Richly Grounding Symbols in ASL*

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It was once common to regard ASL as less than a full-fledged language, as a mere combination of miming, pointing and a few primitive gestures. That conception of ASL was laid to rest by William Stokoe's landmark work [22] and much careful research that has come in its wake. This work has emphasized the similarities between ASL and spoken natural languages. The present essay argues that, nevertheless, we should not lose sight of an important respect in which ASL differs from spoken languages. Because in ASL meanings are associated with signs rather than sounds, there are more possibilities in ASL for what we call Richly Grounding Symbols or RGSs—symbols whose meanings have a cognitively natural link to the symbol. One can appreciate the wide use of such symbols in ASL without falling back into the picture of ASL as less than a language.

There is a natural tendency in human communication to use richly grounding symbols whenever the medium and techniques of communication make this possible. In face to face communication, gestures, diagrams on blackboards and a host of other familiar devices are used to supplement the thin medium of speech. As fast as computer technology allows, icons, pull-down menus, windows, and other graphical techniques are used to supplement printed text. The use of such richly grounding symbols is poorly understood, because it has not been studied very much; research on natural language seems often to take a phone conversation between English teachers—full, carefully crafted sentences delivered with no possibility of supplementation by gesture or diagram—as the paradigm of language.

In this essay we make two preliminary contributions to increasing the appreciation of the role of richly grounding symbols in ASL. First we develop some general points about richly grounding symbols. We feel that failure to grasp these points can encourage the view that "real" languages cannot

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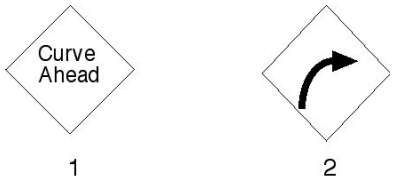
rely on such symbols. Second, we discuss a number of examples of richly grounding symbols, so understood, in ASL.

1 Richly Grounding Symbols

For many purposes, icons are more satisfactory than words. Consider the two road signs below:



1 2

Sign (2) has three distinct advantages over sign (1).

RIM: Sign (2) has what we call readily inferable meaning or RIM. Anyone with a little experience at driving and a certain amount of common sense can be counted on to figure out what it means. In particular, drivers do not need to know English, as is the case with (1).

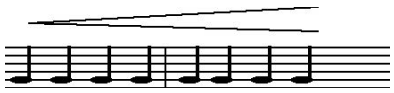
ERM: Sign (2) also has what we call easily remembered meaning or ERM. Even if someone couldn't figure out what (2) means, once they were told, they would find it easy to remember. Since (2) has both RIM and ERM, it is not the best example to use to distinguish them. But in general it is less of a demand on an icon to have easily remembered meaning than it is to have readily inferable meaning. Many of the signs that are used on roads and in cars these days are not that easy to figure out, but once they have been figured out or explained are easy to remember. Similarly, many ideographs have ERM even though they do not have RIM. One case in which the distinction is crucial is Lingraphica, an icon-based language for aphasics [7].

IMM: Sign (2) actually tells us quite a bit more than sign (1). It shows the direction and severity of the curve. To convey everything in words that (2) conveys might require more words than could easily fit on a sign or be read by a speeding motorist. The efficiency of the icon results from a property we call internally modifiable meaning or IMM. When we change the properties of the icon, we change its meaning in

ways that are systematic and predictable. The sharper the curve of the line on the sign, the sharper the curve coming ahead on the road. If the curve on the sign goes to the left, the curve coming ahead on the road will go to the left (assuming the sign is accurate!). In contrast, modifications to sign (1) would require additional words: "Right curve ahead, moderately severe".

Sign (2) is a better road sign than (1) because it is more quickly and easily grasped by a wider group of motorists and because it conveys more information than (1). These virtues all stem from the fact that it uses a richly grounding symbol. By this we mean that a substructure of the symbol's properties has a robust cognitive correspondence with a substructure of the properties of that which it symbolizes. In the case of (2) the line has curvature which has a right or left direction and a degree of sharpness; these properties it shares with the road ahead. Here the cognitively robust correspondence is identity.

Consider, for a contrast, the case of a crescendo marking on a measure of music.



Here the cognitively robust correspondence is more complex than identity. The increase in the spatial gap as one moves from right to left on the score indicates an increase in loudness as one plays through the measure.

Our concept of richly grounding symbols is a generalization of Peirce's concept of an icon. Peirce distinguished sixty-six categories of signs; the most basic distinction was among icons, indexes and symbols. Icons resemble what they signify, indexes are causally or geographically related to what they signify; symbols are conventionally related to what they signify.[1]

The term "resemblance" has an air of simplicity that we feel is misleading. There is certainly a sense in which the curve on the road sign resembles the curvy road it symbolizes. Perhaps there is also a sense in which the crescendo sign resembles the music's increasing loudness. If we asked someone to explain in what the resemblances consisted, however, they would have to adumbrate the correspondences between the substructures of properties that we described above.

[1]For an account of Peirce's distinction, see [4]. For our approach to meaning, see [2] and [18].

Our phrase *robust cognitive correspondence* is chosen to emphasize that whether symbols with a certain substructure of properties are richly grounding symbols for phenomena of a certain sort is a psychological issue of considerable complexity, and not a matter of a direct relation between the two structures of properties. This allows the possibility that differences in context, culture and experience can lead to symbols being richly grounding for one group but not for another.

Consider, for example, the trashcan icon on a Macintosh screen. It stands for the file-folder into which files that are to be erased are put. "Emptying" the trash can means erasing those files. The meaning will be readily inferable and memorable only for those who have seen trashcans resembling the icons and know what trashcans are used for, and who realize that there is an operation of deleting files. It is (barely) conceivable that some day computers will eliminate the use of trashcans for paper (since everything will be online) and intensive recycling will make them unnecessary for any other purpose. One can imagine the Macintosh trashcan living on in a world in which no one who sees it is reminded of a trashcan (except antique collectors). Its meaning will no longer be richly grounded in the symbol.

A symbol can richly ground one of its meanings but not others. The trashcan is again a good example. One can eject a disk from a Macintosh by moving it into the trashcan. That is, moving the disk icon on the computer screen into the trashcan icon is a way of getting one's disk back from the computer. This meaning of the trashcan icon is not richly grounded, and, in fact, conflicts with the richly grounded meaning. It is frightening the first time one ejects a disk this way; the richly grounded meaning is so powerful that one thinks the disk may be erased ("trashed"), and the instruction book may be in error in suggesting that this is a way of getting one's disk back.

2 Arbitrary Conventional Symbols

In contrast to sign (2), we say that the connection between sign (1) and its meaning is due to arbitrary conventions. Most words of spoken languages are arbitrary conventional symbols rather than richly grounding symbols. It is an arbitrary convention of English that "curve" means curve; the same word could have meant "straight" for all that the intrinsic properties of the word have to do with it. The cleverest linguist in the world could not figure out that "curve" meant curve and "straight" meant straight just by thinking of the connections between the properties of the two symbols and

the two meanings. There is nothing, apart from the arbitrary conventions of English, that makes "Curve Ahead" more suitable for indicating that there is a curve ahead than that there is a gas station off to the right.

Note that the contrast we are making is not between richly grounding symbols and conventional symbols. It is between richly grounding and *arbitrary* conventional symbols (ACSs).[2]

We adopt David Lewis's concept of a convention ([15], 42ff.) A convention involves common knowledge in a population about what people do in certain situations, in which everyone is better off if everyone does the same thing. Suppose Elwood and Ernie meet each week at the Student Union, and then decide where to go for lunch. The Student Union is a large rambling place with several entrances. All would be reasonable places to meet. Clearly Elwood and Ernie are better off if they do the same thing—go to the same place. So they agree to meet at the East Entrance. This may be an explicit agreement, or just a regularity in practice that develops and that they both rely on. The East Entrance is a reasonable and natural place to meet, but not more so than the West Entrance. The conventional element comes from the choice between alternatives, not the arbitrariness of the one chosen. Language, according to Lewis, is a system of such conventions on which a linguistic community relies. In spoken languages the symbols we conventionally use are conventional, and also typically have no natural link with their meaning, but only an arbitrary one. These properties are connected, in that it is hard to see how such symbols could be linked to their meanings except by convention. So being an arbitrary symbol may entail being a conventional one. But the entailment does not go the other way. Symbols with natural links to their meanings may still be conventional. Thus, showing that a symbol is conventional does not show that it is not a richly grounding symbol.

The richly grounding symbols that are used in languages, computer interfaces, systems of road signs and the like are usually conventional. In a Macintosh interface, a labelled icon stands for a file, and a window stands for a file folder. The labelled icon being inside a window represents that the file is in the file folder. This is a convention. An alternative, equally grounded solution might be to represent file folders as large open wedges, with arrows into the concavity from files to represent being inside. Macintosh users and programmers mutually believe and expect that the former rather than the latter will be used, and so this symbol is both richly grounding and

[2]Margaret Deuchar [9] explores this type of contrast in connection with "iconicity" in ASL. Her many examples make the distinction very clearly.

conventional.

The arbitrariness of ACSs means that their meanings are more difficult to infer and remember. Typically, as in the case of our road signs, modification involves adding juxtaposed symbols rather than internal modification. Thus, ACSs lack the three properties that make RGSs desirable.

The primary advantages of ACSs is that a system ACSs can be supported by a very "thin" medium of communication, that does not support RGSs. Spoken language is of course the chief case in point. In a spoken language a relatively small number of sounds yields a very large number of possible words. Most of these will not sound like much of anything other than themselves. The properties of and relationships among combinations of sounds do not correspond to the properties of and relationships among other sorts of objects in nearly as cognitively robust a way as do combinations of shapes and gestures.

3 Richly Grounded Modifications

We observed above that a characteristic advantage of RGSs was that their meanings can be internally modified. As the shape of the line on the road sign changes, the type of curve it indicates changes also. The manner of modifying a symbol can be richly grounded, although the modified itself is not. Suppose that someone says

> "Cisely, Alaska is a llllonnng way from New York."

The English term "long" is not a RGS; indeed, it is a rather short word! In this example, this short word was modified by making it longer, and most listeners would easily recognize that the intended meaning was more or less the same as

> "Cisely, Alaska is a very long way from New York."

This is an example of a richly grounded modification of a symbol. It is made possible in this case by the fact that the spoken or written symbol has a property (length) that is directly relevant to its meaning. Even though this property was not exploited in giving the original symbol its meaning, it can be exploited in modifying it.

Something similar is sometimes done by modifying the type size of words like “big” and “small”.

This sort of IMM is necessarily exceptional with spoken languages and written forms whose representational strategy is primarily phonetic. In the latter case, the responsibility for representing the sound of the spoken word usually co-opts the possibilities for exploiting the richer structure of the written sign.

However, written communication not tied to a phonetic structure offers many opportunities for IMM. The written symbol, as a physical object with size and shape and position in the spatial world, has many more properties in common with the concrete spatial objects that occupy most of our discourse. Languages based on the dynamic use of space have, in addition to size, shape, and position, properties of relative location and motion in common with concrete spatial objects. In these languages, opportunities for IMM abound.

4 Richly Grounded Modes of Combination

Imagine someone giving a lecture on marriage. She says there are three types of marriages, and then writes on the board:

`Wife`	`Husband`	`Husband-Wife`
`Husband`	`Wife`	

The audience will probably understand in this context that the relative positions of the words (above, below, at a level) correspond to three power relationships that one finds in a marriage.

Here we have ACSs, combined in ways that are richly grounded.

It is characteristic of language that expressions are combined to form more complex expressions, and especially to create sentences which express thoughts. In the paradigm of logicians and linguists both the symbols and the modes of combination are arbitrary rather than richly grounded. In

fact, not only basic symbols and modifications of them, but also modes of combining different symbols to express thoughts are often richly grounded, relying on robust cognitive correspondences that listeners with a certain amount of wit and common sense can be relied on to comprehend. And, as we saw above in the section on modification, it is not only RGSs, but ACSs that can be combined via these richly grounded modes of combination.

5 Dual-Representation Languages

We use the term *dual-representation language* to refer to languages that combine ACSs and RGSs, each in substantial amounts. A familiar example is Macintosh style graphical user interfaces (GUIs) which convey meaning through a combination of written English (largely ACSs) and graphics intended to have RIM or at least ERM. Such languages are interesting because they reflect an intuition that the RGSs are appealing to users; presumably they clarify communication or speed the rate of human/computer interaction.

Dual-representation languages are playing an increasingly important role in human-computer communication. In addition to the GUIs, there are communication strategies that rely on a combination of keyboard and mouse input, and languages that are combining sound icons with graphics and printed text.

Another example is Lingraphica, an icon-based computer application to aid communication by aphasics. Recent work with global aphasics indicates that languages based on RGSs can be used by individuals who have lost the ability to use standard languages. [7], [21]. This suggests that the difference between RGSs and ACSs maps on to different cognitive abilities and neural structures.

Again, when the focus is on gesture as an integral part of spoken language [5],[16], [24] or with the use of icons, diagrams, and other graphics with text (e.g., [1], [24]), it is useful to think of the resulting combinations as dual-representation languages.

All of these languages are being developed without the benefit of linguistic theory because linguists have concentrated on the arbitrary conventional symbols of spoken languages.

6 ASL as a Dual-Representation Language

On our view ASL is a very successful dual-representation language, from which there is a great deal to be learned about the construction, use and cognitive processing involved in such languages. We want to provide an analysis that characterizes its dual-representational nature. We seek to understand the strategies used in ASL to integrate richly grounding and arbitrary conventional symbols and to apply this understanding to the design of new dual-representation languages as well as to the investigation of theoretical and practical issues in ASL.

We believe that the dual-representational nature of ASL is an important part of the explanation of two striking phenomena. The first of these was described by Bellugi (reported in [12]) and replicated by Grosjean [11]. This is that while the rate of articulation for English words is roughly double the rates for corresponding signs in spontaneous narratives (Bellugi) and in memorized narratives (Grosjean), the rates for corresponding propositions (roughly equivalent to sentences) are the same across both languages. Bellugi attributed this to a common temporal process governing the rate of production of propositions in language and to "ASL's special ways of compacting linguistic information" ([12], 194).

Our hypothesis is that among the special ways of compacting are instances of all the types of RGSs that we have surveyed, and that skilled ASL users use the richly grounded aspects of ASL to increase the the efficiency, rapidity, and clarity of communication. These signers interweave the the two forms of representation so that each is used for the purpose for which it is particularly well suited. A corollary to this hypothesis is that the comparative rates of ASL and English will differ depending on how much use can be made of richly grounded symbols, modification, and modes of combination.

The second of our observations may be more controversial. Since Stokoe's work [22], [23], a great deal of progress has been made by the application of concepts drawn from the linguistics of spoken languages to ASL. Our observation is that this progress has been significantly greater at the level of ASL phonology and morphology than at the level of sentence level syntax and constraints on word-order. For example, Valli and Lucas's [25] Linguistics of American Sign Language contains 108 pages on ASL morphology and only 18 on syntax.

We believe these phenomena are connected. The concepts drawn from the linguistics of spoken language provide less illumination at precisely the point at which an understanding of the importance of RGS to ASL becomes

crucial.[3]

We do not think we are in a position to prove our hypothesis. Our goal here is merely to explain it. First we give examples of each of the types of RGSs in ASL, and then we illustrate with an example how the richly grounded aspects can increase efficiency, rapidity, and clarity.

7 ASL Vocabulary Doesn't Depend on RIM

Because gestures that accompany speech often have RIM, it is perhaps natural for individuals who do not use ASL to assume that it consists mostly of iconic gestures. A considerable amount of work has been directed at showing that this is not so; while many ASL vocabulary words (that is, the citation forms of signs that make up the ASL vocabulary items and typically correspond to single English words) may have had their origins in imitation or miming, there is a natural tendency for the signs to lose RIM [10]. The signs themselves become more stylized; the associations that originally supported a cognitively robust correspondence may disappear as the population changes, and so forth. Ample evidence that the vast majority of ASL vocabulary items do not have RIM has been given by Klima and Bellugi [12], Frishburg [10], Kuschel[13], Battison and Jordan [3], and others. As with ideographs in Chinese and Japanese, signs in ASL may retain a certain amount of ERM, even after they can no longer be regarded as having RIM; this is an issue on which further experimental evidence needs to be gathered. But, to reiterate, it is *not* part of our hypothesis that most ASL vocabulary items have RIM.

It is equally important to emphasize, however, that many of the vocabulary words are internally modifiable in ways that are readily inferable or easily memorable once the meaning of the citation form is known. The translation of the modified forms into English generally requires more than one word, and often requires several. Examples are:

- KISS becomes different kinds of kisses by changing the location and modifying the motion.
- STREET becomes a particular kind of street by modifying the space between the hands and the path of the hands;

[3]We are not the first to argue that the formalisms of the linguistics of spoken languages are not sufficient for ASL. An early proponent was Asa DeMatteo who in his 1977 paper, "Visual Imagery and Visual Analogues in American Sign Language," [8] urged that iconicity be incorporated into the grammar of ASL, not just as part of it, but as the base of it.

- OPERATE and HURT become more specific as to type by changing the location and modifying the motion;
- IMPROVE becomes improve by some amount by changing the point of contact.

8 Richly Grounding Symbols in ASL

We suggest that the following elements of ASL are richly grounding symbols:

- Object classifiers including person, vehicle, four-legged animals, flying objects, stationary objects, runny liquids, etc.
- Size, shape, and handle classifiers.

These elements share properties with the objects they are used to represent that, within the context of a communication strategy, have the potential of conveying meaning which will be readily inferable or easily memorable. For example, the person classifier shares the property people have of being being taller than their width and the vehicle classifier shares properties vehicles have of having front and rear and left and right sides.

In addition, classifiers are internally modifiable. For example, the person classifier can be bent to reflect posture and can be moved to reflect different rates of walking. A handle classifier can be adjusted to reflect the size and position of the handle.

The variety of modifications to classifiers that can be used in establishing cognitive correspondences include:

- Modifications to indicate shape and size, as in describing the shape of a swimming pool, the height of a stack of books, or the shape of a pile of newspapers;
- Modifications to the form; as in using the index and little finger in the legs classifier instead of the index and second finger;
- Modifications to the orientation, as in showing a flying object upside down;
- Modifications to the location, as in showing an object high above, behind and to the left, etc.;
- Modifications to the trajectory, as in showing a person walking up and down hills;

- Modifications to the the velocity, as in showing a person hurrying or dawdling, etc.;
- Modifications in the manner, as in indicating confident steps vs. mincing steps;

Using these sorts of modifications, pairs of classifiers can indicate relationships between the properties exemplified by the pairs of objects. Relative velocity can be used in describing the finish of an auto race, relative trajectory can be used to describe the paths the cars took. The form and intensity of contact can be used to describe a near miss, a side-swiping, or a head-on collision.

The signer, the signer's body parts, and the other people, objects, and events in the utterance situation can be used as richly grounding symbols. They can either represent exactly what they are (as when they are referred to by pointing), or they can represent other objects with like properties. The signer's knee can represent the knee of a dog, the signer can represent herself, another individual, or several other individuals in turn, etc.

9 Combining Signs in ASL

Now we want to work through an example that shows how skilled ASL users combine signs—both ACSs and RGSs—using richly grounded modes of combination. This example suggests to us that the use of such richly grounded modes of combination enhances rapid and efficient communication, explaining the Bellugi phenomenon, at least in part. This suggests that the syntactic concepts adequate for ACS-based spoken languages must be augmented to account for strategies for weaving together the two kinds of symbols in ways that use each type for what it does best and result in smoothly flowing narratives.

Here are two accounts of an automobile accident. Although this example is similar to a sample dialogue in Cokely and Baker [6], it is taken from an actual event. The first account is in English, the second is a description of an ASL narrative.

(1) Something awful happened yesterday. My car was stopped at a red light. Suddenly from out of nowhere, another car came from behind it on the right and crashed into its rear right bumper.

(2) The signer first identified the nature of the event, the subject matter, and the time: HAPPEN AWFUL YESTERDAY ME CAR.Then she used a

vehicle classifier with her left hand (this signer's subdominant hand), moving her left forearm out from her body and stopping it with the slight backward motion of a car coming to a stop. With her right hand above and in front of her left, she signed RED LIGHT. Then she formed a vehicle classifier with her right hand, and moved her right forearm briskly from a position in back of the standard signing space so that her right hand collided with the back of her left palm (corresponding to the right rear of the vehicle), causing her left hand to bounce away a short distance and showing on her face the shock of the situation.

We take it that these accounts express the same thoughts. In accord with Bellugi's observation, the speaker and signer conveyed these thoughts in more or less the same amount of time. We want to make several points.

A. In (1) there are four references to cars, three to the speaker's car and one to a different car. A listener needs to figure out which expressions corefer. The relations between the references are indicated by the adjective "another" and the pronoun "it". Note that common sense has to be relied on to get the reference of "it" to be the speaker's car and not the second car.

In (2), the two cars are indicated by the two hands. The problem of coreference does not arise in the same way that it does in the English sentence. This sort of fact is important in understanding why the logical apparatus of spoken languages is often difficult for ASL speakers to master—they get little practice with an apparatus that is not necessary in their own language.

B. There is a difference in the way that use is made of time. It takes some time for the ASL narrator to introduce the subject matter, about as much or even a little more than the time it takes to utter the first sentence of (1). But once this is done, the description of the central bit of action takes very little time—just the time it takes to move the right hand into the left—much less time than the second sentence of (1).

C. This efficiency depends on the skill of the speaker. Had she started using her dominant hand for her own car, for example, she would have had to change hands to make the crash come out right.

D. The first three points, taken together, illustrate what we take to be an important moral. With each type of language, spoken or signed, come certain difficulties and opportunities that need to be dealt with, and may not have exact analogues in the other type. The skilled user of a spoken language will use a variety of devices to show the referential relations of different noun-phrases. Many of these problems simply do not arise for the corresponding signed narrative, where a single classifier does the work of

multiple references to the same object, and different classifiers (left hand, right hand in our example) indicate diversity of objects.

The skilled signer will "set up" a narrative so that spatial and dynamic relationships among the classifiers can be used in richly grounded ways to indicate corresponding relationships among their referents. It is the exploitation of this possibility, on our hypothesis, that allows the rapid expression of thought once the subject matter is introduced. It is not clear that there is an exactly corresponding skill in spoken language.

E. The concept of a sentence is a central organizing category for the syntax of spoken languages. The applicability of this concept to the ASL narrative is not clear. We might think that the ASL narrative contains three sentences,

> Something happened to my car recently.
>
> It was stopped at a light.
>
> From out of nowhere, another car crashed into it.

But this doesn't quite fit. In the narrative, a single representational object, the hand used as a classifier, remains in position and stands for the user's car throughout the narrative. To see the narrative in terms of three sentences, we need to see this one representation as occurring in all three sentences, or to suppose that the narrative is a single long sentence.

F. Different combinations of signs have varying degrees of RIM. The ones used in this example are on the high end. When the actual accident happened, the ASL user gave an account similar to (2) to the hearing, non-signing police officer, who had been quite confused by the spoken accounts he had been given by others. It took a while for the officer to grasp that the classifiers represented the cars: these representations have little RIM. Once he had grasped that, however, he understood the rest of the narrative in every detail, and grasped what had happened for the first time. Once the meaning of the classifiers was established, the way they were modified and combined had RIM.

10 Research Directions

We have suggested some of the issues we would like to pursue concerning the syntax and meaning of ASL propositions. We feel that our perspective of ASL as dual-representational and our broadened concept of icons as richly

grounding symbols suggest new directions in the study of other linguistic issues as well.

For example, some of the language-acquisition literature [14], [17], [19], [20] suggests that some elements that are considered iconic are acquired late or with difficulty. One of the reasons suggested [17], [20] is that iconicity may conflict with the abstract picture of linguistic representation. Our perspective would suggest cutting the data in terms of our broader notion of richly grounded meaning and asking a different set of questions. For example, when do children begin to understand that their language contains two forms of information? Are some of the generalization errors due to confusion over which modes of modification and combination are appropriate for the different forms? When do children begin to interweave the two forms, and when do they become fluent at this? The language-acquisition data is rich and important, but there may be some latitude in its interpretation given (a) our analysis of iconicity as richly grounded meaning, and (b) the difficulties inherent in learning dual-representation languages.

Similarly, the cross-linguistic literature shows clear differences in the arbitrary conventional symbols across signed languages. How similar are the richly grounded structures in various signed languages? And do all signed languages make as much use of RGSs as ASL does?

Concerning education, are ASL-using students of English especially troubled by rules that are AC in English but handled in ASL by strategies that are richly grounded? Would students of ASL be helped by a formalization of the strategies for interweaving ACSs and RGSs? What effect does the dual-representational nature of ASL have on the issues surrounding fair ASL translations of English-based tests?

11 Conclusion

Richly grounding symbols, though rare in the spoken languages that have been the paradigm for students of language, are found wherever the medium of representation shares enough features with the subject matter represented. Given the rich structure of gestures, it is not surprising that richly grounding symbols play an important role in ASL. Appreciation of that role will be enhanced if we keep three things in mind. First, the use of richly grounding symbols does not imply that ASL lacks the features of structure and productivity that are the hallmarks of language. Second, the meaning of RGSs may be conventional. The correct contrast is between symbols whose structure has a cognitively robust relation with the structure of that

which is symbolized, and hence is easily inferred and/or remembered, and symbols whose connection with their meanings is arbitrary. Third, richly grounded meaning is found in the way we modify and combine symbols, as well as in the basic symbols themselves. Rich grounding at the higher levels can play an important role in a system of communication, even when most of the basic symbols have arbitrary conventional meaning.

Thus our perspective of ASL as a dual-representation language is a way to tease apart some of the meaning-carrying principles of visual languages that are rare in spoken languages and thus not well handled by traditional linguistic formulations. We see implications of this in both theoretical and practical directions.

In closing, we observe that an understanding of ASL as a dual-representation language will help in the development of new dual-representation languages such as graphical-user interfaces. For many users, interfaces based on even poorly designed dual-representation languages are preferable to text-only options. But each such interface poses a problem for some part of the population: graphical user interfaces pose a problem for blind individuals, mouse input for some motor impaired individuals, and sound icons for deaf individuals. For these individuals, the development of accessible interfaces that have similar appeal depends on an understanding of the structure of dual-representation languages. It would be only fitting if the study of ASL, a language developed by and for the Deaf community, would help provide the understanding of dual-representation languages that will improve the languages already in use and encourage the development of new ones.

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