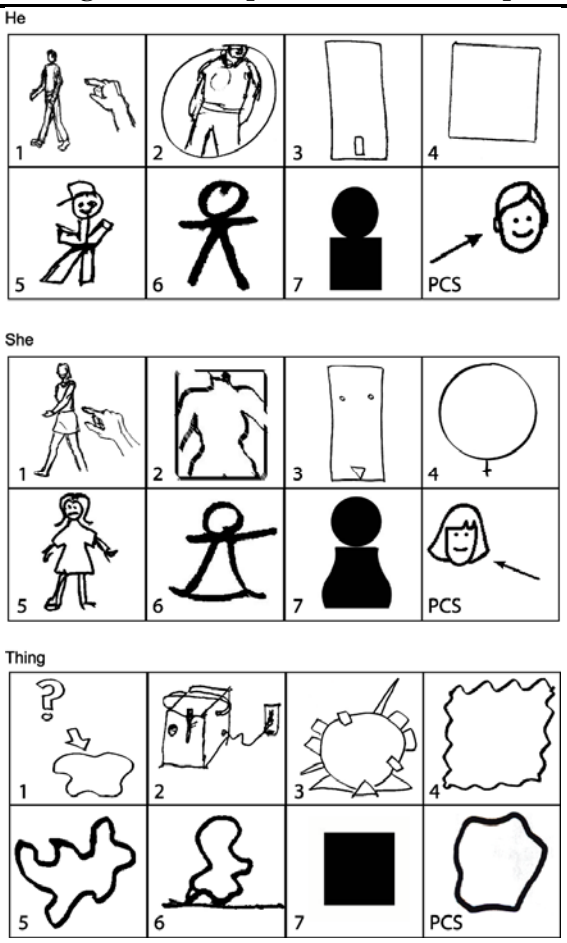
Concept Depicted	Visual Principles					
	Gestalt	Semantic Attributes	Cartoon Conventions	Line Interpretation	Compositional Distinctions	Iconicity
Pet	Connectedness					
Pretty			Emotion expression			
She			Embodied experience		Singularity	Transparent
Talk		Possible outcomes	Physical phenomena, Cartoon metaphors	Active lines		Transparent
That			Arrows		Juxtaposition	
Thing					Singularity	
This			Arrows		Juxtaposition	
Want			Cartoon metaphors		Juxtaposition	
Yes			Cartoon metaphors			Translucent

agent "thing," only the <singularity> feature was common among the PCS and the artists' illustrations.

Relationship concepts such as "friend" and "pet" were conveyed using the <connectedness> feature in the artists' and PCS renditions (Figure 2). Both groups of artists also used compositional distinctions of <symmetry> and <repetition> to convey the concept "friend." It should be noted that "pet" was depicted as both an action and a noun in PCS and by one artist.

In PCS, action concepts such as "eat," "talk," and "give" were all conveyed using the <embodied experience> feature. Additional cartoon conventions were also used to illustrate these concepts in PCS. The artists' renditions used a variety of cartoon convention features which did not overlap across concepts. Both PCS and the artists' drawings used the same visual features to convey these concepts. For example, "talk" was illustrated using <active lines>, "give" was depicted using <motion>, and "eat" was illustrated using the <embodied experience> feature. PCS and artists' drawings, used cartoon metaphors to depict concepts such as "maybe" and "yes" which convey level of certainty and <arrows> to depict concepts such as "this" and "that" which are used to show or point out something directly (Figure 3). The artists also used <juxtaposition> (i.e., conveying differences among element through

Figure 1. Agents were conveyed using the <singularity> feature which casts the visual focus on a single element within the drawing. © 2007, Rupal Patel. Used with permission.



adjacent placement) to contrast the meaning of these concepts.

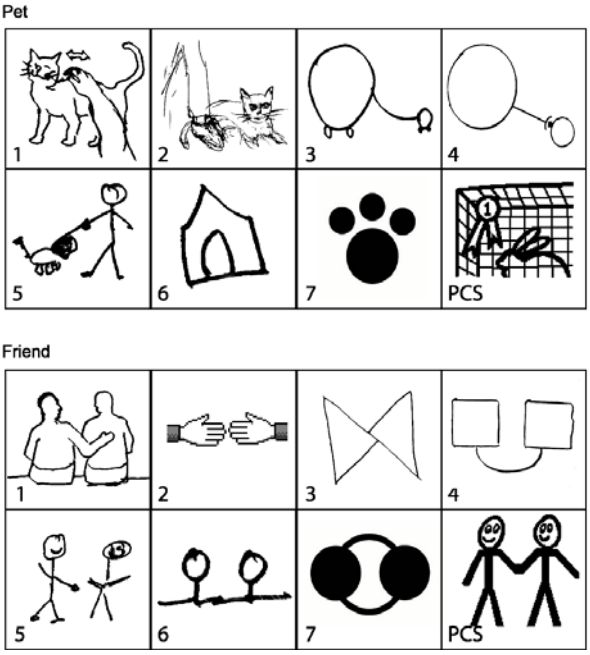
The artists and PCS conveyed comparisons such as "better" and "more" using compositional distinctions of <asymmetry> and <juxtaposition> (Figure 4). Additionally, <arrows> and <increment> (i.e., depicting progression) features were used to convey these concepts in PCS.

Artists and PCS used similar features to convey categorical concepts (see Figure 5). For example, the superordinate classes "animals" and "feelings" were depicted using the <examples> and <juxtaposition> features by both artist groups. Gestalt features such as <proximity> and <similarity> were also used to depict these category concepts.

Discussion

To date, the study of graphic representations in AAC has focused on categorizing symbols along the iconicity continuum (cf. Fuller & Lloyd, 1987, 1991; Soto et al., 1996). The present study sought to provide initial insights for identifying a broader set of visual features for the analysis of graphic representations. The results suggest that it may also be fruitful to analyze graphic representations in terms of visual features within the gestalt, semantic attributes, cartoon conventions and compositional distinctions principles in order to understand which features are necessary for depicting the meaning of concepts. Although line interpretations may also be useful for conveying abstract concepts (Fuller & Lloyd), these features were only commonly used

Figure 2. The <connectedness> feature was used to convey relationships. © 2007, Rupal Patel. Used with permission.



across artists and in PCS for illustrating the concepts "talk" and "pain" in the present study. This finding may be due in part to the limited size and breadth of concepts depicted.

Compared to all other visual features, PCS relied most heavily on cartoon conventions.

Figure 3. Deictic (pointer) concepts were conveyed using <arrows>.© 2007, Rupal Patel. Used with permission.

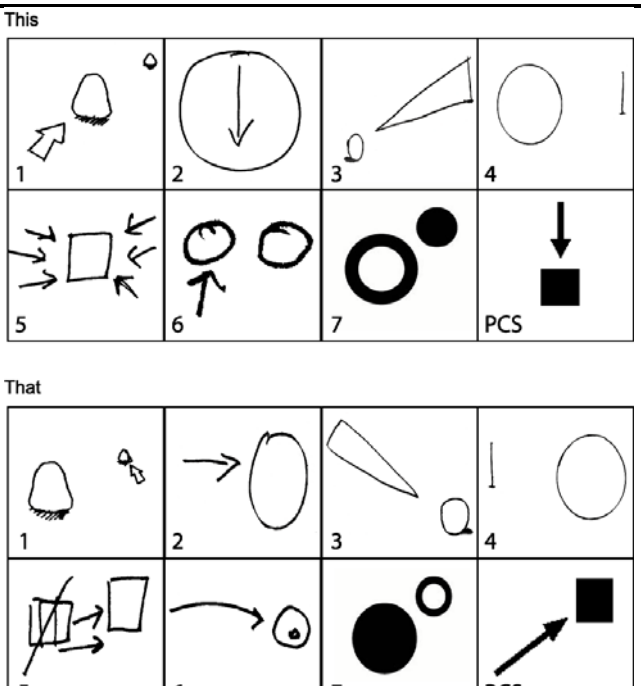
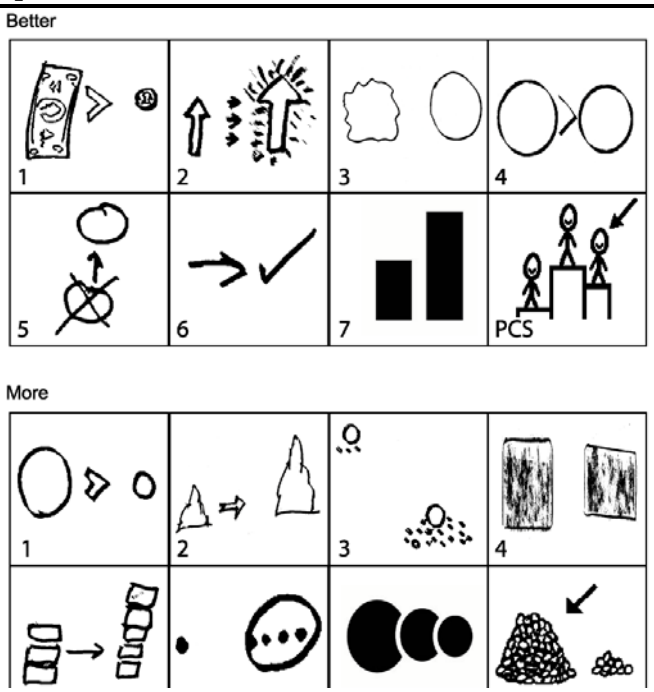


Figure 4. Comparisons were depicted using <asymmetry> and <juxtaposition> features. © 2007, Rupal Patel. Used with permission.



While these conventions may be appropriate for some users of AAC, they may not be obvious to older users or to those from other cultures. [See Huer (2000) for an analysis of differences in interpretations of graphic symbols across cultures.] The use of additional visual features may address a broader range of ages and cultures. Given that Wierzbicka (1996, 1997) identified a set of core semantic primitives that extend across cultures, perhaps a set of visual primitives may also exist for symbol communication. It is possible that these features may be combined to create a novel symbol system appropriate for a diverse group of individuals who use AAC.

With respect to iconicity, PCS and the artists' depictions differed along two main themes. First, artists differed among one another in the degree of iconicity used to depict concepts. Second, PCS were biased toward one end of the iconicity spectrum, namely <transparent> and <translucent>, for all 25 concepts studied. In contrast, the artists tended to use a broader range of the iconicity spectrum (i.e. they also used <opaque> representations). Tying iconicity to a given symbol set may limit the ability to adequately represent the range of concepts from concrete to abstract. Instead, if iconicity were an index of abstractness, users may have additional cues for deciphering the underlying meaning of the concept being depicted.

The visual profiles of a small set of concepts, namely, "again," "animals," "feelings," "pet," "eat," "in," and "thing," were identical across the artists' and PCS renditions. For all other concepts, different patterns of visual features were noted in the artists' and PCS drawings.

An examination of the results in terms of semantic relations revealed patterns in the visual profiles of related versus unrelated concepts. Concepts that differed in meaning also differed in visual profiles. For example, the set of visual features used to convey "better," "eat," and "this" were distinct from one another. On the other hand, semantically related concepts shared common visual features. For example, relationship concepts

such as "pet" and "friend" were conveyed using the <connectedness> feature.

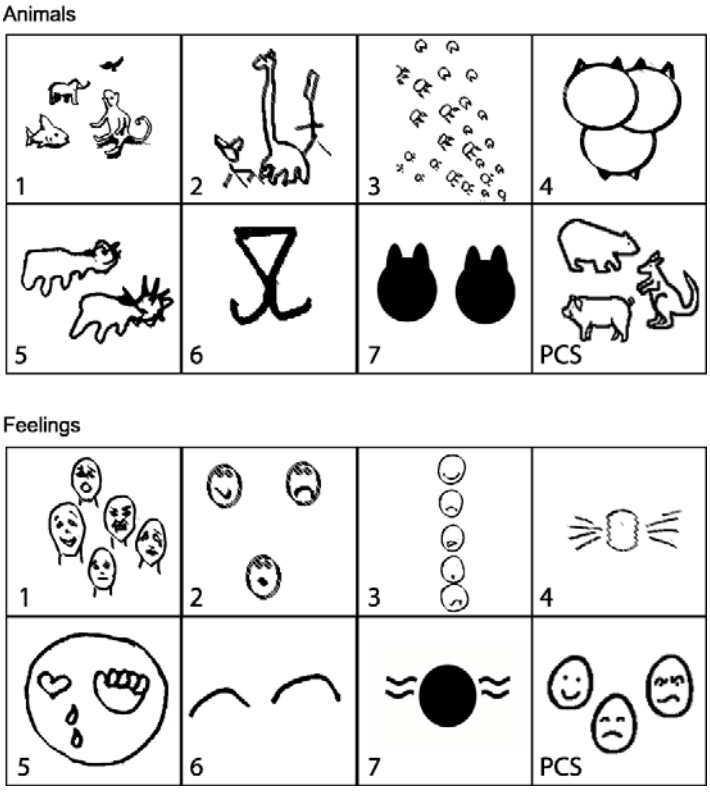
In terms of taxonomic concepts, Schlosser (1997a, b) has noted that existing AAC symbol sets lack visuo-graphic links between representations. The categories "animals" and "feelings" were depicted using the <examples>, <juxtaposition>, and either <similarity> or <proximity> features in PCS and by the artists. Thus gestalt and compositional distinction principles appear to be helpful for visually portraying relationships between elements of a taxonomic category.

In summary, the findings of this preliminary investigation suggest that PCS and artists' renditions included a broad range of visual features to convey conceptual semantics. Further inquiry into the extent to which particular features are used to convey individual concepts or groups of similar concepts is warranted. This additional information would be critical for studying how meaning is conveyed in existing symbols as well as for developing new symbols.

Outcomes and Benefits

The present study sought to identify a broad set of visual features for convey meaning in AAC symbols. To extend beyond iconicity, visual features within five visual principles as defined by Horn (1998) were used to analyze the illustrations of seven artists and PCS. A total of 20 visual features within the gestalt, semantic attributes, cartoon conventions, and compositional distinctions principles were commonly used across concepts. While the visual profile of the PCS and artists' renditions were identical for a small set of concrete concepts, the two groups differed in the features used to depict a majority of concepts. PCS renditions relied on cartoon conventions. In contrast, a broader range of features were present within the artists'

Figure 5. Category concepts were illustrated using the <examples> and <juxtaposition> features. © 2007, Rupal Patel. Used with permission.



renditions. The two groups also differed in the degree of iconicity across concepts. While the artists' depictions spanned the iconicity continuum, PCS renditions tended to be either <transparent> or <translucent>. Despite differences among artists' and PCS depictions of individual concepts, common visual patterns were noted among both groups for conveying related versus unrelated concepts. These findings suggest that a broader set of visual features may be useful for analyzing how meaning is conveyed in existing symbol sets and for developing novel symbol systems.

While this initial investigation provides interesting insights into a broad set of visual features that may be useful for studying graphic representations, it also evokes many open questions that require further inquiry. Furthermore, the results must be interpreted with caution in that the set of concepts depicted was limited. A larger set of conceptual items are required to generalize these findings. Providing artists with definitions of each concept would reduce the confounding effects of different word senses. Methodological changes in subsequent investigations should consider the homogeneity of artists with regard to training, cultural backgrounds, and level of experience. In addition, informing artists about the target population's needs and abilities may yield findings that are more relevant to users of AAC. With regard to the set of visual features and principles studied and the coding scheme, this investigation was a first step in extending visual analysis of AAC graphic representations beyond iconicity and complexity. Some visual features proved difficult to interpret and thus a more detailed glossary of feature descriptions may be necessary to improve rater agreement. Future work may also benefit from focusing on the subset of visual features that were reliably and commonly used in the present study.

In terms of implications of this work, additional research is required to assess whether individuals who use AAC and their communication partners may benefit from graphic representations that utilize a broad spectrum of visual features and whether these elements help in decoding the semantic content. The study of age and culture specific differences in interpreting graphic representations may also be fruitful.

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