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ARTICLE

Better letter: iconicity in the manual alphabets of American Sign Language and Swedish Sign Language

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Abstract

While iconicity has sometimes been defined as meaning transparency, it is better defined as a subjective phenomenon bound to an individual's perception and influenced by their previous language experience. In this article, I investigate the subjective nature of iconicity through an experiment in which 72 deaf, hard-of-hearing and hearing (signing and non-signing) participants rate the iconicity of individual letters of the American Sign Language (ASL) and Swedish Sign Language (STS) manual alphabets. It is shown that L1 signers of ASL and STS rate their own (L1) manual alphabet as more iconic than the foreign one. Hearing L2 signers of ASL and STS exhibit the same pattern as L1 signers, showing an iconic preference for their own (L2) manual alphabet. In comparison, hearing non-signers show no general iconic preference for either manual alphabet. Across all groups, some letters are consistently rated as more iconic in one sign language than the other, illustrating general iconic preferences. Overall, the results align with earlier findings from sign language linguistics that point to language experience affecting iconicity ratings and that one's own signs are rated as more iconic than foreign signs with the same meaning, even if similar iconic mappings are used.

Keywords: fingerspelling; iconicity; L2 learners; lexical rating; manual alphabet; proficiency; sign language

1. Introduction

Iconicity – a non-arbitrary, resemblance-based form–meaning mapping – is a phenomenon that has received plenty of attention within sign language linguistics, most likely stemming from the fact that sign languages very obviously contain depictions of objects and actions in many signs (Meir & Tkachman, 2018; Taub, 2001; Wilcox, 2004). More recently, iconicity has increasingly become a topic of interest within spoken language linguistics, finding that there are iconic patterns found in all languages to some extent, regardless of modality (Dingemanse et al.,

2015; Perlman et al., 2018; Perniss et al., 2010). While iconicity is sometimes defined in terms of transparency – that is, how easy it is to guess the meaning from the form of, for instance, a word (see Occhino et al., 2020; Ortega, 2017) – experimental work has found that subjectivity and gradience are key properties of iconicity, and that iconicity ratings may differ between individuals based on, among other things, language experience (Dingemanse et al., 2020; Occhino et al., 2017; Winter et al., 2023). In a study comparing iconicity ratings of signs from American Sign Language (ASL) and German Sign Language (DGS, *Deutsche Gebärdensprache*), Occhino et al. (2017) showed that signers rate the signs of their *own* sign language as more iconic than corresponding signs in a *foreign* sign language, even if the iconic mappings are similar, which they attribute to the fact that language experience and entrenchment of exposure and use influence how we interpret and grade form–meaning mappings in languages.

In this article, I use Occhino et al.'s (2017) study as a starting point to look at another aspect of form–meaning mappings across sign languages, namely the encoding of written characters (i.e., letters of the alphabet) as handshapes in manual alphabets, used to spell out written language in the signed modality. Here, I look at deaf/hard-of-hearing (DHH) L1 signers and hearing L2 signers of ASL and Swedish Sign Language (STS; *svenskt teckenspråk*), as well as hearing non-signers, with regard to how these groups rate the iconicity of the letters of the manual alphabets of ASL and STS in relation to the written letters they correspond to. By doing so, I investigate to what extent language experience (L1 and L2) influences iconicity ratings and whether the findings align with those of Occhino et al. (2017) for lexical signs, thus expanding the view of iconic mappings into the domain of written characters as represented in the signed modality. Additionally, the findings will give insights into the iconicity of individual letters of these two manual alphabets through the iconicity ratings collected across signers and non-signers. As such, this article expands on previous research and adds to our knowledge about how iconic mappings are perceived across different multimodal representations of language.

Section 2 provides a background to previous work on iconicity and subjectivity, as well as the manual alphabets of ASL and STS, which lays the foundation for the research questions guiding this study. Section 3 outlines the methodology, including the data collection procedure, the participants and data analyses. The results are presented in Section 4, and Section 5 concludes the article with a general discussion of the findings.

2. Background

2.1. Iconicity as a subjective phenomenon

Iconicity in language – that is, when linguistic forms resemble their meanings – has been known for a long time in linguistics (see Joseph, 2015), but has traditionally been regarded as a fairly marginal phenomenon. However, iconicity has received increasingly more attention in linguistics, and it is now well established that spoken and signed languages alike make use of iconic forms on many levels of language structure, from direct iconic depictions, such as *onomatopoeia* (i.e., *the cow goes **moo***), to more abstract grammatical structures (Dingemanse et al., 2015; Meir & Tkachman, 2018; Perlman et al., 2018; Perniss et al., 2010). The definition of iconicity varies between different works addressing the issue, but the shared core

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tends to state that a linguistic form (e.g., a word) is motivated (i.e., non-arbitrary) in a way that resembles the meaning (i.e., the referent). Since the definition involves resemblance, iconicity is sometimes operationalized in terms of *transparency*, assuming that if it is possible to guess the meaning of a linguistic form – for instance, a word – without previously having learned its specific conventionalized form–meaning relationship, the mapping is iconic (see Dingemanse et al., 2020; Occhino et al., 2020; Ortega, 2017; Sevcikova Sehyr & Emmorey, 2019; Winter et al., 2023). In sign language linguistics, the seminal work by Klima and Bellugi (1979b) categorized signs on the basis of transparency as a way to grade the iconicity of a sign, but later work has also shown that while correlated, transparency and iconicity ratings of signs can differ from one another (Sevcikova Sehyr & Emmorey, 2019). Recent studies have included gradience as a property of iconicity, but also noted that subjectivity plays a role in several ways. First, iconicity can be graded as more or less on the basis of *how many* people rate something as iconic, and *how much* resemblance they perceive on a scale, but also how many aspects of the form itself can be mapped iconically to the meaning and how many aspects of the referent are iconically depicted (Emmorey, 2014; Grote & Linz, 2003; Motamedi et al., 2019; Occhino, 2017; Winter et al., 2023). For example, many iconic signs depict only a specific, salient feature of the referent, for example, a depicted beak representing the whole referent 'bird'. Second, iconicity is subjective in the sense that iconicity ratings differ across individuals, such that each individual has their own experience of the extent to which a form resembles the meaning (Dingemanse et al., 2020; Motamedi et al., 2019; Occhino et al., 2017; Winter et al., 2023). For example, some people may perceive a beak-depicting sign for 'bird' to be less iconic than a wing-depicting sign with the same meaning. The gradience and subjectivity of iconicity push us away from a categorical and universal definition of iconicity and toward one that allows for gradience and preferential patterns across individual variation. Thus, one way to explain it succinctly is with Dingemanse's (2019) definition of iconicity as a 'perceived resemblance between aspects of form and meaning' (p. 18). This captures the fact that resemblance is perceived, and therefore subjective to some degree, and that the iconic mapping can be related to parts of the form and/or parts of the meaning – that is, a beak-depicting sign is iconically mapped to 'bird' even if only a part of the referent is depicted (see also Winter et al., 2023). If iconicity is indeed perceived (i.e., subjective), the iconicity of, for example, a word cannot be defined categorically by any one person. Because of this, many studies have operationalized iconicity using some form of rating task across multiple participants in order to account for (a) gradience in perceived iconicity (rating an item as more or less iconic) and (b) variation across participants (averaging across multiple ratings per item) (Motamedi et al., 2019).

With regard to subjective differences in iconicity ratings, Occhino et al. (2017) showed that ASL and German Sign Language (DGS) signers exhibit a preference for their own sign language when rating signs from their own as well as another (foreign) sign language. That is, iconic signs from one's own sign language are rated as more iconic than corresponding signs from a foreign sign language, even if the iconic mappings have the same motivation and the forms are similar. The explanation here is that experience with a language in terms of exposure and use entrenches structures and patterns in that language, and familiar iconic structures are consequently rated as more iconic. Because of this, some iconic patterns are more specific, salient and entrenched in one language, and therefore, perceived as more iconic by the users of

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that language who are familiar with those structures (Occhino et al., 2020; see also Padden et al., 2013). In another study following up on the cross-linguistic iconicity ratings of signs, Omardeen (2018) found that signers of Dutch Sign Language (NGT; *Nederlandse Gebarentaal*) and Chinese Sign Language (CSL) rate foreign signs as more iconic if there is overlap in phonological form with the corresponding signs in one's own sign language. This further suggests that familiarity of (iconic) structures influences iconicity ratings. In fact, although iconicity is a property that can be highly useful for successful cross-linguistic communication such as *cross-signing* (i.e., communicating across sign languages), it is crucial that the iconic mappings being used can also be interpreted by the interlocutor by being shared across languages (Börstell, 2023; Börstell et al., 2020; Zeshan, 2015, 2019). That is, iconicity 'reflects perceptual and real-world experience' (Motamedi et al., 2019, p. 191), which means that shared experiences are needed to share the perception of whether or not – or, rather, to what extent – something is iconic across individuals, languages and cultures. As such, knowing the linguistic and cultural background of the iconicity raters is important for any rating task, as is the design of the rating task itself with regard to how the raters are instructed to evaluate any items – for example, rating categorically (iconic vs. non-iconic) or on a gradient scale (less iconic to more iconic) (Motamedi et al., 2019).

While iconicity has been a frequent theme in sign language linguistics, one property of sign languages that has received surprisingly little attention in iconicity studies is the manual alphabets used to fingerspell written words. The relative lack of research into manual alphabets, in general, may be attributed to the fact that they are sometimes seen as peripheral to the language systems, being a product of language contact (with the surrounding written language) and formal education. However, fingerspelling is undeniably integral to many sign languages, and in particular to ASL and STS, which are both known to make use of it frequently in natural signing (Börstell et al., 2016; Lepic, 2019; Morford & MacFarlane, 2003). When it comes to form–meaning mapping, manual alphabet letters are quite different from other signs, since the mapping is based on individual handshapes being mapped to individual letters of a written alphabet, which in fingerspelling are then produced in sequence to spell out entire words, thus combining multiple layers of form, meaning and associations to the written modality. While it is difficult to trace iconicity historically, it is clear that at least some letters of both the ASL and STS manual alphabets are iconically motivated through the use of handshapes/movements that resemble aspects of the form of their corresponding written letters (see Section 2.2). Thus, this serves an ideal testing ground for investigating perceived iconicity of an under-explored aspect of sign languages, namely how the visual perception of manual letters relates to the visual perception of written letters, and whether language experience and familiarity affect the iconicity ratings of such letter-to-letter mappings. Whereas previous work has found cross-modal effects of iconicity ratings between sounds, graphemes and meaning, such as associating 'spiky' sounds and letters with 'spiky' meanings (e.g., Cuskley et al., 2017; Ćwiek et al., 2022), this study aims to expand our understanding of iconicity by investigating the perceived associations between signed and written representations of graphemes.

The following section introduces the manual alphabets of ASL and STS and further establishes the motivation behind the current study, looking at iconicity and subjectivity in evaluations of two manual alphabets.

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2.2. Manual alphabets

Manual alphabets exist in many sign languages, particularly those used in formal education. The use of a manual alphabet allows for encoding written letters as handshapes, such that written strings (e.g., names and words) can be fingerspelled through the sequential articulation of the corresponding manual letter handshapes. The manual letters are in fact not only handshapes, but can also be defined like other signs in sign language phonology, with orientation (where the fingers are pointed and the palm is facing) and movement (including static holds) parameters, too. Manual alphabets have been used for centuries and have been employed in deaf education and communication as a way to incorporate letters and words into signing, and there are many different manual alphabets in use today, with 'families' of alphabets that can be distinguished from each other (see, e.g., Fan, 2022; Padden & Gunsauls, 2003; Power et al., 2020). In the typology of manual alphabets, the ASL manual alphabet is part of the French Sign Language (LSF) family due to historical connections between the languages (Power, 2022; Power et al., 2020; Woodward, 1978), whereas the STS manual alphabet forms a separate family with ties to the manual alphabet used in modern day Portuguese Sign Language and those used previously in the sign languages of Finland (Bergman & Engberg-Pedersen, 2010; Power et al., 2020). There are both one-handed and two-handed (or mixed systems) manual alphabets among the sign languages of the world, but both the ASL and STS manual alphabets are exclusively one-handed (Fan, 2022). Historical sources suggest that while the founder of deaf education in Sweden did draw inspiration from LSF education in France, he was unaware of the established use of a manual alphabet there and invented his own manual alphabet specifically for STS (Bergman, 1977, p. 30; Bergman & Engberg-Pedersen, 2010, p. 87) which over time underwent some changes in the shape and orientation of letters (Bergman, 1977, pp. 30–31; Österberg, 1916). Figures 1 and 2 show the ASL and STS manual alphabets in their modern form, although there will naturally be some variation in the exact articulation of the letters, based on both

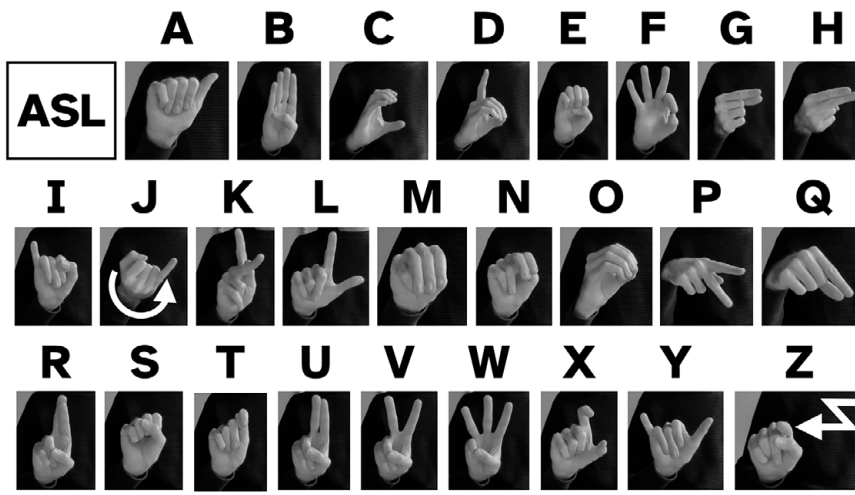

Figure 1. The ASL manual alphabet.

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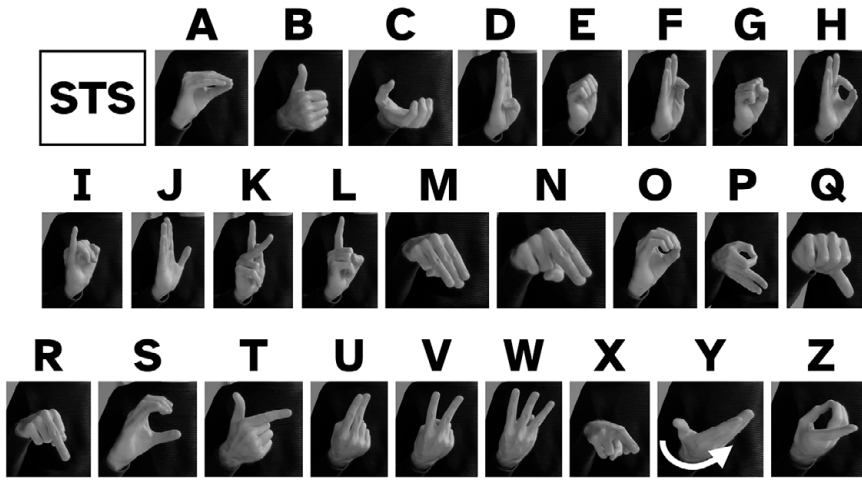

Figure 2. The STS manual alphabet (excluding <Å, Ä, Ö>).

sociolinguistic and individual variation and phonological context (Bergman, 1977, pp. 30–32; Jerde et al., 2003; Wilcox, 1992).

Based on Figures 1 and 2, we notice that there is some overlap between the alphabets. For example, the letters <I, O, K> are nearly identical in both alphabets. The letters <F, M, N> have only slight differences in handshape, and the letters <U, V, W> have identical handshapes but different orientations in the two alphabets. Conversely, the ASL letters <B, C, D, R, S> more or less correspond to the STS letters <D, S, L, X, G>, such that the forms overlap, but the meanings (i.e., the written letters encoded) differ – that is, constituting false friends for fingerspelling between ASL and STS. Thus, most letters are different in the two alphabets (n = 17), some of which are mismatched between form and meaning (n = 5), but some letters are identical or similar (n = 9). Some handshapes in both manual alphabets are quite clearly iconically motivated (e.g., <I, O, V, W> in both languages, <C> in ASL and <Q> in STS), but it is unclear to what extent the handshapes were originally chosen to be iconic, and for ASL it has been argued that the handshape-to-letter mappings are mostly arbitrary (Padden & Gunsauls, 2003, p. 11). However, historical depictions of the STS manual alphabet depict the handshapes (some of which had different orientations compared to today) next to lowercase cursive letters of similar form (Österberg, 1916), implying a form-resemblance mapping between handshapes and written letters. Two of the ASL letters – <J, Z> – include a tracing movement that arguably depicts the written letter shapes iconically (cf. Fan, 2022), but the tracing of the STS letter <Y> is not as obviously motivated iconically. Thus, while it is difficult to pinpoint the exact iconic motivations underlying the historical handshapes used in manual alphabets, it is safe to say that some could (still) be considered resembling their corresponding written letter, and some of these iconic forms (e.g., <I, O>) are practically identical across the two alphabets.

Whereas some handshapes may intuitively seem iconic in their form–meaning mapping, such that the handshape resembles a written letter, fingerspelling in itself is something that can be problematic when cross-signing or translanguaging if there is no shared system to be used, and often cross-linguistic communication involves the

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use of the ASL or international manual alphabet or simply tracing letters in the air (De Meulder et al., 2019; Holmström & Schönström, 2018; Kusters, 2021b; Zeshan, 2015, 2019). However, while fingerspelling may be avoided in cross-linguistic communication, both ASL and STS exhibit a fair amount of fingerspelling in regular language use (Börstell et al., 2016; Lepic, 2019; Morford & MacFarlane, 2003), such that fingerspelling is an integral part of both languages, with many signs that consist of fingerspelling by default. In fact, the processing of fingerspelling during early language acquisition has been argued to first involve interpreting fingerspellings as wholes, no different from other signs, before the form is reinterpreted as a sequence of letters relating to a written string of individual letters (Padden, 2005; see also Zakia & Haber, 1971).

In this study, the focus is not on fingerspelling as it is employed in regular signed conversation, but rather on the iconicity ratings by signers and non-signers of individual handshape-to-letter mappings in the ASL and STS manual alphabets, and whether language experience and proficiency influence such ratings. Since the two manual alphabets are unrelated but partially overlap in form for some letters, it will be possible to dig deeper into possible effects of language experience. That is, the comparison concerns not only whether familiarity with the form–meaning mappings within an individual language influences ratings, but also whether similarities in form–meaning mappings across manual alphabets have an effect, thus looking at interactions of both language experience and form overlap. This design follows the previous work of Occhino et al. (2017) and Omardeen (2018) but adds to that work by expanding the view of possible iconic mappings into a new area, namely to what extent there is perceived iconicity in the form–meaning mappings between signed forms (i.e., manual letters) and the written representations of the letters of the alphabet (i.e., graphemes). Thus, this study aims to expand on our knowledge about iconicity in language by looking at how it is employed (e.g., depicting written language) and across which modalities (e.g., mapping signed forms to graphemes), and how the perception of iconicity is potentially influenced by language experience (e.g., manual alphabets and writing systems).

2.3. Research questions

From the previous sections, we can gather that the view and definition of iconicity have changed somewhat in linguistics, now acknowledging the gradient and subjective nature of the phenomenon. Cross-linguistic iconicity ratings point to entrenchment and familiarity affecting the perceived resemblance in form–meaning mappings, such that one's own sign language is rated as more iconic than foreign ones (Occhino et al., 2017). We have also seen that while there are some partial overlaps between the ASL and STS manual alphabets, they are classified as different manual alphabet systems on the basis of both historical sources and form-similarity typology (Bergman & Engberg-Pedersen, 2010; Power et al., 2020). Thus, the two manual alphabets form a suitable sample for investigating cross-linguistic iconicity ratings and the impact of familiarity and exposure. By sampling two historically unrelated manual alphabets, we can avoid form overlaps between the alphabets that are a direct consequence of shared origin. Although the ASL and STS manual alphabets do share some form–meaning mappings, these are not based on historical cognates, but possibly similar iconic motivations in their creation and/or change over time. The

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fact that some letters do in fact still overlap across the two alphabets allows for an interesting additional point to address: Are similar forms in a foreign sign language rated as more iconic by L1 and L2 users? and Does the form-similarity suggest a shared iconic motivation across languages (e.g., as perceived by non-signers)? Additionally, since ASL is a sign language that many deaf users of other sign languages know or have been exposed to, including STS signers, it is possible to see whether proficiency in ASL correlates with iconicity ratings – that is, whether higher familiarity with the language (specifically the manual alphabet here) corresponds to higher iconicity ratings. Since the two manual alphabets are both exclusively one-handed systems, it removes the dimension of number of hands in the articulation as a variable in the comparison, and most letters are encoded by unique handshapes and mainly in a static articulation (only a few letters involving tracing).

The research questions guiding this study are the following:

1. Do deaf/hard-of-hearing L1 signers of ASL and STS rate their own manual alphabet as more iconic than the other (foreign) one?
2. Does the L2 ASL proficiency of deaf L1 signers of STS affect how iconic they rate the ASL manual alphabet?
3. Do hearing L2 signers of ASL and STS rate their own manual alphabet as more iconic than the other (foreign) one?
4. Do hearing non-signers rate either manual alphabet as more iconic than the other?
5. Which manual letters are rated as more iconic across groups?

3. Methodology

3.1. Data collection

For this study, an online survey was created using Google Forms and shared through social media platforms with voluntary participation. The survey consisted of an initial section with information about the study and collection of basic, non-identifiable metadata (e.g., age, language background, language proficiency in ASL and STS). The respondents would choose if they wanted to respond to the questions in English or Swedish, and subsequent questions were in the selected language only. Following the metadata questions, a prompt was shown reading, *'For each letter in the alphabet, select how similar the handshapes are to the shape of the letter: from 0 (not similar) to 7 (very similar)'*, after which each letter of the English alphabet ($n = 26$) was presented in alphabetical order one at a time. The Swedish alphabet (and similarly the STS manual alphabet) has a total of 29 letters, consisting of the 26 letters of the English alphabet and the additional <å, ä, ö>, in that order, at the very end of the alphabet – these extra Swedish letters were thus excluded from the survey as they have no corresponding letters in the English or ASL alphabets. In this article, I will use lowercase letters in angle brackets to represent the written grapheme (e.g., '<a>'), but uppercase letters in angle brackets to refer to the manual alphabet representations (e.g., 'ASL <A>'). Each letter was presented with a letter stimulus consisting of the letter in upper- and lowercase in two different fonts: Arial (representing printed letters) and Bradley Hand Bold (representing handwritten letters) – see Figure 3.

Below each letter stimuli, there were two still images: the first showing the corresponding manual alphabet letter in ASL; the second showing the corresponding

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Figure 3. Example of written letter stimuli for the letter <a> in the survey.

manual alphabet letter in STS. Images for letters that contain a movement – that is, ASL <J, Z> or STS <Y> – had arrows superimposed on the image to indicate the movement. Below each image, there was a rating scale from 0 (*'Not similar'*; left) to 7 (*'Very similar'*; right), where each score 0 to 7 could be selected using radio buttons. The survey responses were anonymous, and no personal identifiers were collected.

3.2. Participants

In total, responses from 128 participants were collected with the survey. However, additional filtering of these responses was carried out in order to arrive at five groups of participants: two representing deaf/hard-of-hearing (DHH) L1 signers of each of the two sign languages (ASL and STS); two representing hearing L2 signers of each of the two sign languages (ASL and STS); and a control group of hearing non-signers who reported no prior knowledge of any sign language (ASL, STS or other). Thus, the final number of participants was 72 (44 women, 24 men, 4 other; mean age = 38, *SD* = 12.7): L1 ASL ($n = 8$; 2 women, 4 men, 2 other; mean age = 35, *SD* = 9.4); L1 STS ($n = 34$; 21 women, 13 men; mean age = 42, *SD* = 12.8); L2 ASL ($n = 10$; 6 women, 2 men, 2 other; mean age = 34, *SD* = 13.6); L2 STS ($n = 10$; 9 women, 1 man; mean age = 37, *SD* = 12.2); non-signers ($n = 10$; 6 women, 4 men; mean age = 30, *SD* = 9.4). The L1 ASL signers reported no or almost no prior knowledge of STS (mean rating = 1.6, *SD* = .35), whereas the L1 STS signers reported varying degrees of ASL knowledge (mean rating = 3.15, *SD* = 1.58) on the same scale from 0 to 7. The L2 signers reported no prior knowledge of the other sign language in the study. Among the 10 non-signers, 3 reported having lived (currently or previously) in the USA or Canada, and 4 reported having lived (currently or previously) in Sweden.

3.3. Data analysis

The responses from the online survey were processed with R 4.3.2 (R Core Team, 2023) using the RStudio (v2023.09.1 + 494) interface, initially tidied and filtered down to the 72 final sets of participants with the packages {here} v1.0.1 (K. Müller, 2020), {janitor} v2.2.0 (Firke, 2023) and {tidyverse} v2.0.0 (Wickham et al., 2019), and then further visualized and analyzed using the packages {ggbeeswarm} v0.7.2 (Clarke et al., 2023), {ggrepel} v0.9.3 (Slowikowski, 2023), {ggtext} v0.1.2 (Wilke & Wiernik, 2022), {lme4} v1.1.33 (Bates et al., 2015), {ordinal} v2022.11.16 (Christensen, 2022), {patchwork} v1.1.2 (Pedersen, 2022), {scales} v1.2.1 (Wickham & Seidel, 2022) and {tidyverse} v2.0.0 (Wickham et al., 2019). In total, the data contains 3,744 ratings of handshape–letter iconicity, since each of the 72 participants has rated every written letter of the alphabet ($n = 26$) twice: once for its mapping to the ASL manual letter and once for its mapping to the STS manual letter. The ratings were further processed such that they were also *z*-scored by participant – that is, each of the participant's ratings was recalculated as the rating score (0 to 7) minus the mean of the

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participant's ratings, divided by the standard deviation of the participant's ratings. This rescaling ensures that participants' scores are more easily cross-comparable, as some participants may use the original rating scale (0 to 7) differently from others – for example, only using the upper end of the scale (see Schütze & Sprouse, 2013, p. 43). It will be explicitly stated whether raw (0 to 7) or standardized (*z*-scored) ratings are used in statistical analyses and visualizations in the following. The data and scripts for analyses are available at https://osf.io/ehdvb.

4. Results

4.1. Iconicity ratings across DHH L1 signers

Addressing the first research question, whether deaf/hard-of-hearing (DHH) signers rate their own sign language's manual alphabet as more iconic than the foreign one, we can see the distribution of iconicity ratings in Figure 4, where the raw score ratings are shown as histograms on the left and the grouped *z*-scored ratings are shown as boxplots on the right. For both ASL and STS signers, there are more ratings on the positive end of the scale for one's own sign language than for a foreign one. The L1 STS raters exhibit a more extreme distribution for foreign-rated letters, with many very high (7) and very low (0) ratings, compared to the L1 ASL raters, whose ratings of the foreign letters are more evenly distributed across the rating scale. For the ratings of one's own manual alphabet, both languages are distributed more similarly.

To investigate whether the ratings differ with regard to rating one's own versus a foreign language, I constructed an ordinal mixed effects regression model with the original ratings as the outcome and language rated (own or foreign) and native language of the participant (ASL or STS) as fixed effects, and letter (<A> to <Z>) and participant as random effects, both with random slopes and intercepts for language rated. An ordinal regression model has the advantage of treating the rating scale not as continuous data, but rather as ordinal data, and as such evaluates whether ratings

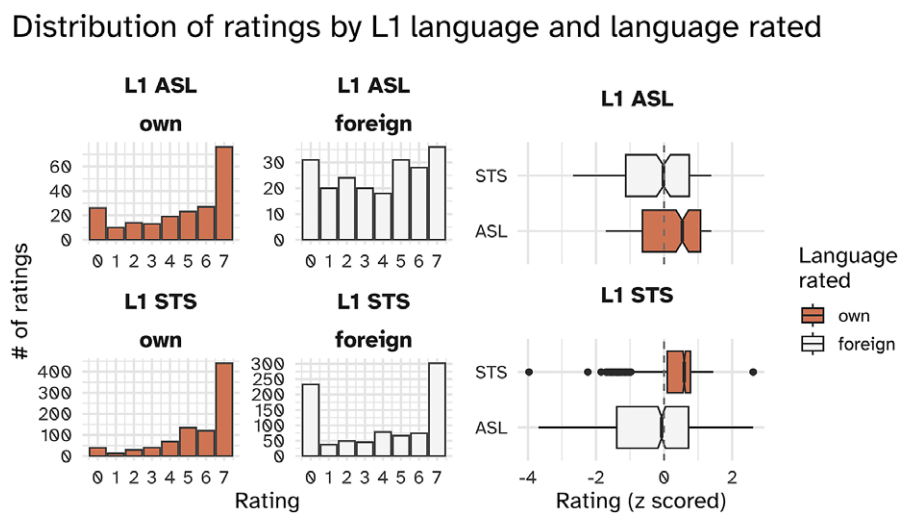

Figure 4. Distribution of ratings across languages by L1 and language rated: red (dark) fill is own language rated; white (light) fill is foreign language rated.

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Table 1. Summary of the fixed effects from the mixed effect regression model of language rated as a predictor of iconicity ratings by L1 signers

Fixed effects	Estimate	*SE*	*z*	
Language rated = foreign	−1.64	0.41	−4.05	***
Native language = STS	0.61	0.39	1.56	

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

are positioned on the ordered scale relative to each other (e.g., above, below or at the same position). A likelihood ratio test comparing the full model against a null model excluding language rated as a fixed effect shows that there is a statistically significant effect of language rated (own or foreign) on the rating of manual letters ($\chi^2(1) = 14.04$; $p < 0.001$***). As can be seen in Table 1, rating a foreign language's manual alphabet is associated with a lower iconicity rating across participants of both L1 languages (ASL and STS), with no significant difference in native language.

Looking at the ratings for each L1 participant individually, calculating the mean of their ratings across all letters, we see from Figure 5 that all 34 of the L1 STS signers rate the STS manual alphabet as more iconic than ASL (points are below the diagonal reference line), and all but one of the eight L1 ASL signers rate the ASL manual alphabet as more iconic than the STS manual alphabet (points are above the diagonal reference line) – that is, all but one of all L1 DHH participants rate their own manual alphabet as more iconic, on average, across all letters. What is also visible from Figure 5 is that six of the STS signers consistently rate the letters of their own manual alphabet as highly iconic (mean rating > 6.5) but with a wide range of mean ratings for the ASL manual alphabet, thus situated along a vertical line at the right-most end of the *x*-axis. However, re-fitting the mixed effect model described above with these participants removed still shows a significant effect of language rated compared to a null model ($\chi^2(1) = 10.33$;

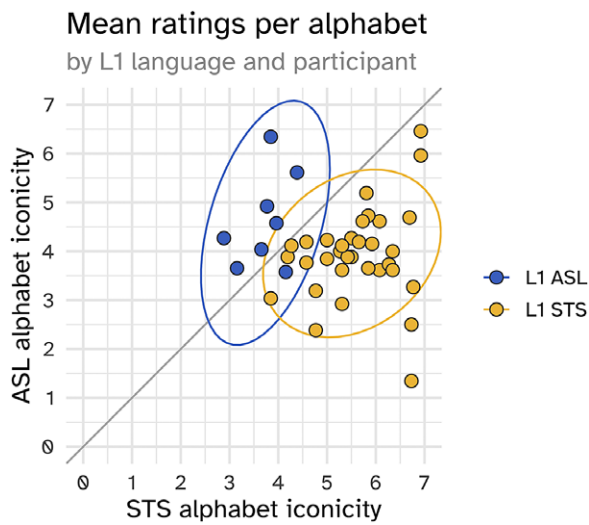

Figure 5. Mean iconicity ratings per manual alphabet by L1 and participant: blue (dark) points show L2 ASL signers; yellow (light) points show L2 STS signers. Points above the diagonal reference line on average rate ASL letters as more iconic, whereas points below the diagonal reference line on average rate STS letters as more iconic.

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$p < 0.01$**), demonstrating that ratings of own language are higher than those of a foreign language, across participants and languages.

Based on the distribution of ratings in the two groups, we can conclude that L1 signers of ASL and STS generally rate their own manual alphabet as more iconic than the foreign one – that is, there is an iconic preference for the manual alphabet in one's own sign language.

4.2. Iconicity ratings across deaf L2 signers

Looking specifically at the deaf L1 STS signers, many of the participants reported some ASL proficiency. This leads to the second research question, which asked whether L2 ASL proficiency level affects iconicity ratings of the ASL manual alphabet by deaf L1 STS signers. Figure 6 shows the distribution of raw and *z*-scored ratings for the ASL manual alphabet, as rated by the L1 STS participants grouped into low (0–3), and high (4–6) proficiency in ASL, based on their self-reported proficiency on a scale from 0 to 7 (no L1 STS participant reported a proficiency at 7).

I fitted a mixed effects regression model based on the L1 STS signers, with *z*-scored ratings as the outcome and L2 ASL proficiency level by category (high vs. low) as a fixed effect and letter and participant as random effects. Here, *z*-scored ratings of the ASL letters are used as they are relative to all the ratings – that is, relative compared to the STS letters – and should thus show higher ratings for those L1 STS signers who rate the ASL letters higher relative to all the letters rated (ASL or STS). A likelihood ratio test comparing the full model against a null model excluding ASL level as a fixed effect shows a non-significant effect of ASL proficiency as a predictor of iconicity ratings ($\chi^2(1) = 2.41; p = 0.12$). We can thus conclude that there is no discernible effect of L2 proficiency on the iconicity ratings of a foreign manual alphabet in this data – see Table 2.

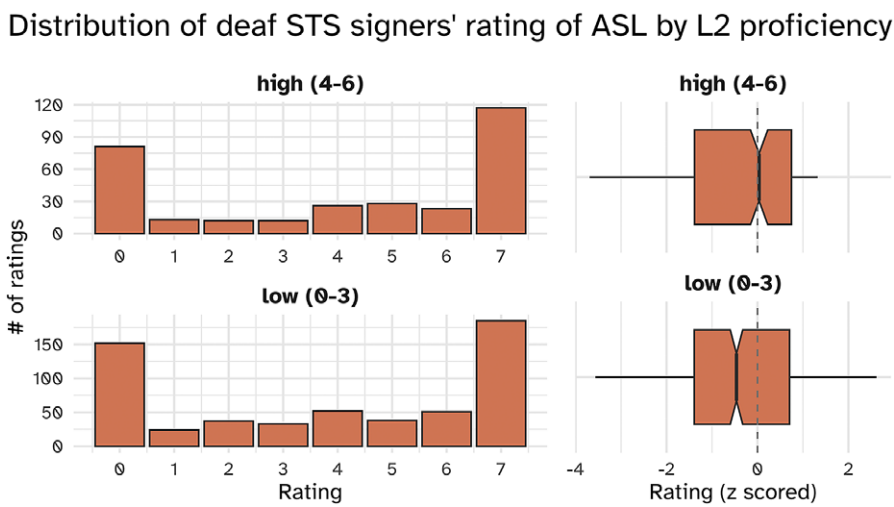

Figure 6. Distribution of ratings across deaf L2 signers of ASL by self-reported proficiency from 0 (lowest) to 7 (highest), grouped into low (0–3) and high (4–6) proficiency level. No signer reported L2 ASL proficiency of 7.

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Table 2. Summary of the fixed effects from the mixed effect regression model of L2 proficiency as a predictor of iconicity ratings of a foreign language by L1 STS signers

Fixed effects	Estimate	*SE*	*t*
(Intercept)	−0.37	0.17	−2.18
ASL level: high	0.10	0.06	1.58

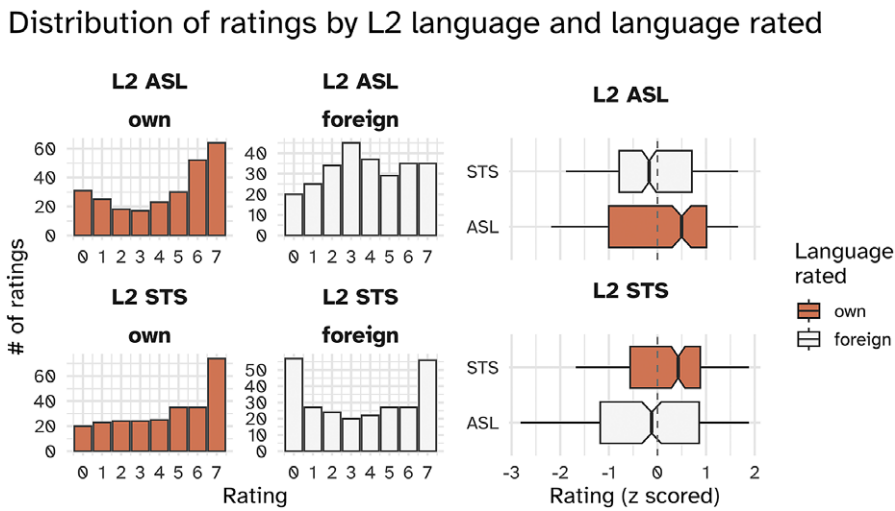

Figure 7. Distribution of ratings across languages by L2 and language rated: red (dark) fill is own language rated; white (light) fill is foreign language rated.

4.3. Iconicity ratings across hearing L2 signers

Turning to the hearing L2 signers, we can address the third research question, whether or not hearing L2 signers rate their own manual alphabet (i.e., the manual alphabet of which they are L2 learners) as more iconic than a foreign one, similar to what was found for L1 signers in Section 4.1. Figure 7 shows the distribution of iconicity ratings for the two groups and demonstrates a similar pattern to that found for L1 signers (Figure 4).

I fitted an ordinal mixed effects regression model with the original ratings as the outcome and language rated (own or foreign) and L2 language of the participant (ASL or STS) as fixed effects, and letter and participant as random effects, both with random slopes and intercepts for language rated. A likelihood ratio test comparing the full model against a null model excluding language rated as a fixed effect shows that there is a statistically significant effect of language rated (own or foreign) on the rating of manual letters ($\chi^2(1) = 10.79$; $p < 0.01^{**}$). As can be seen in Table 3, rating a foreign language's manual alphabet is associated with a lower iconicity rating across participants of both L2 languages (ASL and STS), similar to what was found for the L1 signers, with no significant effect of their L2.

Looking at the ratings for each L2 participant individually, calculating the mean of their ratings across all letters, we see from Figure 8 that all 10 L2 STS signers rate the STS manual alphabet as more iconic than ASL (squares are below the diagonal reference line), and 8 out of 10 L2 ASL signers rate the ASL manual alphabet as more

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Table 3. Summary of the fixed effects from the mixed effect regression model of language rated as a predictor of iconicity ratings of a foreign language by L2 signers

Fixed effects	Estimate	*SE*	*z*	
Language rated = foreign	−0.72	0.20	−3.61	***
L2 = STS	−0.37	0.23	−1.60	

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.

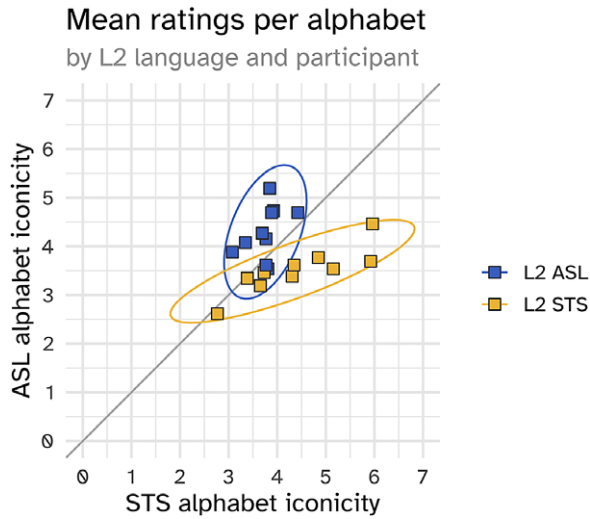

Figure 8. Mean iconicity ratings per manual alphabet by L1 and participant: blue (dark) squares show L2 ASL signers; yellow (light) squares show L2 STS signers. Squares above the diagonal reference line on average rate ASL letters as more iconic, whereas squares below the diagonal reference line on average rate STS letters as more iconic.

iconic than the STS manual alphabet (squares are above the diagonal reference line). The picture is thus very similar to the one shown in Figure 6 in that hearing L2 signers – like DHH L1 signers – exhibit a preference for their own (L1 or L2) manual alphabet compared to a foreign one. Unlike the picture for L1 signers (Figure 6), there are no participants in the L2 signer group that consistently rate all of the letters of their own manual alphabet as highly iconic.

4.4. Iconicity ratings across signers and non-signers

The last two research questions addressed whether hearing non-signers exhibit a preference for higher iconicity ratings for one of the two sign languages' manual alphabets (ASL or STS) – that is, judge one manual alphabet to be more iconic than the other – and whether there are patterns across groups for certain letters being rated as more or less iconic. Figure 9 shows the mean iconicity ratings for each of the two manual alphabets across the hearing non-signing participants (i.e., participants who reported no knowledge of any sign language, whether part of this study or not), compared to the L1 and L2 signers' ratings, repeated from Figures 5 and 8, but in fainter colors. Figure 9 shows that whereas L1 and L2 signers generally show a

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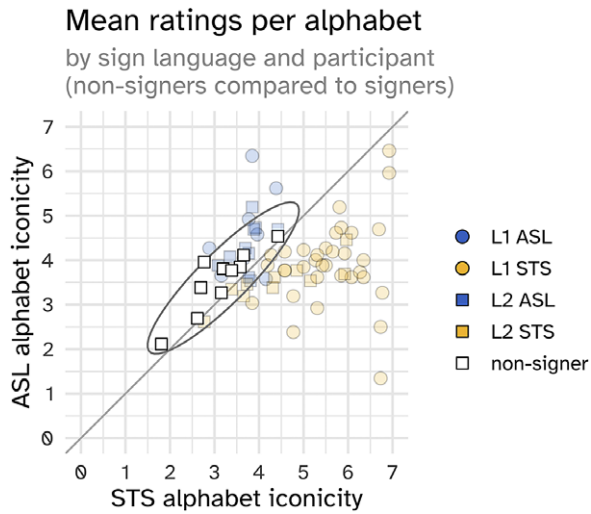

Figure 9. Mean iconicity ratings per manual alphabet by sign language and participant (non-signers compared to L1 and L2 signers). Squares/points above the diagonal reference line on average rate ASL letters as more iconic, whereas squares/points below the diagonal reference line on average rate STS letters as more iconic.

preference for one language (namely their own, familiar language), the non-signers' ratings are distributed very evenly along the diagonal reference.

I fitted an ordinal mixed effects regression model with the original ratings as the outcome, with language rated (ASL or STS) as a fixed effect and letter and participant as random effects, both with random slopes and intercepts. A likelihood ratio test comparing the full model against a null model excluding language rated as a fixed effect shows that there is no statistically significant effect of language rated (ASL or STS) on the iconicity ratings of manual letters among non-signers ($\chi^2(1) = 1.87$; $p = 0.17$). That is, non-signers do not rate the two manual alphabets differently with regard to iconicity of their manual letters – see Table 4.

Finally, we can look at the iconicity ratings of individual manual letters across all groups to see if there are general preferences visible across groups. Figure 10 shows the mean of means of iconicity ratings as well as the range of means across the five groups (L1 ASL, L1 STS, L2 ASL, L2 STS and non-signers) – that is, each group is weighted as one (mean) value. In Figure 10, letters are sorted alphabetically from left to right, with the ASL letter ratings in the top panel and STS letter ratings in the bottom panel, with the dots showing the mean of group means and the whiskers showing the range (i.e., the highest and lowest) of the group means.

In Figure 10, we can see that a number of letters are rated as higher than average in iconicity, with all group means above the zero line. Several of the letters rated as

Table 4. Summary of the fixed effects from the mixed effect regression model of language rated as a predictor of iconicity ratings of two unknown manual alphabets by hearing non-signers

Fixed effects	Estimate	*SE*	*z*
Language rated = STS	−0.59	0.42	−1.41

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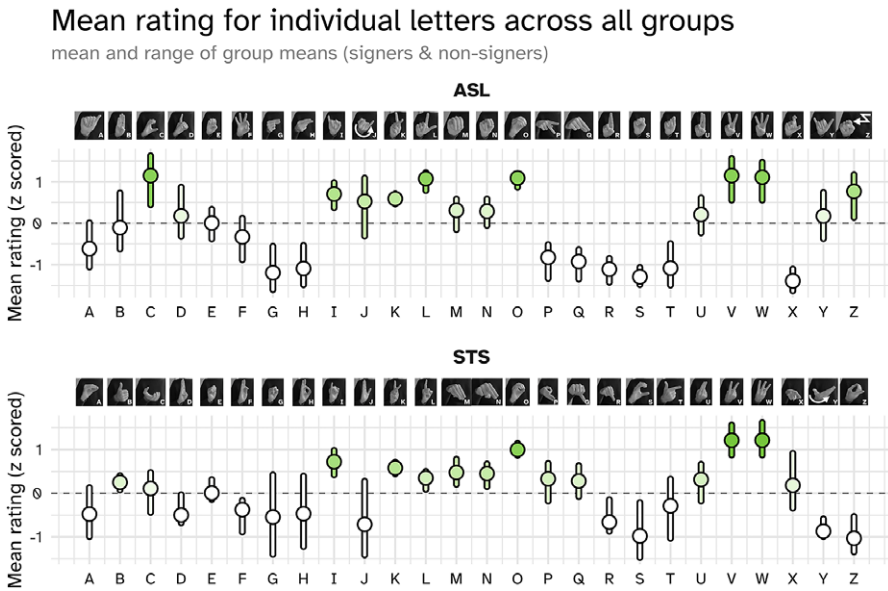

Figure 10. Iconicity scores across groups (signers and non-signers). Points show the mean of means of *z*-scores by group across the five groups, such that each group is given equal weight, and the whiskers show the range of group means. The green fill color reflects mean iconicity (darker means higher cross-group mean iconicity ratings).

highly iconic across groups are rated as iconic in both ASL and STS, and are very similar in form across languages, for example, <I, K, O, V, W>. Additionally, we can see that some letters are rated as low in iconicity in both manual alphabets, for instance, <S, R, G, H>, which all use different handshapes in ASL and STS. This can be compared to Figure 11, in which the letters are ranked from those rated as most iconic in ASL on the left side of the *x*-axes to those rated as most iconic in STS on the right, by showing the difference in ratings for each letter: the ASL letter rating minus the STS letter rating, both *z*-scored, per letter and participant. Blue (dark) filled points mark letters rated more iconic in ASL across all groups, and yellow (light) filled points mark letters rated more iconic in STS across all groups; unfilled (i.e., white) points have no absolute cross-group preference. The whiskers show the range of the highest and lowest rating differences across groups.

From Figure 11, we can see which individual manual letters are seen as more iconic in either language or equally iconic in both. For instance, we see that those letters that are similar in form across the ASL and STS manual alphabets are positioned along the zero reference line, as they are also rated as similarly iconic in both languages. We also see that four manual letters are rated more iconic in ASL across all groups – <C, Y, Z, L> – and four manual letters are rated more iconic in STS across all groups – <R, P, Q, X>, and these are conversely letters that differ in handshape and/or orientation across the two languages. Here, it is noteworthy that <R> has a cross-group preference for STS – that is, all groups rate STS <R> as more iconic than ASL <R>, on average – but Figure 10 shows that <R> is rated as relatively low in iconicity in both languages. As such, <R> is not rated among the most iconic letters in either language, but raters across groups see it as more iconic in STS compared to its ASL counterpart.

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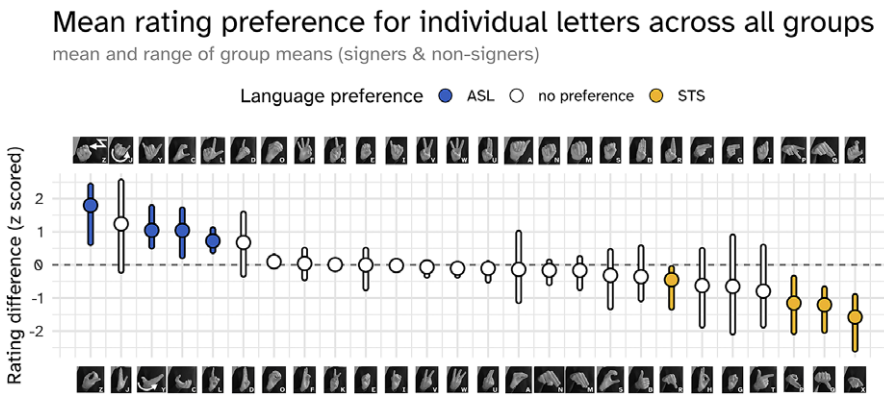

Figure 11. Iconicity preferences for individual letters in both manual alphabets across all groups. Points show the mean of means across groups, and the whiskers show the range of group means. Blue (dark) filled points show letters for which all group means are higher for the ASL manual letter, and yellow (light) filled points show letters for which all group means are higher for the STS manual letter. Whiskers show the range of group mean differences.

We can see from Figures 10 and 11 that there is a lot of variation in the ratings of individual letters. As such, neither manual alphabet is always preferred across the board in any group: although the L1 and L2 signers show a bias in the direction of their own manual alphabet, individual letters can still be rated as more iconic in the foreign one. However, based on Figures 10 and 11, it is striking that letters that are identical or highly similar across the ASL and STS manual alphabets not only tend to be rated similarly, which is expected, but also as highly iconic in both languages. For instance, out of all the letters that are similar across alphabets – <I, O, K, F, M, N, U, V, W> – only <F> is rated as less iconic than most other letters across groups (see Figure 10) and some of the others are rated as the most iconic letters overall (e.g., <V, W>). To delve deeper into this, Figure 12 shows the distribution of *z*-scored ratings across groups based on whether or not the letter handshapes are similar for the same meaning across ASL and STS.

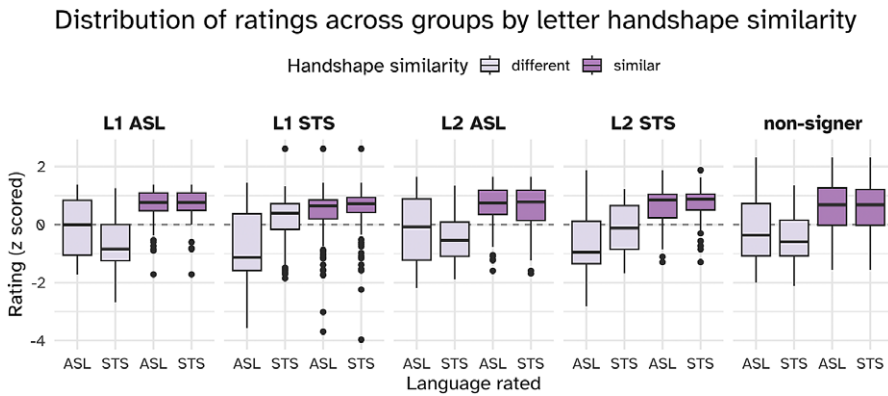

Figure 12. Distribution of iconicity ratings (*z*-scored) across groups (signers and non-signers) based on form-similarity between the ASL and STS letters (different or similar).

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I fitted another ordinal mixed effects regression model with the original ratings as the outcome and similarity (different or similar) as a fixed effect and group and participant as random effects, both with random slopes and intercepts. A likelihood ratio test comparing the full model against a null model excluding similarity as a fixed effect shows that there is a statistically significant effect of similarity (similar or different) in the handshape encoding the same letter on the iconicity ratings across signers and non-signers ($\chi^2(1) = 18.84$; $p < 0.001^{***}$). The effect of similarity is statistically positive (est. = 1.66, $SE = 0.11$, $p < 0.001^{***}$), such that similar forms on average are rated as more iconic than forms that are different across signers and non-signers.

5. Discussion

It is well known that sign languages make use of iconicity in both established and productive signs (Emmorey, 2014; Klima & Bellugi, 1979a; Lepic & Occhino, 2018; Meir & Tkachman, 2018; Taub, 2001; Wilcox, 2004) and the handshape parameter of a sign may contribute to a specific iconic mapping, such that it represents the shape of an object, or represents the hand as it is performing an action (Coppola & Brentari, 2014; Occhino, 2017; Ortega & Morgan, 2015; Padden et al., 2013, 2015). It is clear that some of the handshapes involved in the ASL and STS manual alphabets were selected on the basis of a form-resemblance to the written character (Bergman, 1977, pp. 30–32), but changes over time could lead to both a reduced resemblance between form and meaning because of phonetic ease of articulation and possible convergence of more iconic forms across unrelated manual alphabets to more closely match the handshape with the form of the written letter (Power et al., 2020) – cf. Frishberg (1975, 1979) on lexical signs. However, the topic of manual alphabets as part of iconic patterns in sign languages has rarely been discussed, leaving a gap in our understanding of how iconicity is perceived in the mapping between the signed and written modalities. Thus, the goal of this study was to look at iconicity ratings of two unrelated sign languages' manual alphabets across groups of signers (L1 and L2) and non-signers to see how individual manual letters were rated as more or less iconic, and to see to what extent language experience influences such ratings.

With regard to the first research question, it was found that L1 experience does influence iconicity ratings of manual alphabet letters, such that DHH L1 signers of ASL and STS generally rate their own sign language's manual alphabet as more iconic than the other (foreign) one. This aligns with the findings by Occhino et al. (2017) who found this pattern in the iconicity ratings of lexical signs by signers of ASL and German Sign Language (DGS). While the iconicity ratings vary by individual manual letter, such that participants find one form to be more iconic regardless of it being native or foreign, there is still a clear pattern of a preference toward one's own manual alphabet. This suggests that the exposure and entrenchment of one's own language affect the familiarity with forms, establishing a perceived resemblance between language-specific form–meaning mappings: in this case, between handshapes and written letters. This also reinforces the importance of taking language background into account when working with iconicity ratings: since language experience influences iconicity ratings, it is crucial to know who your raters are and what they are asked to rate (cf. Motamedi et al., 2019).

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The second research question expanded on the question of language experience and proficiency influencing perceived resemblance between form and meaning in a manual alphabet by looking at the self-reported L2 ASL proficiency ratings of the L1 STS signers, since ASL is a sign language often used in international settings and one that many deaf and hard-of-hearing people outside North America are exposed to (see Kusters, 2021a). It was found that the data does not support the assumption that ASL proficiency ratings predict iconicity ratings for ASL manual letters in L1 STS signers knowing ASL as an L2. The use of self-reported proficiency here may be a less ideal metric for judging ASL familiarity and proficiency, which could instead have been measured using a language test (cf. Occhino et al., 2020; Schönström & Hauser, 2022). However, two things should be taken into account here. First, the overall data shows that participants across groups tend to vary their ratings on the level of individual manual letters, as was intended in the experimental design, such that each letter is rated on its own iconic merits. Participants generally agree that certain manual letters are iconic and some are not, regardless of which manual alphabet they belong to. Second, the task itself required participants to rate both languages' manual alphabets simultaneously, meaning that each written letter of the alphabet is rated for its iconic mapping to both the ASL and the STS manual letter, which could influence the ratings compared to a monolingual design where only ASL was tested. While the design may have an impact on the ratings, such that participants were always exposed to both options (ASL and STS) for each written letter, the variation in ratings of individual letters seen across groups still suggests that participants generally rated their perceived form–meaning resemblance accurately on a letter-by-letter basis.

The third research question expands on the first two research questions, looking at how hearing L2 learners of ASL and STS rate their own (L2) compared to a foreign manual alphabet. In line with the findings from the L1 signers, L2 signers too show a preference toward their own manual alphabet compared to a new, foreign one, with L2 ASL signers showing an iconic preference for the ASL manual alphabet and L2 STS signers showing an iconic preference for the STS manual alphabet. As with the L1 signers, there is a lot of variation on the basis of individual letters, showing that participants do rate each letter on its own form–meaning resemblance, but that the pattern of known, familiar and entrenched forms being rated as more iconic still holds. This is particularly interesting seeing as it suggests that this familiarity and entrenchment of form–meaning mappings is visible not only in life-long L1 exposure, but also in late(r) L2 learners of the languages.

The fourth and fifth research questions both addressed whether there are global preferences or trends in the iconicity ratings of the two manual alphabets, such that hearing non-signers with no reported sign language knowledge would exhibit an iconic preference for one manual alphabet over another, and whether certain individual letters are iconically preferred across groups. Interestingly, the hearing non-signers show no preference for either manual alphabet as a whole, further supporting the idea of language familiarity, exposure and entrenchment being important in the iconic rating of form–meaning mappings. That is, with no exposure to either language, their manual alphabets are judged as equally iconic – taken as a whole. It should be noted that it is unclear whether the non-signers – and also signers who reported no knowledge of any other sign language – would have ever seen either of the two manual alphabets before they participated in the study. The ASL manual alphabet is often used to represent sign languages internationally in different ways, such as in logotypes or merchandize referencing sign language(s), and the ASL

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manual alphabet is also similar to manual alphabets in other sign languages, due to the size and spread of that manual alphabet family (see Power et al., 2020), and manual alphabets in general tend to be used in various contexts outside of formal sign language teaching. Nonetheless, when compared to the L1 and L2 signer groups, it is clear that some of the manual letters are rated as iconic without the participants having any prior knowledge of the language (including STS, which would be much less likely to be exposed to outside of Sweden), seeing as there are some preferences across all groups, including the non-signers.

Looking at the letters that are preferred across groups, there are several observations that can be made. Interestingly, two of the preferred ASL letters involve tracing the shape of the letter, <J> and <Z> (see Figure 1), which may influence the preference in favor of those letters – that is, rather than the *handshape* itself resembling the written letter, it is the *tracing* that resembles the letter. This is particularly noteworthy considering the instructions in the survey stated that participants were to rate the resemblance of the *handshape* rather than the movement, but it is unsurprising that participants identify these manual letters as iconic since it involves tracing the shape of the written letters in the air, which is a strategy that may be used in multimodal gestural communication even without any sign language knowledge. Naturally, although the task instructions ask the participants to rate the handshape, they cannot avoid seeing the tracing depicted and will undoubtedly be influenced by it, consciously or not. In general, it is difficult to know how each individual participant, across groups, interpreted the instructions given in the task. Although they rated the handshapes in terms of their similarity to the printed letters (see Figure 3), they may not have the same idea of how to evaluate this – whether or not the comparison is made directly with the printed letters shown or some abstract idea of the shapes of these letters, or if they also include a relative comparison between the representations (handshapes) in the two languages. However, this comes back to the issue of why iconicity needs to be evaluated across participants, that it is crucial to account for participants' linguistic and cultural background, and that the way the task is designed is documented and reported (cf. Motamedi et al., 2019).

Furthermore, some letters that are nearly identical in both manual alphabets (<I, O, K>) end up being rated more or less equally across all groups, as are most of the letters with only slight differences in handshape (<F, M, N>) and or orientation (<U, V, W>). Apart from <F>, these letters generally have relatively high iconicity ratings across groups for both languages. This shows that most similar forms across languages are perceived as more iconic across groups of signers and non-signers, suggesting that such forms are either iconically motivated from their creation and/or have converged on similar iconic forms, with the iconic mapping between form and meaning perceived even by non-signers who were not familiar with any sign language. The fact that some letters happen to be highly iconic and simultaneously similar in form across the two manual alphabets could be a consequence of a conscious motivation in the original formation of the manual alphabet, but also historical changes that may relate to convergent evolution in preference of iconicity (cf. Power et al., 2020) or to some extent even language contact. With regard to the last point, anecdotal evidence suggests that younger STS signers prefer a variant of <L> that looks like the ASL <L>, resembling the uppercase written letter (see Svenskt teckenspråkslexikon, 2023, https://teckenspraklexikon.su.se/ord/08941/samma-betydelse). This could be a consequence of language contact with other sign languages, including ASL, as is seen in the incorporation of ASL borrowings in other sign

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languages (cf. McKee & McKee, 2020). This change, whether completed or not, could also partially stem from a preference for a form that maps onto the more uniquely shaped uppercase <L> compared to lowercase <l>, in order to make the iconic mapping more salient. Thus, an interesting further experiment would be to see whether there is a generational difference among STS signers not only in their use of the two variants of <L>, but also whether they have different perceptions about their iconicity.

One issue – raised by an anonymous reviewer – is that this study, in fact, involves yet another dimension of language experience, namely familiarity with the Latin script. Since both English and Swedish use alphabets with variations of the same script, it means that all participants were familiar with this script already. In the context of the experimental design and aims of this study, this is unproblematic seeing as the iconic ratings only involved the mapping between one written script and two manual alphabets, thus focusing on the perception of the manual alphabets' form only. However, there are many more manual alphabets across the sign languages of the world, and in some cases, there is overlap in the manual alphabets even if a different script is used for the written language in a sign language community. For example, Israeli Sign Language uses a manual alphabet based on the European-derived system that is also used in ASL, but the manual letters represent graphemes of the Hebrew script, with some minor adaptations. Thus, an interesting follow-up study to this one would be to include form-differences also in the grapheme part of the mapping, for example, how the <A> handshape is perceived as iconically depicting the written <a> vs. <א> (the Hebrew letter *alef*) by signers of ASL and Israeli Sign Language.

Taken together, the results of this study support previous findings by Occhino et al. (2017) and Omardeen (2018) in that sign language experience and entrenchment, but also form overlap, influence iconicity ratings. In their studies, the target was lexical signs from one's own or a foreign sign language, but here it was the individual letters of the manual alphabets of the languages. Here, the focus was on the letters of the unrelated manual alphabets of two unrelated sign languages (ASL and STS), with the goal to see whether the same subjective patterns due to language experience would still hold for mappings between handshapes and written characters, thus expanding our understanding of this phenomenon into a previously under-explored dimension of cross-modal iconic mappings (i.e., signed to written language). Across groups, some letters are generally rated as more iconic, but across both L1 and L2 signers of ASL and STS, there was indeed an effect of language experience and exposure such that the letters of one's own familiar manual alphabet are rated as more iconic than those from a foreign one, further supporting previous claims that language exposure and experience influence iconicity ratings, making iconicity a subjective phenomenon that is dependent on language background as well as cultural and personal experiences.

Data availability statement. The data and scripts used for this study are available at: https://osf.io/ehdvb.

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Competing interest. The author declares none.

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