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Semantic Transparency and Translucency in Compound Blissymbols

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Blissymbolics is a graphic symbol system used for communication by individuals whose speech is nonfunctional. The transparency and translucency of Blissymbolics have been viewed in the context of the visual relationship between symbols and their referents. This article suggests a new perspective in the study of Blissymbolic transparency and translucency that is semantic conceptual. At present, only compound symbols are discussed. Semantic transparency/translucency is conceived in this article as representing the relationship between the composite meaning of symbol components and the symbol referent. This relationship is measured by guessability, and by subject rating of degree of agreement between the composite meaning of symbol components and the symbol referent. We hypothesized that semantic transparency/translucency is affected by referent prototypicality or uniqueness, and by the interpretation of thematic relationships of symbol components. In the present study, we investigated the effect of referent prototypicality. An experiment administered to nondisabled adult subjects demonstrated the contribution of referent prototypicality to semantic transparency/translucency. Implications for Blissymbol codability are discussed.

KEY WORDS: aided symbols, Blissymbols, conceptual representation, iconicity, prototypicality, representativeness, semantic translucency, semantic transparency, translucency, transparency

Blissymbolics is a graphic symbol system used for communication by individuals whose speech is nonfunctional, and who are unable or prefer not to use written words for communication. These individuals usually use a board and/or an electronic aid on which Blissymbols or other symbols are displayed. In order to communicate via the board, they point or use other methods to indicate the target symbol. Each symbol stands for a word or words similar in meaning (e.g., one symbol stands for "to make" and "to produce"). The written words always appear above the symbols, so that the message can be understood by addressees who do not know Blissymbols. With an electronic aid, when indicating the symbol, a prerecorded auditory message is heard. Blissymbolics is also currently used on the Internet.

The inventor of Blissymbolics was Charles Bliss, whose purpose was to enhance world unity through a universal symbol system (Bliss, 1965). It was adapted to the nonspeaking community in the 1970s (McDonald, 1980; McNaughton, 1985). A comprehensive description of Blissymbolics can be found in McNaughton (1985) and McDonald (1980). The most recent English written dictionary including Blissymbols is by Wood, Storr, and Reich (1992). The source of symbols in the present work is the *Hebrew Dictionary of Blissymbols* (Shalit, Wine, & Yaniv, 1992). This dictionary is based on the English written dictionary of Blissymbols (Hehner, 1980), plus additional symbols developed at the International Blissymbol Panel Workshops held in Jerusalem, Israel, in August 1989, which were later approved by the International Blissymbol Committee.

Blissymbolics is nonphonetic and meaning based. Some examples are presented in Figure 1. As can be seen, some symbols consist of one element and some of several elements. The basic elements in Blissymbolics can be combined to form an infinite number of new Blissymbols. For example, the symbol "architect" consists of "person" + "plan" + "house." The symbol "dress" consists of "clothing" + "woman." This generative quality of the system enables it to represent abstract concepts that cannot be adequately represented in pictures (pictographs). Symbols that consist of more than one element are called compound symbols.

The meaning of some symbols is very obvious, and can easily be guessed in the absence of their referents.

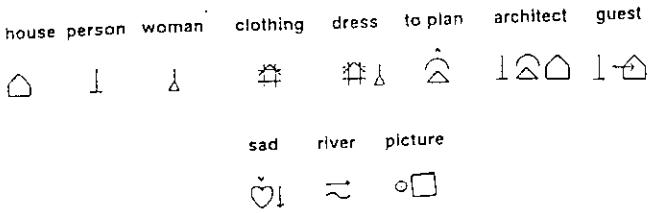

Figure 1. Examples of Blissymbols.

These symbols are regarded as transparent (Fuller & Stratton, 1991). For other symbols, the meaning is not obvious, but once the referent is provided, the relationship between symbol and referent can be perceived. These symbols are regarded as translucent. Finally, symbols for which no relationship between symbol and referent can be perceived, even when the meaning of the symbol is known, are termed opaque. Transparency has been operationally defined as "guessability": the symbol referent can be guessed in the absence of the referent. Translucency has been operationally defined by subject ratings of degree of agreement between symbol and referent, as measured on a scale of 7 points, from low (1 point) to high (7 points) (Fuller & Stratton, 1991). Yovetich (1986) and Yovetich and Young (1988) prefer to use the term "representativeness" rather than translucency, within the framework of dual coding theory (Paivio, 1986).

Blissymbolics' research has viewed transparency and translucency as representing iconicity, which is the visual agreement of similarity in appearance between symbols and their referents. Fuller and Lloyd (1991) present a survey showing the association of the terms "transparency/translucency" with iconicity in the literature of manual signs and Blissymbolics (see their Table 1, p. 216). Iconicity is defined as referring "...to the visual relationship of a symbol to its referent" (Fuller & Lloyd, 1991, p. 216), or "the perceived relationship between a symbol and its referent" (Fuller & Stratton, 1991, pp. 51–52). Similar definitions for iconicity in signs and gestures appear in Mandell (1977, pp. 57–58) and Armstrong, Stokoe, and Wilcox (1995, p.191). Blissymbol representativeness, a term suggested by Yovetich (1986) and Yovetich and Young (1988) instead of the term Blissymbol translucency, was also conceived of as a visual relationship. It was defined by Yovetich (1986) as the degree to which a symbol is perceived as representing its concept or word referent.

We claim that this approach, focusing solely on the visual relationship, is too narrow. We suggest investigating, in addition to iconicity, the semantic relationship between symbols and their referents. Two types of transparency/translucency should be distinguished: one visual (representing iconicity) and the other semantic. We define semantic transparency/translucency as representing the relationship of agreement between two meanings: the composite meaning of symbol components and the meaning of the symbol referent. For example, the degree of agreement between the components "house" + "fabric" and its referent "tent," or between "insect" + "wings" and its referent "fly," is the degree of semantic transparency/translucency of the symbols "tent" and "fly," respectively. (The symbols are shown in Appendix A.) We use the terms "transparency" and "translucency" jointly (transparency/translucency) whenever we focus on their identical function as representing degrees of agreement, either iconic or semantic. When we distinguish between the different measurements of guessability versus ratings of agreement, we use separately either the term "transparency" or the term "translucency," respectively.

Our perspective in the present study is that Blissymbolics transparency/translucency research has almost exclusively focused on visual transparency/translucency, or on representativeness, which is visual as well, ignoring semantic transparency/translucency. Studies that have investigated conditions of providing subjects with information about the meaning of symbol components, and their effect on transparency/translucency (Shalit, 1991) or on learnability (e.g. Hetzroni, 1995; Schlosser & Lloyd, 1993; Shepherd & Haaf, 1995), were not concerned with semantic transparency/translucency in the sense that we define it. The difference between these studies and our present research will presently be explained. Our point is that semantic transparency/translucency, as defined in the present article, has been ignored in the relevant literature.

Overlooking semantic transparency/translucency has led to theoretical flaws in understanding Blissymbol representational aspects, and has also affected clinical implementations. Ignoring semantic translucency leads current research in Blissymbolics to provide inadequate explanations for some translucency phenomena. First, among the symbols rated high in translucency by the scales in Fuller and Stratton (1991) (e.g., Lloyd, Karlan, & Nail, 1990), there are a few abstract symbols, such as "sad" (see Fig. 1). If translucency were based solely on visual agreement between symbol and referent (iconicity), how would it be possible to establish such a relationship with abstract concepts, which are by definition not visual? Second, it is impossible to explain differences in degrees of translucency based on visual factors only; for example, how does one explain the difference between "river," rated high in translucency, and "picture," which is rated low (see Fig. 1)? Is there something more visual about the symbol "river" compared to the symbol "picture"?

Ignoring semantic transparency/translucency also means ignoring a basic construct within the system of Blissymbolics, which, in turn, could affect learnability. It has been strongly established that transparency/translucency has a powerful facilitative effect on guessability, recall, and learnability of Blissymbols (see review in Fuller & Stratton, 1991). It is, therefore,

important to investigate the distinct contributions of visual as well as semantic transparency/translucency to learnability. Semantic transparency/translucency affects symbol informativeness and guessability, which are potent factors in learnability; these factors are involved whenever a learner is supposed to determine the symbol referent based on the meaning of symbol components. This process is common to all phases of learning; it emanates from the very nature of Blissymbolics as a generative system.

At present, our goal is to hypothesize a variable that we call semantic transparency/translucency, define it operationally, suggest some preliminary parameters affecting it, and demonstrate it empirically. The present work is restricted to compound symbols only. In the following section, we introduce the theoretical framework, divided into three subsections: what semantic transparency/translucency is; the difference between semantic transparency/translucency and other aspects of semantic component processing in Blissymbolics; and factors affecting semantic transparency/translucency. In the second section, we present experimental evidence supporting our hypothesis.

THEORETICAL FRAMEWORK

What Is Semantic Transparency/Translucency?

The extent of semantic agreement between the composite meaning of components and the meaning of the target referent varies in different symbols. If we take guessability as an operational measurement of semantic agreement, it is clear that given the components "room" + "sleep," subjects will easily guess that the symbol represents a bedroom, but given "insect" + "wings," the components of the symbol "fly," subjects are more likely to guess that it represents a butterfly rather than a fly. Given "water" + "upwards," the components of the symbol "vapor," subjects may guess that it represents a fountain; given "enclosure" + "light," the components of the symbol "camera," subjects will certainly not be able to guess its meaning.

Similarly, we hypothesize that subject ratings of degree of semantic agreement between symbol referents and the composite meaning of symbol components will show a similar pattern. The degree of agreement between "room" + "sleep" and "bedroom" is expected to be rated very high. The degree of agreement between "water" + "upwards" and "vapor" is expected to be rated lower, while the degree of agreement between "enclosure" + "light" and "camera" is expected to be rated low.

These examples demonstrate that only in some cases does the composite meaning of symbol components fully agree with their target referents (e.g., "room" + "sleep" --> "bedroom," "animal" + "hump" --> "camel." For other symbol components, their meaning only partially agrees with their target referent (i.e., it represents several referents in addition to the target referent): "clothing" + "woman," which represents a dress, might equally represent a bra, panty hose, or a skirt; "building" + "teach," which stands for a school, might as well stand for a university. However, in spite of this partial agreement, we assume that subjects tend to prefer and correctly guess the target referents ("dress" and "school") in these examples. Other cases of partial agreement appear to involve a higher degree of arbitrariness and are less guessable. For example, there is no reason to prefer a fly to a butterfly as the referent of "insect" + "wings," or to prefer "vapor" to "fountain" as the referent of "water" + "upwards." There are a few extreme cases, like "enclosure" + "light" representing "camera," in which the semantic agreement between symbol components and the target referent appears to be very low when presented with no additional information.

It is true that these symbols have rationales behind the selection of their components, which are explicated in Hehner (1980) and Wood et al. (1992). However, we are investigating the implicit meaning generated from compositions of bare semantic components, as conceived by subjects who are not provided with rationales. Through understanding the processing of bare symbols, we can clarify how much additional information, and what type of information is needed, in order to make symbol meanings explicit when teaching them. This is in line with iconicity research, which has usually concentrated on bare symbols.

The range of semantic agreement between the composite meaning of symbol components and their referents will be referred to henceforth as semantic transparency/translucency, and we will distinguish it from visual transparency/translucency. Visual transparency/translucency is based on iconicity of symbol components (i.e., visual resemblance of the symbol to its target referent), whereas semantic transparency/translucency is based on the components' semantic-conceptual features. We operationally define semantic transparency as semantic guessability: the ability to guess the target referent when given the meaning of symbol components. Semantic translucency is operationally defined as subject ratings of the degree of semantic agreement between the meaning of symbol components and the referent. Parallel to the partial overlap between visual transparency and translucency (Fuller & Lloyd, 1991), we assume a partial overlap between semantic transparency and translucency.

Our claim is that visual transparency/translucency is an important factor in processing Blissymbols but is not the sole factor; it acts in tandem with semantic transparency/translucency. These two aspects of transparency/translucency—the visual and semantic—are disassociated: a symbol may be rated high on one scale and low on the other. For example, according to the translucency scale of Lloyd et al., presented in Fuller and Stratton (1991), "dress" (see Fig. 1) is rated as a low translucency symbol, presumably

because of its low visual resemblance to its referent. Yet given the semantic components "clothing" + "woman," it is easy to guess that it represents a dress (i.e., its semantic transparency is high). The weight of semantic transparency/translucency compared to visual transparency/translucency in symbol processing needs to be investigated in future research.

Our approach is that a model of transparency/translucency, both visual and semantic, needs to be explanatory. It must explain why a symbol is high or low in translucency and not merely provide statistical and correlational data.

In an experimental setting that aims at isolating semantic transparency/translucency from visual transparency/translucency, it is mandatory to avoid presentation of the visual symbol when investigating semantic transparency/translucency as iconicity might otherwise interfere in judgments.

The present study concentrates on semantic transparency/translucency in compound symbols, which quantitatively encompass a large percentage of the total number of Blissymbols. In our gross estimate, based on some samples, compound Blissymbols seem to account for at least 60% of all Blissymbols. (There are some questions as to the definition of a compound symbol that we will not discuss in this paper.) In any case, the factor of semantic transparency/translucency, as defined above, concerns a large body of symbols.

Difference between Semantic Transparency/Translucency and Other Aspects of Semantic Component Processing in Blissymbolics

Some previous studies have investigated the processing of semantic components of Blissymbols (e.g., Hetzroni, 1995; Schlosser & Lloyd, 1993; Shalit, 1991; Shepherd & Haaf, 1995). These studies have demonstrated that informing subjects about the meaning of symbols' components facilitates some aspects of learnability.

However, these studies were not concerned with semantic transparency/translucency as we conceive of it. Shalit (1991) conducted two relevant experiments on compound symbols, one on guessability (transparency) and the other on degree of representativeness (translucency). Each experiment included two conditions. Under the first condition, in each experiment, subjects were not informed of the meaning of each symbol component while guessing the target referents or rating the degree of representativeness of symbols. Under the second condition, subjects were informed of the meaning of each symbol component while performing the above-mentioned tasks. It was found that knowledge of the meaning of components caused a significant increase in ratings of transparency and translucency. However, it is important to note that the transparency and translucency results in this study involved iconicity, since subjects were presented with the visual signs. More importantly, there was diversity among symbols in the degree of increase in ratings of translucency and transparency. Some target referents were not guessed by many subjects, in spite of their being informed of component meanings, and some ratings of degree of representativeness did not change. This diversity is the focus of the present study; we claim that it reflects the diversity in semantic transparency and translucency, which was not investigated by Shalit (1991).

Providing semantic information about symbol components, as Shalit did, is a necessary but insufficient condition for high values of semantic transparency/translucency. In order for a symbol to have a high transparency/translucency value, its components must not only be known to the subject, but also must meet the demand for agreement between the meaning of components and referent. Hence, providing information about components (extraconceptual condition) is a preliminary stage for accessing the inner conceptual semantic relationships represented by the symbol. Thus, Shalit's work focused on a different aspect of semantic transparency/translucency than the present study.

Shepherd and Haaf (1995) found that subjects learned Blissymbols more quickly when the meaning of symbol elements was included in training than when training did not include symbol elements. Based on Shalit (1991), we may explain this effect as the result of increasing the symbol's overall transparency/translucency. Similarly to Shalit, Shepherd and Haaf's concern lies in the effect of manipulating subjects' knowledge about symbol components. This issue differs from semantic transparency/translucency as defined in the present article.

Schlosser and Lloyd (1993) and Hetzroni (1995) compared learnability of compound Blissymbols under two conditions of informing subjects about the meaning of symbol components. One condition consisted of teaching symbol components prior to teaching the compounds containing those components. The other condition consisted of teaching symbol components concurrent with the teaching of compounds that contained them. Hetzroni also compared active versus passive learning of symbol components under each condition. The effect of these conditions on recall of the previously taught compound symbols, and on novel compound symbols comprising the previously taught elements, was investigated. Thus, Schlosser and Lloyd and Hetzroni compared conditions of providing information about the meaning of symbol components. However, semantic transparency/translucency, as defined in the present paper as an intrinsic semantic relationship between components and referent, was not an issue in these works. Trans-

parency/translucency, in the conventional (iconic) sense, was also not taken into consideration in Schlosser and Lloyd's (1993) and in Hetzroni's (1995) studies.

We are interested in investigating degrees of semantic transparency/translucency; in other words, we are interested in semantic transparency/translucency as a measurable continuum. The previous studies that pointed to the effect of informing subjects about semantic components (Schlosser & Lloyd, 1993; Shalit, 1991; Shepherd & Haaf, 1995) were not concerned with degrees of semantic informativeness.

Finally, a comparison can be drawn between our claim for the existence of semantic transparency/translucency and Yovetich's claim for verbal relationships in Blissymbol processing. Similarly to our claim, Yovetich (1986) and Yovetich and Young (1988) distinguish between the visual and nonvisual aspects of Blissymbol processing. Their verbal referential relationship might have been interpreted as semantic. However, the essential difference between Yovetich's and our approach is that Yovetich assigns referential connections to compound Blissymbols as conglomerates, with no consideration of componential meaning, whereas we discuss referential connections constructed out of each Blissymbol component.

Factors Affecting Semantic Transparency/Translucency

The present study addresses one of the factors speculated as affecting semantic transparency/translucency, namely, prototypicality of referent. Our hypothesis is that prototypicality of referent increases the symbol's semantic transparency/translucency. Prototypicality of referent plays a role when the composite meaning of symbol components encompasses several referents. In that case, the referent that is most prototypical (i.e., a representative, typical, good example of its category) (Rosch, 1975) is being guessed and rated as highly related to the symbol. If this referent happens to be the actual referent, which we will name the "target referent," then the symbol is high in transparency/translucency. For example, the components "clothing" + "woman," which mean "woman's clothing," represent several items, like "dress," "skirt," "bra," and "panty hose." We assume that "dress" is the most prototypical (representative) item of women's clothing; hence, we hypothesize a tendency to guess "dress" in response to the stimulus "clothing" + "woman."

Prototypicality was originally investigated in categories such as "birds" and "furniture" (Rosch, 1973, 1975). Members of these categories were graded on a continuum of category representativeness, or on how good an exemplar they were of their categories. The good examples were called prototypes. For instance, in the category "birds," robin was found to be a good example, but not ostrich.[1] The effect of prototypicality has also been found in categories referred to as conceptual combinations (Osherson & Smith, 1981; Zadeh, 1965); (e.g., the category "pet fish," in which "guppy" is a prototypical member). This is relevant for compound Blissymbols, which can be viewed as conceptual combinations (e.g., "woman's clothing" [the symbol for dress] and "a person who protects" [the symbol for policeman]).[2]

Although we are focusing on the factor of prototypicality, there are additional factors that affect semantic transparency/translucency. One of these factors is relatively straightforward and somewhat trivial, namely, uniqueness of referent. We assume that uniqueness of referent contributes to semantic transparency/translucency. Uniqueness of referent occurs when symbol components include a distinctive feature of the referent. For example, a hump is a distinctive feature of a camel; hence, we assume that people easily guess that "animal" + "hump" represents a camel. In the present research, due to technical limitations, we will not treat the assumption of referent uniqueness as a research hypothesis; however, some observations regarding uniqueness will be made.

Another factor affecting semantic transparency/translucency is thematic interpretation. Thematic roles are the functions that arguments fill, such as agent, recipient, location, etc. (Fillmore, 1968). For instance, in "person" + "protection," the symbol of policeman, "person," is the agent rather than the recipient of the act of protecting. Most Blissymbols contain isolated component combinations, which lack explicit thematic relationships; hence, processing these Blissymbols might cause an ambiguous thematic interpretation. For example, the combination "person" + "protection" may be interpreted as either a person who receives protection, or a person who provides protection. In "chair" + "water," the water can either surround the chair or be inside it. In "material" + "glass," the material may either be contained in the glass, or the glass may be made of it. This thematic ambiguity is assumed to reduce symbol transparency/translucency when bare symbols, with no explicit thematic interpretation, are presented to subjects. When teaching

[1]The arguments in the cognitive research regarding the status of prototypicality theory for concept and category construction, in comparison to other suggested theories (e.g., Murphy & Medin, 1986), are not relevant to our discussion; in spite of the differences, there is a general agreement about the existence of a prototypicality effect and about its influence on some aspects of conceptual processing. Our discussion is restricted to the relationship between prototypicality and Blissymbolic semantic transparency/translucency.

[2]In the present study, we are not concerned with comparing the status of an exemplar in conjunction to its status in each constituent of the conjunction (e.g., the status of "guppy" in the category "pet fish" compared to its status in the categories "pet" and "fish"), which is a main issue in conceptual combination research (Osherson & Smith, 1981; Zadeh, 1965). We are looking at the status of exemplars in conjunctions only.

Blissymbols, an explicit thematic interpretation is provided to the learners, following Hehner (1980) and Wood et al. (1992), in order to eliminate thematic ambiguities.

Thematic ambiguity should be avoided in an experimental setting that attempts to isolate different factors affecting semantic transparency/translucency. In the present study, we attempt to explore the effect of prototypicality; hence, the possible effects of thematic ambiguity should be avoided. For example, when investigating the effect of prototypicality of "policeman" in the category "a person who protects" ("person" + "protection"), we have to correlate the degree of prototypicality with measurements of guessability and rating of agreement. We must ensure that all of the data from all measurements correspond to the category "a person who protects" and not to "a person who receives protection," since these categories are distinct and yield different prototypes. If the experimenter does not clarify to which of these categories subjects should relate, responses may be inconsistent. In a guessability experiment, subject A may guess "refugee" as the referent of "person" + "protection," referring to the category "a person who receives protection," while subjects B and C may guess "bodyguard" and "policeman," respectively, referring to the category "a person who protects." Both "bodyguard" and "refugee" reduce the degree of guessability of "policeman." However, the factors affecting this reduction are different: "refugee" stems from the ambiguity of thematic interpretation, which creates two categories, while "bodyguard" and "policeman" are speculated to derive from varied conceptions about prototypicality status among items within the same category. A correlation between the guessability and prototypicality of "policeman" may be influenced by answers such as "refugee." Since some of the answers may be derived from two different categories, the correlation is not informative for our purpose. To summarize, when the effect of prototypicality is being investigated, thematic ambiguity may contaminate the results by creating inconsistencies within and between measurements.

We avoid thematic ambiguities by presenting phrases with explicit thematic relations between components. These phrases are similar but not identical to the phrases given by Hehner (1980) and Wood et al. (1992). The reason we generated our own phrases is that Hehner's and Wood et al.'s phrases are generous in the amount of additional information. This is appropriate for instructional purposes but, for the purpose of our experiment, stimuli need to be as close as possible to the bare semantic components of symbols. The phrases in the present study were created with three guidelines: (1) they included all of the words denoted by the symbol components; (2) words that were not denoted by symbol components were added with an attempt to minimize their number; (3) we attempted to preserve the order of the symbol components in the phrase; word order in Hebrew enables adhering to word order of the symbol components. These guidelines aim at achieving the highest possible agreement of the experimental stimulus phrases with Blissymbol structure while keeping the phrases comprehensible and thematically unambiguous.

For example, the symbol "gym," which includes "room" + "activity" + "healthy," was phrased by Hehner (p. 122) and Wood et al. (pp. 1–65) as "a room for activity that keeps one healthy." We avoided the extra words "keeps one" by presenting the phrase "a room for healthy activity." Since in Hebrew the noun ("activity") precedes the adjective ("healthy"), word order in the Hebrew phrase adheres to the order of symbol components. Another example is "nut," "seed" + "tree," phrased by Wood et al. as "edible seed from a tree" (pp. 1–97), with the word "edible" added. In the present study, it was phrased as "a seed that comes from a tree."

Thematic ambiguity does not occur in every component combination. In "room" + "sleep," "insect" + "wings," "water" + "upwards," or "food" + "flower," the thematic relationships are obvious. However, all of the stimuli in our experiment were presented in a uniform manner as phrases with explicit thematic relations.

Future research will have to take thematic interpretation into consideration and investigate it as a factor affecting semantic transparency/translucency. The stimuli that should be presented to subjects in future experiments measuring semantic transparency/translucency should be written words, without visual graphic symbols and without thematic relationships: [component] + [component] + [component], for example: "person" + "protection" (for policeman).

Such an experiment, exploring the processing of bare symbols, will clarify the conditions under which additional thematic information is needed, and what kind of additional information is needed for each symbol.

EXPERIMENT

The experiment was designed to examine the assumption that prototypicality affects semantic transparency/translucency. Through investigating the correlation among the three measurements of prototypicality, guessability, and rating of agreement, the association among these constructs can be demonstrated. Three questionnaires were administered in order to measure (1) guessability of symbol referents, (2) degree of agreement between referents and symbol components, and (3) prototypicality. Our hypothesis was that a high correlation would be found between prototypicality and guessability and between prototypicality and rating of agreement.

METHOD

Subjects

Subjects were nondisabled, aged 21 to 50 (mean age = 35). In the guessability section, there were 40

subjects (mean age = 34; range 24–50), 37 women and 3 men. In the agreement rating section, there were 42 subjects (mean age = 38; range 21–50), 37 women and 7 men. In the prototypicality questionnaire, there were 32 subjects (mean age = 39; range 25–48), 24 women and 8 men. Subjects were volunteers who had either a university or teaching-school degree or were in the process of studying toward one. All were unacquainted with Blissymbols. The division into groups was arbitrary.

Stimuli

Thirty-three compound Blissymbols were selected from the *Hebrew Dictionary of Blissymbols* (Shalit et al., 1992). Thirty-one, which were ultimately analyzed, are shown in Appendix A; two were deleted, as will be explained later. The selection of Blissymbols was based on the criterion that they represent concrete concepts. This selection was done in order to begin our research on the simplest concepts to avoid issues concerning abstract concepts at the present. The concepts included natural, artificial, and nominal concepts, as defined by Keil (1989), but there was no control of this aspect. The concepts are represented by basic level nouns, rather than superordinate or subordinate level nouns, as defined by Rosch, Mervis, Gray, Johnson, and Boyes-Braem (1976).

Each symbol was verbally represented in the form of a written phrase (Table 1). Each phrase comprised words denoting the symbol components (e.g., "water going upwards" for the symbol "vapor," "a person who protects" for the symbol "policeman") in order to preclude ambiguities in thematic processing, as explained above. The stimuli were in Hebrew and, due to word order in Hebrew, the words denoting symbol components appeared in the phrases in the same order as they appear in the Blissymbols. This order could not always be maintained in the English translation of the phrases (see Table 1). The actual visual, graphic symbols, was not presented to the subjects to prevent interference of visual representation in the semantic task, and thus to enable isolation of the semantic processing.

Table 1 includes 31 of the original 33 concepts and phrases; two concepts were deleted after being rated by subjects, due to the authors' erroneous thematic interpretation provided for these two concepts. The phrases in the guessability and agreement rating questionnaires were divided into two groups to shorten the task by reducing the number of stimuli for each subject. Each subject was presented with 16 or 17 phrases (instead of the original 33). The prototypicality questionnaire included only 30 phrases; when following the analysis of the guessability results in stage 2, 3 of the 33 original phrases were found to represent unique referents (see Data Analysis section below). For these three symbols, the question of prototypical referent became irrelevant, since a prototypical referent can be selected only among other items that are members in the same category. When there is only one member in a category, prototypicality becomes irrelevant. The order of stimulus presentation in the questionnaires was randomized.

Procedure

In order to shorten the task for each subject, we divided the guessability and agreement rating questionnaires into two questionnaires, each read by a different group of subjects. In the guessability questionnaire, the two groups included 20 subjects each; in the agreement rating questionnaire, we had two groups of 21 subjects each.

All of the questionnaires were presented in written form, and subjects were asked to write down their answers. The instructions for the guessability questionnaire were given orally, either to a single subject or to a few subjects in a group. The instructions for the agreement rating and prototypicality questionnaires were written on the forms, including two examples for each questionnaire. These questionnaires were either handed or mailed to subjects to be completed on their own free time. Each questionnaire took about 10 to 15 minutes to complete. Appendix B contains the complete instructions.

In the guessability questionnaire, subjects were asked to guess the target referent of each phrase (stage 1), and then to try and think of other possible referents (stage 2). In the agreement rating questionnaire, subjects were presented with the target referents, each attached to its phrase, and were asked to rate the degree to which each phrase matched its referent on a 7-point scale. In the prototypicality questionnaire, each of the target items was presented as a member of its category (e.g., "policeman" in the category "people who protect," "goose" in the category "big water birds"). The subjects were asked to rate the degree of prototypicality of the items on a scale of 1 to 5 points.

Data Analysis

Four values were assigned to the concepts: guessability, agreement rating, uniqueness (to three concepts only), and prototypicality (to the remaining 28 concepts). These are presented in Table 1.

Each symbol was assigned its guessability value, corresponding with the number of subjects who correctly guessed it. The highest possible guessability value for each phrase was 20 (the number of subjects in each guessability group). A correct guess was counted if the target referent was written in the first stage. Referent uniqueness was assumed when subjects either all suggested only one referent for the phrase, or suggested additional referents, which are not in the target category according to our criteria. For instance, one of the suggestions for "grain grow-

TABLE 1: Target Referents, Phrases, and Values of Mean Prototypicality, Mean Agreement Rating, and Guessability for Each Target Referent

	Referents	Phrases Representing Symbols	Prototypicality—5 points (N = 34)		Agreement Rating—7 points (N = 42)		Guessability—20 points (N = 20)
1	Citizen	A *person* related to the *earth*	1.71	(0.84)	1.6	(0.42)	0
2	Nut	A *seed* that comes from the *tree*	2.5	(1.36)	2.57	(1.54)	0
3	Cast	A medical enclosure on the body (*enclosure medical body*)	3.18	(0.75)	2.14	(1.14)	1
4	Fastener	An *object* to *fasten cloths*	3.22	(0.86)	4.45	(1.97)	0
5	Honey	*Food* that comes from *flowers*	3.28	(1.04)	3.26	(1.65)	13
6	Factory	A *building to make* things	3.4	(1.22)	3.23	(1.92)	13
7	Toilet	A *chair* with *water*	3.41	(1.56)	2.35	(1.72)	12
8	Monster	A strange creature (*creature strange*)	3.41	(1.32)	4.07	(1.52)	4
9	Fireplace	An open fire (*fire open*)	3.43	(1.22)	4.23	(1.85)	0
10	University	A *building* for the *exchange* of *knowledge*	3.5	(1.14)	4.3	(1.74)	9
11	Policeman	A *person* who *protects*	3.53	(0.99)	4.14	(1.26)	8
12	Goose	A big water bird (*bird water big*)	3.73	(0.91)	5.69	(1.35)	1
13	Guest	A *person* who *visits* at *home*	3.87	(1.13)	6.23	(0.97)	16
14	Vapor	*Water* going *upwards*	3.93	(1.3)	4.04	(1.84)	7
15	Haman taschen*	A *cookie* related to an *ear*	3.93	(1.56)	4.54	(2.16)	18
16	Elephant	An *animal* with a (prominent) *nose*	4.09	(1.2)	4.19	(1.81)	11
17	Glass (material)	The *material glasses* are made of	4.31	(1.14)	5.14	(1.71)	17
18	Glue	A *chemical substance* that *adheres* things	4.34	(0.89)	5.45	(1.34)	10
19	Hamster	A rodent pet (*animal teeth pet*)	4.4	(0.79)	6.04	(1.26)	13
20	Fly	An *insect* with *wings*	4.34	(0.83)	4.95	(1.70)	10
21	Duck	A water bird (*bird water*)	4.5	(0.83)	5.85	(1.37)	9
22	Gym	A *room* for healthy activity (*activity healthy*)	4.59	(0.78)	4.88	(1.56)	18
23	Concert hall	A *room* for *music*	4.62	(0.6)	5.38	(1.52)	6
24	Yarmulka (kippa)	A Jewish hat (*hat jew*)	4.62	(0.78)	5.4	(1.09)	15
25	Architect	A *person* who *designs buildings*	4.84	(0.36)	6.8	(0.54)	17
26	Cemetery	The *place* of a *grave*	4.87	(0.54)	5.26	(1.65)	18
27	Dress	Woman's clothing (*clothing woman*)	4.87	(0.04)	6.1	(1.14)	15
28	Bedroom	A *room* for *sleeping*	4.87	(0.00)	6.61	(0.67)	20
29	Rice	*Grain* that grows in *water*	Unique		5.61	(1.78)	11
30	Tent	A *house* made of *fabric*	Unique		5.95	(1.18)	19
31	Challah	*Bread* for *Sabbath*	Unique		6.59	(0.78)	20

Standard deviations are in parentheses.
The phrases are translated from Hebrew. Words denoting symbol components in their Bliss and Hebrew order are in italics.
*"Haman taschen" is a cookie that symbolizes Haman's ears, in Jewish tradition.

ing in water," the phrase representing "rice," was "beans," which does not belong in the category "grain." Hence, "rice" was regarded as a unique referent of this phrase.

Three concepts were found to be unique referents in their categories: "rice" in the category "grain growing in water," "tent" in the category "a house made of fabric," and "challah" in the category "bread for Sabbath." Subjects suggested more than one possible referent for the great majority of items: "sleep laboratory" and "hotel room" in addition to "bedroom" for "a room for sleeping"; "house contractor" in addition to "architect" for "a person who designs houses," etc.

A value for agreement rating was calculated for each of the 31 items presented in the agreement rating questionnaire. The value of agreement rating is the mean value across subjects, ranging from 1 (low) to 7 (high).

A prototypicality value was calculated for each of the 28 items presented in the prototypicality questionnaire. The mean prototypicality value across subjects was calculated, ranging from 1 (low) to 5 (high).

After obtaining the values described above for each symbol, a Pearson product-moment correlation was calculated between guessability, agreement rating, and prototypicality.

Results

The mean guessability value for the total sample of symbols was 10.64 (range 0–20; SD = 6.86). The mean value of agreement rating was 4.73 (range 1–7; SD = 1.46). The mean prototypicality value was 3.89 (range 1–5; SD = 0.84).

Reliability was measured through the standard deviation for each item in the prototypicality and rating of agreement scales. In the prototypicality (5 points) scale, 92% of the items have standard deviations of 1.4 or below. In the agreement rating (7 points) scale, 93% of the items have standard deviations of 2 or below. These data indicate that stability across responses provided for each item was adequate.

The Pearson product-moment correlation between rating of agreement and prototypicality was 0.84 (r^2 = 0.71; $p < .001$) (Fig. 2); the correlation between guessability and prototypicality was 0.70 ($r^2 = 0.49$; $p < .001$) (Fig. 3); the correlation between guessability and rating of agreement was 0.54 ($r^2 = 0.29$; $p < .005$).

All three unique concepts were rated as high or very high in rating of agreement: "rice" 5.61, "tent" 5.61, and "challah" 6.59 (of a possible 7 points). Two of the three were rated very high in guessability: "tent" 18 and "challah" 20 (of a possible 20). "Rice" received a guessability value of 11, which is still above the mean. However, only 16 of the 20 subjects suggested any referent for the phrase "grain growing in water." This is a low rate compared to the other phrases. Some subjects commented, after the experiment ended, that they had not known that rice grew in water. Hence, the

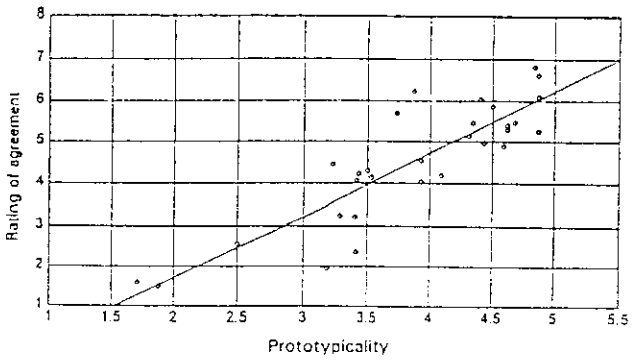

Figure 2. Correlation between prototypicality and rating of agreement.

reason for the relatively low guessability value of "rice" may lie in world knowledge. However, our very small number of unique referents should make us cautious in interpreting these results.

DISCUSSION

The high correlations obtained between prototypicality and rating of semantic agreement (.84) and prototypicality and guessability (.70) seem to support our theoretical assumption that semantic transparency and translucency are strongly related to prototypicality of the target referent, as a member in the semantic category created by symbol components. When the target referent is a prototypical member of the category created by symbol components, it has a good chance of being guessed when the meaning of symbol components is provided (high transparency); it has a very high chance to be rated as matching its semantic components when both target referent and the meaning of symbol components are provided (high translucency).

We do not claim that the values obtained for guessability and agreement rating are the values of semantic transparency and translucency since, in our experiment, we added explicit thematic relationships to the original symbol components. However, we assume the values obtained in this study to be close approximations of semantic transparency and translucency.

In our experiment, most symbols scoring high on guessability and rating of agreement also had high prototypicality values. Prototypicality seems to be the principle that enables subjects to guess the target referents from among other possible referents. Assuming that Blissymbolics is a code that strives toward clarity of message, prototypicality contributes to this end by enabling identification of the target referent.

However, in the interest of clarity, one might claim that it would be even better to have a unique referent for each symbol. A unique referent would enable a totally unambiguous message. In other words, it would increase referent accuracy. Indeed, one of our assumptions is that unique referents increase seman-

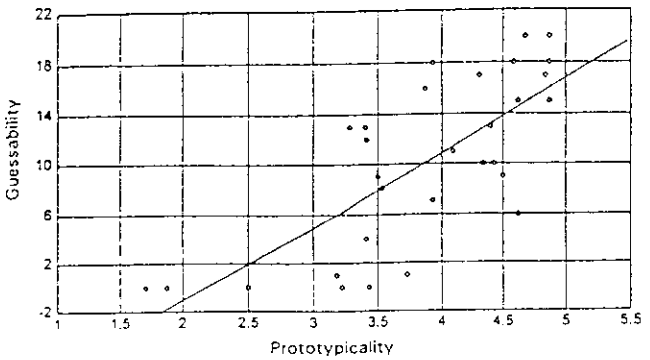

Figure 3. Correlation between prototypicality and guessability.

tic transparency/translucency. If so, why does Blissymbolics choose to rely (in at least some cases) on prototypicality, rather than on referent uniqueness?

The answer is that prototypicality enables economizing the number of symbol components (i.e., achieving symbol compactness), while unique referencing requires multicomponent symbols. The reason for this is that in order to establish a unique referent, the meaning of symbol components must be highly informative and accurate. A high degree of informativeness and accuracy can be achieved through specifying all of the relevant semantic components. However, most compound Blissymbols representing nouns comprise two to three components. This appears to often be insufficient in meeting the demand for accuracy. For many of these symbols, the first component represents a taxonomic category, while the second and third components represent specific features of the referent. One or two features alone are not always sufficient for accurate identification of a referent, yet adding more components could result in a cumbersome symbol. It appears that Blissymbolics tends to avoid cumbersome, multicomponent symbols, sacrificing referential accuracy for symbol compactness. Interestingly, in spite of forfeiting referential accuracy via uniqueness, symbols can still be semantically transparent/translucent, due to prototypicality.

This quality of certain Blissymbols is clearly revealed when they are compared to dictionary definitions. Like compound Blissymbols, dictionary definitions usually begin with a taxonomic category and then provide specific features of the referent. However, they tend to specify more features of the referents than Blissymbols do. For instance, the dictionary definition for "dress," taken from *Webster's Ninth New Collegiate Dictionary* (1984), is "an outer garment (as for a woman or girl) usu. consisting of a one-piece bodice and skirt." The Blissymbol for "dress" consists of the components "clothing" (garment) + "woman," which are a part of the dictionary definition. This example clearly demonstrates that the dictionary definition aims at higher informativeness and referential accuracy, as compared to the Blissymbol. It is clear that, in this case at least, the dictionary definition represents one and only one referent: a dress. As for the Blissymbol, other referents besides dress are possible (panty hose, bra, skirt, etc.). Hence, Blissymbolics does not always strive for referent uniqueness when the cost of uniqueness involves forfeiting compactness.

It is in this light that we now refer to the writing of Charles Bliss, the inventor of Blissymbolics. In his book *Semantography* (Bliss, 1965, p. 10), he mentioned, as one of his goals, developing a writing system that contains simple semantics and logic. Our discussion reveals that "semantic simplicity" is not a simple concept; it contains, in this context, two aspects that may be in conflict, namely, compactness and referential accuracy. This conflict is solved when relying on high prototypicality.

In addition to the prototypical and the unique referencing symbols, our experiment included symbols neither highly prototypical nor uniquely referencing, and which rated low in guessability/rating of agreement. We have not yet attempted to examine whether our sample is representative of the total body of Blissymbolics.

Finally, Epel (personal communication) has commented that frequency of words, not controlled for in the present study, might have influenced our measurements. Let us comment in response that we believe the selection of symbol components, rather than the frequency of referents, is the crucial factor. Thus, had the symbol for "fastener" contained the components "metal" + "part" + "belt" (the metal part of the belt), instead of "object" + "fasten" + "cloths," and the symbol for "citizen" contained "person" + "country," instead of "person" + "earth," it seems obvious that the values of all three measurements would have risen sharply. In this case, the fact that "fastener" and "citizen" are low-frequency words does not affect the relevant measurements.

To summarize, our research provides preliminary data regarding the nature of semantic transparency and translucency and offers explanations for these phenomena by investigating factors affecting them. Our work provides data about guessability and rating of semantic agreement, which are strongly related to recall and learnability. Semantic transparency/translucency, as presented in our study, is clearly distinct from iconicity (visual transparency/translucency); all of the experimental tasks involved processing written words, with no visual graphic symbols. Semantic transparency/translucency is also distinct from states of knowledge of semantic components; knowledge of the semantic components has been shown to be insufficient for obtaining high values of semantic transparency/translucency. Semantic transparency/translucency is an inner conceptual relationship between the meaning of the target referent and the composite meaning of symbol components. It is affected by referent prototypicality or uniqueness and

by thematic interpretation. The reliance of semantic transparency/translucency of some Blissymbols on prototypicality structures, rather than on referential accuracy, enables symbol compactness.

We believe that the question of semantic representation in Blissymbolics has importance beyond the specific symbol system of Blissymbolics, offering implications for the domain investigated in cognitive science of semantic-conceptual organization/representation. This study also has implications for manual sign languages, in which transparency/translucency has been investigated in other contexts (see survey in Fuller & Lloyd, 1991).

CLINICAL IMPLICATIONS

Our research has clinical implications both for the construction of new symbols and for the teaching of Blissymbolics. In constructing new symbols, it is important to be aware of the different and sometimes conflicting demands for economy (compactness), iconicity, and semantic transparency/translucency. One should be aware of the fact that high semantic transparency/translucency may be achieved by using prototypicality rather than referent accuracy. This may also guide us in changing some existing symbols. It should be taken into account that prototypicality is culture dependent, and some symbols that include prototypes of one culture are not appropriate for other cultures (A. Shalit, O. Hetzroni, personal communications). A good example for this is the symbol "policeman," which includes the components "person" + "protection." Israeli-born subjects usually guessed "soldier" as the referent of "a person who protects," while people who came from other countries tended to guess "policeman." This corresponds with the common Israeli conception of the army as a defence force.

In teaching Blissymbols, it is necessary to take into consideration the semantic ability of the learner and to examine whether the symbol is semantically transparent/translucent for him/her, or whether the symbol can become transparent/translucent after being explained. Different symbols require different quantitative and qualitative information in order to support the learner's understanding their rationales.

Suggestions for Future Research

It is necessary to investigate what proportion of Blissymbols rely on prototypicality, rather than on unique referencing or nonprototypical referencing. Semantic transparency/translucency needs to be studied without providing explicit thematic relationships, since real Blissymbols do not contain components representing thematic relations. The difference between the two conditions (i.e., providing thematic relations versus eliminating them) may reveal the contribution of thematic interpretation to different Blissymbols, and demonstrate the quantitative and qualitative thematic information that is required in teaching different symbols. Investigation should be made into the contribution of semantic transparency/translucency to processing actual graphic symbols; what is the relative weight of semantic transparency/translucency compared to visual transparency/translucency in Blissymbol processing? We believe that semantic translucency/transparency is relevant for simple (single element) symbols as well and should be investigated. The questions concerning Blissymbolics' semantic transparency/translucency need to be investigated according to different referent dimensions, such as abstractness of referents, natural versus artificial referents, and different parts of speech. Semantic transparency/translucency should be studied among different populations: children of different ages, developmentally delayed populations, adult aphasics, etc. Finally, since manual sign languages include compound signs, it is recommended that the semantic structures of these signs should also be investigated.

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APPENDIX A

List of Blissymbols

1. citizen
2. nuts
3. cast
4. fastener
5. honey
6. factory
7. toilet
8. monster
9. fireplace
10. university
11. policeman
12. goose
13. guest
14. vapor
15. haman taschen
16. elephant
17. glass (material)
18. glue
19. hamster
20. fly
21. duck
22. gym
23. concert hall
24. yarmulka (kippa)
25. architect
26. cemetery
27. dress
28. bedroom
29. rice
30. tent
31. challah