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Effects of Iconicity and Semantic Relatedness on Lexical Access in American Sign Language

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Iconicity is a property that pervades the lexicon of many sign languages, including American Sign Language (ASL). Iconic signs exhibit a motivated, nonarbitrary mapping between the form of the sign and its meaning. We investigated whether iconicity enhances semantic priming effects for ASL and whether iconic signs are recognized more quickly than noniconic signs are (controlling for strength of iconicity, semantic relatedness, familiarity, and imageability). Twenty deaf signers made lexical decisions to the 2nd item of a prime–target pair. Iconic target signs were preceded by prime signs that were (a) iconic and semantically related, (b) noniconic and semantically related, or (c) semantically unrelated. In addition, a set of noniconic target signs was preceded by semantically unrelated primes. Significant facilitation was observed for target signs when they were preceded by semantically related primes. However, iconicity did not increase the priming effect (e.g., the target sign PIANO was primed equally by the iconic sign GUITAR and the noniconic sign MUSIC). In addition, iconic signs were not recognized faster or more accurately than were noniconic signs. These results confirm the existence of semantic priming for sign language and suggest that iconicity does not play a robust role in online lexical processing.

Keywords: semantic priming, iconicity, American Sign Language, lexical recognition

For spoken languages, lexical priming effects have been found for words that are phonologically, morphologically, or semantically related (e.g., Hamburger & Slowiaczek, 1996; Marslen-Wilson, Tyler, Waksler, & Older, 1994; Meyer & Schvaneveldt, 1971). Facilitatory and inhibitory priming effects (i.e., error rate and reaction time for a target word are reduced or increased by a preceding prime word) provide evidence for how linguistic information is structured and accessed in the mental lexicon. A growing body of research is beginning to establish the nature of lexical priming for sign languages, uncovering both parallel and unique aspects of lexical processing in visual–manual compared with aural–oral languages. Identifying modality-independent and modality-specific effects is imperative for determining what aspects of lexical processing are universal to all human languages and for documenting how the characteristics of sign versus speech shape the nature of lexical access and word recognition.

Phonological priming effects have been found for signed languages, despite the fact that sign phonology is not based on sound and does not involve oral articulation. For spoken languages, consonants and vowels constitute the basic units of phonological structure, whereas for signed languages, handshape, location (place of articulation), movement, and orientation constitute basic phonological elements (for reviews, see Brentari, 1998; Sandler & Lillo-Martin, 2006). Using a lexical decision task with sign pairs, several studies report inhibitory (negative) priming effects when prime and target signs share the same location (Carreiras, Gutiérrez-Sigut, Baquero, & Corina, 2008; Corina & Emmorey, 1993; Corina & Hildebrandt, 2002). Carreiras et al. (2008) proposed that this inhibitory effect is due to activation of lexical competitors by the prime sign, which slows recognition of the target sign, and they suggested that this effect parallels the inhibition observed when spoken prime–target word pairs share initial phonemes (e.g., Hamburger & Slowiaczek, 1996). No significant priming effects have been observed for prime–target signs that have the same handshape (Carreiras et al., 2008; Corina & Emmorey, 1993), and mixed results are reported for phonological priming with movement (Corina & Emmorey, 1993; Dye & Shih, 2006). It is currently unclear why different priming patterns are observed for different phonological units in sign language, but the answer likely lies in the nature of sign-specific phonological representations—for example, handshape may be best treated as a complex autosegment that is not easily primed (Sandler, 1986)—and/or in the nature of visual processing—for example, location information is perceived prior to movement (Emmorey & Corina, 1990), which could lead to early lexical competition (Carreiras et al., 2008).

Morphological priming has also been observed for American Sign Language (ASL). Emmorey (1991) used repetition priming to investigate the organization of morphologically complex signs in the ASL lexicon (see also Hanson & Feldman, 1989). Two sepa-

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rate experiments showed that verbs inflected with aspect morphology (but not with agreement morphology) produced strong facilitation for later recognition of the base verb (i.e., the citation form of the same verb). The task was continuous lexical decision and approximately 1 min (30 items) intervened between the prime and target signs. Repetition priming was not observed for nonsigns produced with ASL aspectual inflections, which indicates that the facilitation effect was a true lexical effect and not due to episodic memory or to priming at the phonological level. Repetition priming with morphologically related forms is generally interpreted as an index of the interrelation among morphologically related forms in the lexicon (see Marslen-Wilson et al., 1994, for a review).

Surprisingly, there has been only one (unpublished) study investigating semantic priming in a signed language, although two recent studies have documented semantic interference effects in sign production (Baus, Gutiérrez-Sigut, Quer, & Carreiras, 2008; Corina & Knapp, 2006). Corina and Emmorey (1993) asked deaf ASL signers to make a lexical decision to the second sign in a prime–target pair and found significantly faster response times when targets were preceded by semantically related primes (e.g., PAPER–PENCIL; HOT–COLD; CAR–TRAFFIC).[1] This finding suggests that semantic similarity effects are universal and may reflect modality-independent principles of semantic organization and representation. Semantic priming effects can be accounted for by spreading activation across nodes within a lexical network (e.g., Collins & Loftus, 1975) or by activation of overlapping semantic features (e.g., Cree, McRae, & McNorgan, 1999).

Our goals in the current study are to replicate the semantic priming effects initially observed by Corina and Emmorey (1993) and to examine a modality-specific semantic property of sign language: the iconicity of linguistic forms. Sign languages exhibit a greater capacity for iconic representation than do spoken languages because the visual–manual modality provides richer resources for creating structural similarities between phonological form and meaning. Spoken languages have iconic words that sound like their referents, for example, onomatopoetic words that denote animal sounds (in English, *meow* or *moo*) or reflect the sounds of actions (*pop* or *crash*). However, such sound-based iconicity is relatively rare, perhaps because most phenomena are not easily depicted with sound, which is a one-dimensional sequential medium. In contrast, the visual three-dimensional modality of sign languages allows for iconic expression of a wide range of basic conceptual structures, such as object and human actions, movements, locations, and shapes (see Taub, 2001, for extensive discussion). For example, the signs illustrated in Figures 1A and 1B all bear a resemblance to the concepts that they denote. The ASL signs PIANO and GUITAR depict how these instruments are played, whereas the signs BOOK and WRITE depict properties of the object and the action that they denote.

There is currently an active debate about whether iconicity plays a significant role in the representation and/or processing of sign languages. Some have argued for a very strong link between form and meaning such that there is no level of strictly meaningless units in sign language (e.g., Armstrong, Stokoe, & Wilcox, 1995; Wilcox, 2004), whereas others consider iconicity an attribute of signs that is not linguistically relevant for sign language processing (e.g., Emmorey, 2002; Klima & Bellugi, 1979; Newport & Meier, 1985). The evidence for these views is mixed. For example, Poizner, Bellugi, and Tweney (1981) showed that iconicity does not bestow a processing or memory advantage for short-term recall. Iconic signs were remembered as accurately as noniconic signs by deaf ASL signers in an immediate serial recall task. Further, iconic and noniconic signs are equally impaired with sign language aphasia (Marshall, Atkinson, Smulovitch, Thacker, & Woll, 2004), and production of iconic and noniconic signs engages the same language-related neural regions (Emmorey et al., 2004). Similarly, iconicity does not appear to guide early sign language acquisition in children. For example, iconic signs are not learned first and are not overrepresented in the early vocabularies of ASL-learning children (Anderson & Reilly, 2002; Orlansky & Bonvillian, 1984). Iconicity appears to be ignored in the acquisition of pronouns, negation, and the directional aspect of verb agreement (Anderson & Reilly, 1997; Meier, 1987; Petitto, 1987). For very young hearing children, iconic and arbitrary referential gestures are learned equally well (Namy, Campbell, & Tomasello, 2004). Together, these studies suggest that iconicity does not play a significant role in language processing.

However, there is growing evidence that semantic processing for sign language can be facilitated by iconicity. For example, Thompson, Vinson, and Vigliocco (2009) recently reported that iconicity aids lexical retrieval in a sign–picture verification task. Signers had to decide whether a sign and a picture referred to the same object, and the iconic relationship between the sign and the picture was manipulated. For example, the beak of a bird is depicted in the ASL sign BIRD, and this property is salient in a picture of a bird's head in profile but not in a picture of a bird in flight. Response times were faster when the property that was iconically depicted in the sign (e.g., the beak of the bird) was highlighted in the corresponding picture. Similar results were reported by Grote and Linz (2003) for German Sign Language and by Ormel (2008) for Sign Language of the Netherlands. In addition, Vigliocco, Vinson, Woolfe, Dye, and Woll (2005) found that iconicity influenced semantic similarity judgments for British Sign Language. These studies suggest that iconicity may confer a semantic processing advantage when there is a close mapping between meaning and phonological form.

In this study, we investigated whether iconicity enhances semantic priming effects for ASL and whether iconic signs are recognized more quickly than noniconic signs. Iconic signs may be more effective semantic primes than noniconic signs because the phonological representations of iconic signs have features that are grounded in perception and action (at least historically). Vigliocco et al. (2005) suggested that iconic signs stimulate mental imagery within a semantic field, and it is possible that shared imagery will enhance semantic priming effects as well as lexical recognition. We selected the lexical decision paradigm to test this hypothesis, rather than the sign–picture verification task, in order to (a) measure lexical semantic priming effects and (b) determine whether iconicity plays a role in sign recognition itself. In sign–picture verification tasks, decision times are recorded to the pictures, not to the signs. We hypothesized that if iconic signs have stronger connections between phonological form and semantic features, then these signs may be recognized more quickly and more accurately than noniconic signs.

[1] Words in capital letters represent English glosses (the nearest equivalent translation) for ASL signs.

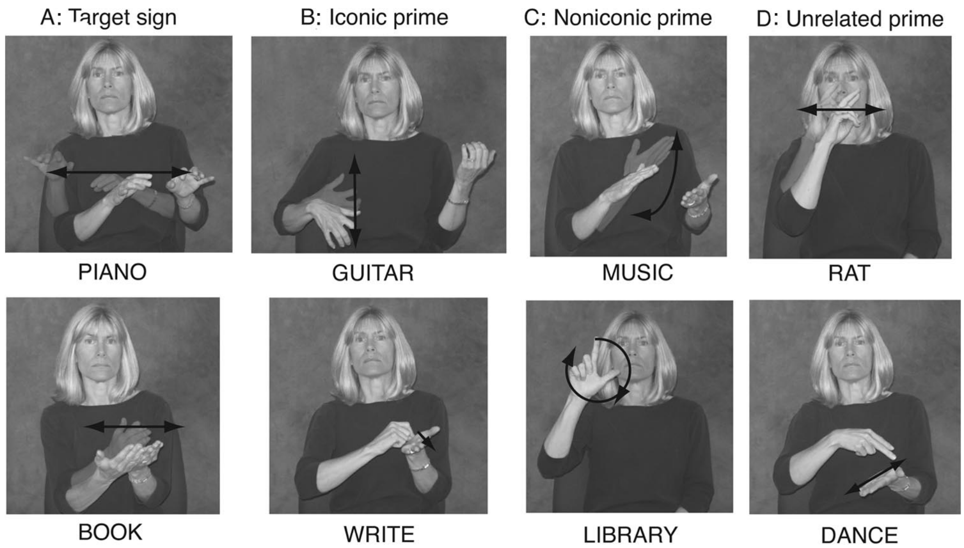

Figure 1. Illustration of two iconic target signs (A) and the prime signs (B–D) that preceded each.

Method

Participants

Twenty prelingually and profoundly deaf participants (6 men, 14 women; M_{age} = 27 years, *SD* = 6 years) were tested at Gallaudet University in Washington, DC; at the Salk Institute for Biological Studies in San Diego, California; or at Deaf Community Services in San Diego. All participants were exposed to ASL by the age of 5 years, and all but three participants had at least one deaf signing parent or older sibling. All participants used ASL on a daily basis as their primary and preferred means of communication.

In addition, 68 hearing participants from the University of California, San Diego, with no knowledge of ASL rated a large corpus of ASL signs for iconicity and semantic relatedness (on the basis of their English translations). An additional five deaf signers who did not participate in the experiment provided iconicity, semantic relatedness, and familiarity ratings for the final subset of stimuli.

Materials

Semantically related and unrelated prime–target sign pairs were created in which the prime was either iconic or noniconic (see Figure 1 and Appendix). For these sign pairs, the target sign was always iconic. A second set of prime–target pairs was created in which the target sign was noniconic and the prime sign was semantically unrelated to the target. The first set of prime–target pairs was designed to allow us to investigate whether iconicity enhances semantic priming, and the second set was designed to help us determine whether iconic signs are recognized faster than noniconic signs in a lexical decision task when both are preceded by primes that are semantically unrelated.

Hearing nonsigners (n = 68) rated 234 ASL signs for degree of iconicity, using a scale of 1 (*noniconic*) to 5 (*very iconic*). The stimuli were chosen with the expectation that about half would be rated as iconic and half as noniconic, with some signs also falling in the middle of the iconicity range. Prior to the rating task, participants were given examples of clearly iconic signs that have very transparent meanings (e.g., EAT is made by bringing the hand to the mouth as if holding food) and examples of signs that are arbitrary and clearly noniconic (e.g., NAME is made with two U handshapes, index and middle fingers extended, contacting each other). After watching and hearing a fluent ASL signer sign and verbalize each item individually, the participants silently marked their ratings on answer sheets. There were five practice items. Participants were tested in groups of five.

After the iconicity ratings, the same 68 participants were asked to rate 195 pairs of written words for semantic relatedness on a scale of 1 (*no semantic relationship*) to 7 (*strongly related in meaning*). The written word pairs represented English translations of ASL sign pairs that could potentially be used in the experiment. Both semantically related and associated pairs were included in the stimuli set. Participants were instructed to assign high numbers to pairs that go together, like *king–queen*, and to pairs that have similar meanings, like *bird–duck*. There were 10 practice pairs. Items were counterbalanced across participants such that no participant saw the same item in the iconicity and semantic relatedness rating tasks. For both rating tasks, participants were encouraged to use the entire scale in making judgments.

Items with mean iconicity ratings at or above 4 were selected as possible iconic signs and items with mean iconicity ratings at or below 1.5 were selected as potential noniconic signs to be used in the experiment. Word pairs with a mean semantic relatedness rating at or above 5.5 were considered semantically related, and pairs with a mean semantic relatedness rating at or below 2.5 were considered unrelated pairs. Signs (n = 131) and sign pairs (n = 105) meeting these criteria were presented to five deaf participants for further iconicity and semantic relatedness ratings. Signs and word pairs that fell in the middle of the rating scales were also included. The procedure for collecting these ratings was the same as the procedure for the hearing participants. In addition, the deaf participants were asked to provide familiarity ratings for the 131 individual signs using a scale of 1 (*rarely signed by deaf people*) to 5 (*seen every day*). These ratings were used to make sure that the conditions were balanced for sign familiarity. Iconicity, semantic relatedness, and familiarity ratings were not obtained on the same day; rather, each rating task was separated by at least a week.

The final experimental stimuli consisted of 32 noniconic target signs preceded by semantically unrelated prime signs and 32 iconic target signs preceded by primes that were (a) iconic and semantically related, (b) noniconic and semantically related, or (c) semantically unrelated (see Appendix).[2] Tables 1 and 2 provide the mean semantic relatedness ratings, iconicity ratings, imageability ratings (from the MRC Psycholinguistic Database; Coltheart, 1981), familiarity ratings, and mean durations for the final prime signs and for the iconic and noniconic target signs, respectively. The prime signs did not differ significantly in imageability, familiarity, or duration (all Fs $<$ 1). The iconicity ratings for the semantically unrelated primes were near the middle of the 5-point scale (M = 3.17) because half of these primes were iconic and half were noniconic. The iconic target signs and the noniconic target signs did not differ significantly in imageability, familiarity, or duration (all ts $<$ 1). Finally, the noniconic target signs were preceded by unrelated primes with a mean semantic relatedness rating of 1.44 (SD = 0.3), which was not significantly different from the relatedness rating for the unrelated primes preceding the iconic targets (M = 1.41; see Table 1), $t < 1$.

In addition, 64 sign–nonsign pairs were created. The nonsigns were created by varying one or two phonological parameters of a real sign (e.g., BUG produced on the chest instead of the nose or MOON produced with a 3 handshape instead of a hooked L handshape). Nonsigns were all permissible but nonoccurring signs in ASL. Nonsign targets were preceded by both iconic and noniconic prime signs. Thus, participants viewed a total of 128 stimulus pairs (64 sign–sign pairs and 64 sign–nonsign pairs). The iconic target pairs were counterbalanced across participants such that no one saw the same target sign twice. In addition, no iconic sign appeared as a prime and as a target for a given participant. All participants saw the same noniconic target signs (all preceded by unrelated primes).

The sign and nonsign stimuli were produced by a deaf native ASL signer and recorded using a Panasonic video camera. When editing the stimuli, we defined the beginning of a sign or nonsign as the moment the hand(s) entered the frame and the end as the moment the hand(s) began to move out of the sign configuration and back down to resting position on the lap. A tone was aligned with the first frame of each target item, and this audio signal was fed into a Carnegie Mellon Button Box response timer. The primes and targets were separated by 333 ms (10 video frames), and 3.5 s of black videotape separated each trial. The videotapes were edited using a Panasonic AG-650 editor controller and Panasonic AG 6500 and 6300 videocassette recorders.

Procedure

The participants were tested individually using a Sony PVM 1380 Trinitron color video monitor. Response latencies were recorded by a Power Macintosh G-3 computer using PsyScope software. Participants were instructed in ASL to decide whether the second sign of each pair (the target) was a true ASL sign or a nonsense sign as quickly as they could without making errors. They responded by pressing the appropriate green button marked *yes* or red button marked *no* on the button box. A practice session of 12 trials was given to each participant.

Results

Mean response latencies and error rates are given in Table 3. Incorrect responses were excluded from the response latency analyses (3.1% of the data). The mean response time for the nonsigns was 1,283 ms (SD = 60 ms), with a mean error rate of 9.9% (SD = 1.8%). We conducted separate one-way analyses of variance for latencies and error rates for the iconic target signs, with prime type as the independent measure and participants (F_1) and items (F_2) as random factors. For response latency, the effect of prime type was significant, $F_1(2, 38) = 5.93$, $p = .006$; $F_2(2, 62) = 4.19$, $p = .02$. As predicted, targets preceded by semantically related primes were responded to significantly faster than were targets preceded by unrelated primes, and this was true for both iconic primes, $F_1(1, 19) = 9.94$, $p = .005$; $F_2(1, 31) = 4.71$, $p = .038$, and noniconic primes, $F_1(1, 19) = 5.76$, $p = .027$; $F_2(1, 31) = 5.94$, $p = .02$. However, the iconicity of the prime did not increase the priming effect: There was no difference between response latency for targets preceded by iconic versus noniconic primes, $F_1(1, 19) = 0.43$, $p = .52$; $F_2(1, 31) = .05$, $p = .94$. As can be seen in Figure 2, the amount of priming created by iconic and noniconic semantically related primes was nearly identical.

For error rates, the main effect of prime type was not significant by participants and approached significance by items, $F_1(2, 38) = 1.84$, $p = .17$; $F_2(2, 62) = 3.20$, $p = .05$. No comparison between the three prime types was significant.

Next, we examined whether iconicity speeded lexical recognition time or reduced error rate by comparing responses to the iconic and noniconic targets when both were preceded by unrelated primes (see Table 3). The latency difference between iconic versus noniconic signs was not significant by participants, $F_1(1, 19) = 0.23$, $p = .63$, or by items, $F_2(1, 54) = 2.04$, $p = .16$. There was also no significant difference in error rate between the two sign types, $F_1(1, 19) = 1.14$, $p = .30$; $F_2(1, 54) = 2.02$, $p = .09$.

Discussion

As expected, signers were faster when making lexical decisions to signs that were preceded by a semantically related prime than by an unrelated prime (see Table 3). This result confirms that semantic priming is a universal linguistic process that is unaffected by language modality. Over the past several years, psycholinguistic research has revealed both similarities and differences in lexical access and representation for signed and spoken languages. For example, lexical access for both languages involves a sequential mapping process between an incoming linguistic signal and stored lexical representations, both words and signs must be phonologi-

[2] After item selection and stimulus design, it turned out that the experimental groups were not balanced for mean imageability, so eight items were removed from the noniconic target set to equate imageability (while maintaining balanced iconicity, familiarity, and semantic relatedness ratings). The summary statistics reported in Tables 1 and 2 and in the text reflect the properties of the final 24 noniconic target signs.

Table 1
Mean Properties of the Prime Signs Preceding the Iconic Target Signs

	Semantically related primes					
	Iconic		Noniconic		Unrelated primes	
Property	*M*	*SD*	*M*	*SD*	*M*	*SD*
Semantic relatedness						
Hearing	6.14	0.5	6.14	0.4	1.47	0.3
Deaf	6.27	0.4	6.29	0.5	1.41	0.5
Iconicity						
Hearing	4.27	0.6	1.96	0.6	3.03	0.7
Deaf	3.86	0.8	2.07	0.5	3.17	0.6
Imageability	560		553		554	
Familiarity	2.63	1.1	3.1	0.9	2.83	1.1
Duration (ms)	993	129	960	107	987	106

Note. The semantic relatedness rating scale was 1 to 7. The iconicity and the familiarity rating scales were 1 to 5. The imageablity data are from Coltheart, 1981.

cally decoded (and encoded), and factors such as lexical familiarity and phonological neighborhood affect recognition (see Emmorey, 2007, for a review). Unlike spoken languages, however, lexical access for sign languages involves a two-stage recognition process in which one set of phonological elements (hand configuration and place of articulation) is initially accessed and then identification of a sign's movement leads directly to lexical recognition (Emmorey & Corina, 1990; Grosjean, 1981). In addition, because of the high degree of simultaneous phonological structure and the varied phonotactic structure of sign onsets, lexical recognition occurs proportionally earlier for signs than for words. The semantic priming that we observed in this experiment suggests that although phonological organization differs by modality, the organization of lexical semantic structure does not.

Further, semantic priming was unaffected by sign iconicity, a lexical property that is highly influenced by the visual–manual modality. As illustrated in Figure 2, prime signs that were highly iconic, such as GUITAR or WRITE, did not lead to increased semantic priming compared with signs that were not iconic, such as MUSIC or LIBRARY (see Figure 1). If iconic aspects of signs are automatically activated during online processing, then iconic prime–target sign pairs would be expected to exhibit enhanced semantic priming due to shared mental imagery that is triggered by overlapping iconicity (cf. Vigliocco et al., 2005). For example, embodied motor actions depicted by the iconicity of the prime GUITAR (which depicts how one plays a guitar) should prime the similarly iconic target sign PIANO (which depicts the action of playing a piano). Similarly, the prime WRITE includes iconic aspects of the target sign BOOK (e.g., the palm of the nondominant hand of WRITE depicts the surface of a page, as do the palms of the hands for BOOK). The iconic features of signs that are grounded in human actions or visual object perception do not appear to enhance semantic priming.

Table 2
Mean Properties of Target Signs

	Target signs			
	Iconic		Noniconic	
Property	*M*	*SD*	*M*	*SD*
Iconicity				
Hearing	3.80	0.9	1.94	0.8
Deaf	4.10	0.7	2.13	0.9
Imageability	576	68	551	84
Familiarity	2.92	1.2	2.90	1.0
Duration (ms)	980	109	945	110

Note. The iconicity and familiarity rating scales were 1 to 5. The imageability data are from Coltheart, 1981.

We also conducted a post hoc analysis to examine whether the type of iconic mapping might affect processing. Roughly half of the iconic prime–target pairs shared a similar type of form–meaning mapping (e.g., both signs depicted an action) and half contained signs with different form–meaning mappings (e.g., the prime sign depicted an action, whereas the target sign outlined the features of an object). Determination of the type of iconic mapping was based on Taub's (2001) analysis of iconicity in ASL. This post hoc analysis revealed no significant difference in response time for pairs that shared the same type of iconic mapping versus those that had a different type of mapping ($p = .35$). However, future studies are needed to systematically examine various types of iconicity to determine whether a specific category of form–meaning mapping might increase semantic priming.

Although the results provide evidence against a robust and general effect of iconicity on semantic priming, it is nonetheless possible that sign iconicity could play a role when prime–target pairs are only weakly related semantically. When prime–target pairs share many semantic features or are strong semantic associates as in our study, shared iconicity may not be able to create much additional facilitation. To investigate whether iconicity alone might prime lexical decision, we compared the response times for target signs when they were preceded by semantically unrelated primes that were rated as either iconic (mean rating = 4.47, SD = 0.58) or noniconic (mean rating = 1.87, SD = 0.52). This analysis revealed that iconic primes did not result in shorter latencies for target signs, compared with noniconic primes (mean response time = 1,079 ms, SD = 232 ms, and 1,087 ms, SD = 192 ms, respectively). Thus, iconicity does not appear to play a role in

Table 3
Mean Response Time in Milliseconds and Error Rate Percentages for Target Signs in All Four Experimental Conditions

	Prime type											
					Semantically related							
	Semantically unrelated				Iconic				Noniconic			
	RT		Error		RT		Error		RT		Error	
Iconicity	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Iconic	1,090	52	2.8	1.1	985	39	1.3	0.9	1,004	45	5.0	1.7
Noniconic	1,074	36	4.4	1.2								

lexical priming when prime–target pairs are either semantically unrelated or strongly related. Further research is needed to determine whether iconic prime–target sign pairs that have a weak semantic relationship produce greater priming than do similar noniconic sign pairs.

Another key result of our study was that lexical decisions to iconic signs were not significantly faster or more accurate than lexical decisions to noniconic signs (see Table 3). This finding indicates that iconic signs are not easier to recognize for deaf signers and that the stronger mapping between form and meaning exhibited by iconic signs does not facilitate lexical recognition. Similarly, Baus, Carreiras, and Emmorey (2010) recently reported that iconic signs were not recognized or translated more quickly than noniconic signs by hearing ASL–English bilinguals. Although adult new learners of ASL were able to recognize and translate iconic signs faster than noniconic signs, the advantage was not present for bilinguals who had achieved a high level of ASL proficiency. In the case of adult new learners, iconicity could provide a learning strategy or mnemonic aid (see also Campbell, Martin, & White, 1992). Together, these results suggest that iconicity in and of itself does not convey a lexical processing advantage.

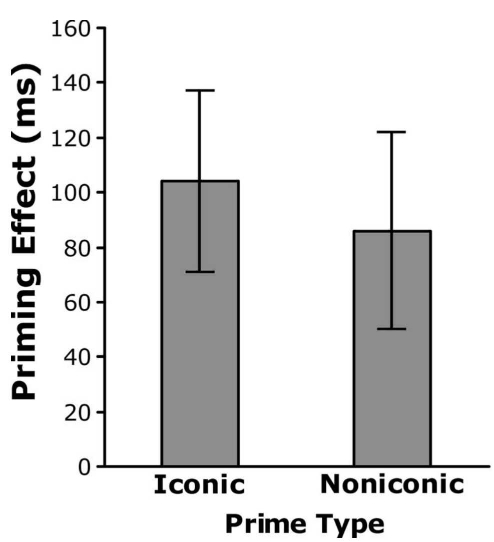

Figure 2. The amount of priming for iconic target signs that were preceded by semantically related iconic and noniconic primes. The error bars represent the standard error of the mean priming effect (in milliseconds).

How can these results be reconciled with the processing advantage found for iconic signs in sign–picture verification tasks (Grote & Linz, 2003; Ormel, 2008; Thompson et al., 2009)? We hypothesize that iconicity only impacts semantic processing when it is in some way relevant to the task. For sign–picture matching tasks, the form of a sign is related to the response because an aspect of the sign form is associated with a property of the pictured object and can therefore facilitate the match decision. For lexical decision, iconicity is not particularly relevant to the response because the ASL lexicon contains both iconic and noniconic lexical forms, and it is not clear that iconic signs are any more or less "signlike" than noniconic signs.

Recently, however, Thompson, Vinson, and Vigliocco (2010) found that iconicity slowed phonological decisions for British Sign Language signs and suggested that iconicity effects arise automatically, even when access to meaning is not relevant to the task. In this study, British Sign Language signers were asked to decide whether the active fingers of a sign were straight or curved (active fingers were defined as those that make contact with the body or have internal movement). Thompson et al. (2010) suggested that handshape decisions were slower for iconic signs because the automatic activation of meaning by iconic signs provided irrelevant information that interfered with the phonological decision. However, another possibility is that the handshape decision was slowed because handshapes in many of the iconic signs were historically derived from classifier constructions in which the handshape was morphemic. For example, many highly iconic signs are derived from handling or instrument classifier constructions in which the handshape morpheme represents an instrument or how an implied agent holds or manipulates an object (e.g., WRITE, KEY, SKI, STIR, LOCK, BOOTS, BRUSH, VIOLIN, and HAMMER in the appendix of Thompson et al., 2010). Noniconic signs are less likely to contain morphemic handshapes derived from classifier constructions. Thus, the potential morphemic status of the handshape in iconic signs could have interfered with the phonological decision.

Nonetheless, if iconic signs do activate semantic features more strongly or more automatically than do noniconic signs, our results clarify the processing consequences of such activation. Specifically, semantic feature activation by iconic signs does not lead to increased priming. Thus, iconicity does not seem to increase feature overlap or connections within a semantic network. However, it is possible that iconicity only boosts semantic priming when signs share few features or are not strong semantic associates.

Furthermore, automatic semantic feature activation does not appear to facilitate lexical recognition: Iconic signs were not recognized faster or more accurately than noniconic signs. We suggest that iconicity does not impact lexical access per se, but it can influence postlexical conceptual processing. For example, in sign–picture matching tasks, signers make their decision after they have accessed and recognized the sign. Iconicity can then be used to speed the match decision because aspects of the sign form match aspects of the target picture. When making metalinguistic judgments about hand configuration, an implicit or explicit awareness of sign iconicity can interfere with this decision, as suggested by Thompson et al. (2009), or knowledge of the morphemic status of iconic handshapes may slow phonological decisions for handshape, as we suggested above. The experiments that have thus far shown an effect of iconicity have not directly tapped lexical access processes and may instead reflect postlexical, metalinguistic processes.

One might ask why iconicity is so prevalent in sign languages when it does not appear to provide a clear lexical processing advantage, promote language acquisition by children, improve short-term memory for deaf signers, or protect against lexical impairment with aphasia. One possibility lies in the gestural origins of sign languages. These languages are relatively young (cf. Aronoff, Meir, & Sandler, 2005), and first-generation users are likely to create motivated gestures that can be quickly and easily understood within this early signing community. Spoken language users also prefer motivated forms in word creation (e.g., Hinton, Nichols, & Ohala, 1994), but the oral–auditory modality affords fewer possibilities for iconically mapping form to meaning. Furthermore, modern signers exploit iconicity in poetry, metaphor, artistic expression, and sign play (e.g., Klima & Bellugi, 1979; Meir, in press; Sutton-Spence, 2005). Although iconicity may play only a limited role in online language processing, it appears to be essential for metalinguistic functions and sign creation.

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(*Appendix follows*)

Appendix

Translations of the American Sign Language Signs Used in the Experiment

	Semantically related prime				
Iconic target	Iconic	Noniconic	Unrelated prime[a]	Noniconic target	Unrelated prime
ANGEL	DEVIL	HOLY	ELEPHANT	ACTOR	POTATO
BANANA	MONKEY	FRUIT	DANCE	ADVICE[b]	LETTUCE
BASEBALL	BALL	PLAY	PARTY	ALCOHOL	DIRT
BOAT	CANOE	WATER	CONNECT	CAREFUL[b]	RACE
BOOK	WRITE	LIBRARY	AWKWARD	CEILING[b]	POOR
BRIGHT	DARK	LIGHT	SISTER	CLASS	NECKTIE
BURN	MATCH	HOT	TALENT	DAUGHTER	TRAIN
BUTTER	BREAD	TOAST	MOOSE	EXERCISE	END
COLD	JACKET	HOT	WORK	EXPLAIN	THEATER
DOG	CAT	ANIMAL	TECHNOLOGY	FEEL[b]	BUSINESS
DRINK	TEA	BEER	BUTTERFLY	GOVERNMENT	CANDY
DRIVE	GAS	TRAVEL	PRAISE	GREEN	BANQUET
ESCAPE	CHASE	RUN	SOCKS	HOME	TEASE
FIGHT	BEAT UP	WAR	WINDOW	HUSBAND	CRACKER
FIND	LOSE	SEARCH	DINNER	LECTURE	FRUSTRATION
FLOWER	GROW	PLANT	GLASSES	LUNCH	CHEMISTRY
HAMMER	WRENCH	BUILD	FISH	MAJOR	UNIFORM
HORSE	RIDE	ANIMAL	WORD	MATH	SUSPECT
KEY	DOOR	LOCK	FUN	ORANGE	RELATIONSHIP
MONEY	COINS	DOLLAR	PANCAKE	PARENTS	TEMPT
PIANO	GUITAR	MUSIC	RAT	PICTURE	IMPROVE
PRIEST	NUN	RELIGION	SALT	RABBIT	IDEA
PRISON	ARREST	MURDER	ICE CREAM	RIVER	SHOW
RAIN	UMBRELLA	WEATHER	COMPUTER	ROCK	POSTPONE
RING	NECKLACE	GOLD	CAMERA	SHORT	COPY
SANDWICH	EAT	LUNCH	HOUSE	SLOW	PENCIL
SHOWER	BATHE	WATER	PLANE	STRAWBERRY[b]	LOVE
SNOW	COLD	WHITE	SPIDER	STRONG[b]	SURPRISE
SOUP	BOWL	VEGETABLE	SCHOOL	TABLE[b]	HATE
SURGERY	INJECTION	DOCTOR	SWEET	TRUTH[b]	ENJOY
TEA	CUP	COFFEE	RAT	VISIT	CURIOUS
TIME	HOUR	SCHEDULE	MOTORCYCLE	WINTER	AUNT

[a] These items vary in iconicity from strong to weak; thus, the semantically unrelated primes are neutral for iconicity. [b] Item removed from analysis; see footnote 2.

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