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1 **How are signed languages learned as second languages?**

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4 Key words: signed Language, second language acquisition, hearing learners

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8

9 **Abstract**

10 This review addresses the question: How are signed languages learned by adult hearing learners?

11 While there has been much research on second language learners of spoken languages, there has

12 been far less work in signed languages. Comparing sign and spoken second language acquisition

13 allows us to investigate whether learning patterns are general (across the visual and oral

14 modalities) or specific (in only one of the modalities), and hence furthers our understanding of

15 second language acquisition (SLA). The paper integrates current sign language learning research

16 into the wider field of SLA by focusing on two areas: 1. does ‘transfer’ occur between the

17 spoken first language and signed second language, and 2. what kind of learning patterns are the

18 same across language modalities versus unique to each modality?

19

20

1. Introduction

1.1 Second language acquisition as a field

Second-language acquisition (SLA) research deals with the process of learning other languages after one's native language (Epstein, Flynn, & Martohardjono, 1996). In addition, SLA research deals with the various strategies that exist for teaching and evaluating language learning in adults. An issue debated in the research on SLA is whether some of the properties or elements that characterize a learner's interlanguage (i.e., developing second language knowledge: Selinker, 1972) can be explained by influence from the first language (L1), or whether they are a by-product of developmental sequences that learners can be expected to move through regardless of different L1 backgrounds (VanPatten & Benati, 2015). This influence is known as language transfer and is argued to occur at all language levels, including phonology, syntax, pragmatics, and even the transfer of gestures from the learner's wider culture (Gullberg & McCafferty, 2008). Transfer can result in errors (negative transfer), facilitation (positive transfer), avoidance (construction infrequency), redundancy or overgeneralization.

SLA research on how learners acquire a new language spans a number of different disciplines (e.g. psychology, linguistics, pedagogy and sociology). Cognitive approaches to SLA research deal with the processes in the brain that underpin language acquisition, for example how language acquisition is related to short-term and long-term memory. Pienemann and Lenzing (2015) argue that second language (L2) learners acquire linguistic structures (i.e., negation, question formation) through predictable stages explained by domain-general processes. According to processability theory, instruction is constrained by these developmental stages as L2 learners follow a rigid route in the acquisition of grammatical structures. This approach

44 defines complexity in relation to language users: what is costly or difficult for language users is
45 seen as complex. Complexity is thus identified with cost and difficulty of processing and
46 learning (Miestamo, 2009). Such theories have uncovered patterns that appear to reveal an effect
47 of universal principles of markedness, with a preference for simplification in the direction of less
48 marked structures. For example, learners often learn a form or construction in one context and
49 extend its application to other contexts e.g. ‘She bought a dress’ instead of using a less frequent
50 (more marked) construction ‘bought’). Some SLA researchers have argued that simplification
51 and overgeneralization can be used by L2 learners to reduce complexity and cognitive burden
52 (Miestamo 2009). These selected domains of SLA research (transfer and learner patterns) are.....
53 relatively broad ones that we to use to organise the current research literature on signed language
54 acquisition. However, they are useful ones with which to describe the overall field before
55 carrying out more in-depth studies of specific aspects of adults’ signed language acquisition of
56 signed languages.

57

58 1.2 Signed languages

59 Signed languages are fully-fledged human languages (Pfau, Steinbach & Woll, 2012) that
60 emerge naturally in deaf communities all over the world (e.g., American Sign Language: ASL;
61 British Sign Language: BSL, etc.). Signed languages are considered ‘minority’ languages as
62 deafness is a low incidence condition (1 in 1000 children are born deaf), and only around 10% of
63 deaf children have deaf parents and are thus considered to be native signers (Mitchell &
64 Karchmer, 2004). Signed languages are acquired as first languages by children of deaf adults
65 following well-attested stages (Baker & Woll, 2009; Chamberlain, Morford & Mayberry, 2000;
66 Chen-Pichler, 2012; Morgan & Woll, 2002; Petitto, 1997). In addition, some hearing parents use

67 a signed language with their deaf children and some hearing children of deaf adults (CODAs)
68 acquire signed languages at a young age (Chen-Pichler, 2012). Signed languages are processed
69 in the brain in traditional language centres, and users of signed languages comprehend and
70 represent signs using similar cognitive processes proposed for users of spoken languages,
71 including networks of lexical representations (Emmorey, 2002; Gutiérrez, Müller, Baus, &
72 Carreiras, 2012; Orfanidou, Adam, Morgan, McQueen (2010).

73
74 This review paper addresses a novel question in SLA research: How are signed languages
75 learned by adult hearing learners? While there has been much research on L2 learners of spoken
76 languages there has been less work in signed languages, despite signed languages being popular
77 languages with adult learners. In 2009 in the UK, for example, there were an estimated 190,000
78 hearing adults who had learned at least basic level BSL (Woll, 2012; for estimates of adult ASL
79 learners see Smith & Davis, 2014). Hearing adults learn a signed language because they start
80 working with deaf people, have a relative or friend who is deaf, plan to train as interpreters, or
81 just develop an interest in learning a new language.

82
83
84 The paper is organised as follows: Section 2 overviews modality issues relevant for sign SLA,
85 Section 3 reviews adult signed language learning with a focus on transfer and the existence of
86 general learning patterns. The motivation for the focus on transfer and general learning patterns
87 is that these represent two central areas of research in the SLA field. The exploration of SLA of
88 signed languages provides a novel learning paradigm (cross-modality SLA) and can provoke
89 new questions in the field. What transfer occurs between language modalities (spoken L1 to

signed L2)? Is SLA of signed languages constrained by domain-general processes or different processes unique to the visual-manual modality? If signed language SLA follows similar stages and evokes similar learner strategies and mechanisms as proposed for spoken language SLA (i.e. modality-similar SLA) it would confirm general patterns of SLA beyond the unitary modality (i.e., observed across signed and spoken languages). Finally, Section 4 draws together some conclusions and offers possible future directions for the field.

2. Modality issues relevant for sign SLA

When learners are exposed for the first time to a new language, they begin to perceive and store the sounds and sound patterns (phonological representations) of the target language. Learners of signed languages need to do the same. In this section we outline the phonological structure of signs, describe aspects of sign language linguistic organisation and the interface with wider communicative systems that are important for hearing second language learners. While some learners are deaf second sign language i.e. within the same modality (M1-L2) the current paper focuses on the L2 acquisition of a signed language by hearing learners thus between different modalities (M2-L2). For these learners, we describe the high amount of iconicity (i.e. motivated links between visual form and meaning) in signs, and how this drives the overlap of signs and gestures. We then document the possibility of expressing several grammatical elements simultaneously on different articulators (i.e. hands, face, and body). This section on signed languages covers several levels of linguistic organisation but is not exhaustive (see Pfau, Steinbach & Woll, 2012 for a comprehensive overview). These aspects are selected as they will be necessary to interpret the results of the signed language SLA research studies reviewed in the following sections.

113

114 2.1 Sign phonology

115 Phonology in spoken languages describes the systematic ways in which a limited set of
116 meaningless sounds are combined to create a potentially unlimited set of meaningful words. In
117 contrast to the sounds of language, signs are composed of four main phonological components
118 (handshape, movement, hand orientation, and location - Brentari, 1999). For example, the BSL
119 signs NAME and AFTERNOON (figure 1) constitute a minimal pair. Both have the same
120 handshape, orientation and outwards movement, but differ in the location (the hand moves out
121 from the forehead in NAME and from the chin in AFTERNOON).

122

123 Figure 1. Phonological minimal pair in BSL



128 NAME AFTERNOON

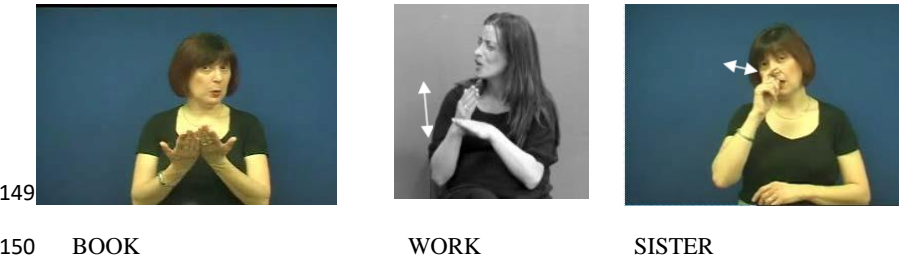
129

130 2.2 Iconicity

131 An important aspect of signed languages is the link between the visual form of the sign and its
132 meaning, and this will be relevant for the following section on transfer. In spoken languages,
133 words are traditionally argued to have an arbitrary form-meaning relationship e.g. the sounds in
134 the English word 'dog', Spanish 'perro' and French 'chien' have no link to the concept of what a
135 dog is or does (de Saussure 1983). However, spoken languages do have instances of sound

136 symbolism e.g. onomatopoeia, and this relationship is implicated in language learning
137 (Deconinck, Boers & Eyckmans, 2017).
138
139 Signed language vocabulary is richly influenced by visual properties of sign meanings (e.g.
140 Friedman, 1976; Perniss & Vigliocco; 2015). Bellugi and Klima (1979) first described iconicity
141 as being on a continuum across different signs e.g. in figure 2 the sign BOOK looks like an
142 opening book, the less iconic TO-WORK in BSL looks like hitting your hands together and is
143 related to the concept of making something. Finally, some signs are non-iconic e.g. SISTER in
144 BSL is articulated with a hooked index finger tapping the bridge of the nose. It is also the case
145 that many signs have lost their iconic motivation over time e.g. the index finger moving down
146 the cheek in GIRL in BSL might have originally referred to the strap of a bonnet.

147
148 Figure 2. Examples of signs in BSL that vary in iconicity



151
152
153 As a result of this iconicity many signs resemble the conventional gestures used by non-signers.
154 For example, TO-THROW and TO-SMOKE in BSL are visually similar to everyday
155 conventional gestures used in wider British society to express these meanings.

156
157 Indeed, some studies have reported that complete novices can correctly guess the meanings of
158 many signs by using world knowledge and their experience with gestures (Ortega, Schiefner, &
159 Ozyürek, 2019). In this study non-signing hearing adults exploited their implicit knowledge of
160 gestures to guess correctly the meaning of iconic signs in Sign Language of the Netherlands
161 (NGT) they had never seen before. When participants saw signs that had a strong visual overlap
162 with gestural forms, they were able to guess the meaning based on their knowledge of those
163 gestures. The implication of this study was that gestural knowledge can ease the interpretation of
164 the meaning of novel signs. The authors went on to propose that iconic gestures that overlap in
165 form with signs served as ‘manual cognates’ that help non-signing adults to break into a new
166 language at first exposure (Ortega, Schiefner, & Ozyürek, 2019).

167
168 Previous research suggested that the similarities between sign, silent pantomime and co-speech
169 gesture are exploited during sign L2 learning (Casey & Emmorey, 2009; Chen-Pichler &
170 Koulidobrova, 2015; Weisberg, Casey, Sevcikova Sehyr & Emmorey, 2020). In Casey and
171 Emmorey’s (2009) study, a group of L2 signers were compared to participants with no
172 knowledge of ASL. In an elicited narrative procedure, the L2 sign learners produced a greater
173 number and type of iconic gestures, as well as a higher rate of such gestures, compared to non-
174 signers. The authors argued that increased iconic gesturing by signers may reflect the iconicity
175 present in lexical, phonological, and spatial aspects of sign languages. The authors further
176 speculated that exposure to ASL influenced signers to visualize the narrative more vividly than
177 non-signers (Casey & Emmorey, 2009).

178

179

180 2.3 Simultaneous articulation of several linguistic elements in sentences

181 Spoken languages generally express sentence-level meaning through a sequence of words or a
182 sequence of morphemes in a word. Sign languages offer the possibility to express a number of
183 meaningful elements simultaneously. This simultaneity can occur within a single sign (across
184 different articulators); for example, Schönström and Mesch (2014) describe how the signer's
185 mouth is able to function as an independent articulator parallel to the hand, allowing movements
186 to add adverbial information to manual lexical signs. Simultaneity can also occur across multiple
187 signs and articulators, i.e. the two hands, body, eyebrows, mouth, eyes and head (Sandler, 2012).
188 One particular instantiation of the phenomenon is the use of classifiers in signing space.

189

190 An example is shown in figure 3 of a deaf BSL signer recounting a section of a story where a
191 boy mistakenly climbs onto a deer's back and is carried away. The signer's head denotes the
192 deer, his left hand forms the sign DEER and the right hand the position of the boy. The signer's
193 face illustrates the discomfort of the boy.



Figure 3 THE BOY SITS UNCOMFORTABLY ON THE DEER'S HEAD

(example from Gulamani, Marshall & Morgan, 2020)

There is a relatively large amount of research concerning classifiers (see Morgan & Woll, 2007), with the main type investigated in sign SLA being handshapes that represent the shape of a referent class. Classifiers are particularly important as referring expressions. Reference and referring expressions are noun phrases or a surrogate for a noun phrase (e.g. a classifier) whose function in discourse is to identify some individual object. For example, in BSL a G-handshape (an extended index finger) can represent any long thin object e.g. PENCIL, TOOTHBRUSH or even TREE. Once the lexical sign for TREE is signed a subsequent mention of this referent can be tied to the classifier handshape (functioning as an anaphoric pro-form). Signers move or locate the classifier in space so as to express different meanings e.g. 'the tree was next to the river' or 'the tree was at the top of the hill'. Signers can also use classifiers in conjunction with other body parts and the face to express several meaning elements simultaneously. For example,

in BSL the V-handshape in figure 3 represents a person and how it moves and is located. Once the sign for BOY has been signed, a subsequent mention of this referent can be tied as an anaphor to the V-hand classifier handshape. Classifiers have been studied in only a handful of SLA contexts (e.g. Janke & Marshall, 2015) and the findings of this research will be reviewed in section 3.1.

A second issue related to gesture and iconicity is that speakers sometimes move their hands around to express location and movement of objects in their co-speech gesture for referential purposes (Perniss & Ozyürek, 2015). Perniss & Ozyürek (2015) compared German co-speech gesture and German Sign Language (DGS) in this domain and found qualitative similarities and differences between sign language and co-speech gesture for reference tracking in discourse. The authors argued that similarities were driven by the shared affordances of the visual modality. Thus, the visual modality requires hearing L2 learners to re-use already present communicative resources in order to learn how signed language classifiers function. Up to this point we have described simultaneity as an aspect of expressive language competence. There is an additional role in learning however for receptive competence. When a signer sees a sign produced by another person it is visually reversed from the point of view of their own production of the same sign. For example when perceiving the sign BOOK in figure 2 a signer sees the back of the hands while in production they see the palm of the hands. Shield and Meier (2018) point out that this has implications for how learners represent a sign they have learned. Shield and Meier (2018) showed that sign language learners improved their ability at mentally reversing a visual representation when compared to non-signers suggesting sign exposure has an impact on cognitive visual-spatial skills. Non-signers made significantly more perspective-taking errors in

their imitation of gestures than either intermediate or advanced signers. In a related study, Watkins and Thompson (2017) provided evidence that both left- and right-handed participants identified signs produced by right-handed models more quickly because both left and right-handed signers are required to comprehend right-handed signing more than left-handed signing. Thus sign language learners will require some degree of visual perspective taking ability (Shield & Meier, 2018).

In summary, sign language learning by hearing adults offers a range of opportunities and challenges for the learner related to the switch in modality it entails. On the one hand, sign meanings might be easier to guess and remember because of their close form-meaning relationship and similarities with learners' own gestures. On the other hand, the articulation of language across different parts of the body and in space is very different to how spoken languages are used. This section has highlighted those areas of the linguistic organisation of signed languages which are relevant for interpreting SLA research. As described at the end of section 1, the exploration of SLA of signed languages provides a novel learning paradigm with respect to the existence of transfer and domain-general processes. In the next section we describe a range of studies of signed language SLA in these two domains.

3. Sign language learning: transfer and general learner patterns

3.1 Transfer

A common feature of SLA is the influence of the native language, i.e. transfer (Gass & Selinker, 2008). How does transfer work in the SLA of signed languages? Hearing L2 learners of a signed language have to master a novel phonological system perceived in the visual and

produced in the manual modality. In comparison, learners of L2 spoken languages adjust their L1 phonological repertoire to include the L2 sounds that partially overlap, as well as master sounds that are not in their language, and this can lead to a foreign accent. Some researchers have argued that because phonology from the L1 cannot transfer across modalities it is not possible for a hearing adult learner of signed languages to have a foreign ‘accent’ (Rosen, 2004). However, mastering the intricacies of sign phonology will bring to bear other demands, e.g. fine motor control (Mirus, Rathmann & Meier, 2001). More specifically, Mirus et al. (2001) found that sign hearing adult language learners used more proximal joints (i.e. those closer to the body) when attempting to sign and also that they signed more slowly. Thus it is possible that while a sign learner may not have a recognisable foreign (i.e. other) language accent, their difficulties in initial articulation of signs may identify them as being ‘hearing’ or ‘learner’ (i.e. non-native) signers.

During the process of learning of sign languages, L2 signers usually adopt certain features, such as word orders of their L1, and even use the spoken L1 and signed L2 at the same time. If the learner’s L1 is English then this is known as Sign Supported English (SSE) or ‘learner signing’ (Chen-Pichler & Koulidobrova, 2015). Signing and speaking at the same time is uniquely possible in sign SLA because each language is articulated in a different modality. While signed languages are independent from the spoken languages used around them, they do borrow from them. For example, many signed languages have a system of manually articulated letters in order to visually ‘fingerspell’ on the hands a word used in the surrounding spoken language e.g. ‘CAR v-o-l-v-o’. Here the BSL sign CAR is followed by the brand word ‘Volvo’ spelt on the hands of the signer: fingerspelling would be used in a situation where signers lack an agreed sign for this

278 particular make of car. Thus BSL and English can be used together by learners during attainment
279 of fluency (Sevcikova Sehyr, Giezen & Emmorey, 2018). For example, a beginner hearing adult
280 learner of BSL in Smith et al.'s (2010) study transferred an English expression 'to miss
281 something' (i.e. emotionally long for) by signing this straight into English fingerspelling as YOU
282 m-i-s-s u-s-a ('Do you miss the USA?') rather than using the sign TO-MISS. More research is
283 required that describes the influence of spoken languages on SLA of signed languages both in
284 diverse learning situations and in longitudinal studies.

286 Another example of transfer in sign learning at the lexical level is the use of 'invented signs'.
287 When a spoken L2 learner has a lexical gap, it is common for them to code-switch back to the
288 L1. This switching is interesting in L2 sign learners, because if the shift meant using their L1
289 then this would have to happen across modalities (i.e. back to their spoken L1). Smith et al.
290 (2010) showed a group of beginner level BSL learners 40 pictures of objects and actions and
291 asked them to name them with signs. It was expected that beginner learners would have lexical
292 gaps and so would be forced to code-switch to speaking. In fact, the learners stayed in the
293 manual-visual modality (i.e. they did not speak) and code-shifted by using gestures with
294 appropriate meanings for over 80% of the items. These pantomimic gestures were very similar in
295 form to lexical signs in BSL, e.g. for a picture of a CAMERA, all 20 learners demonstrated
296 taking a photograph with a camera. Thus sign language learners transfer co-speech gesture
297 system into pantomimes at the earliest stages of sign learning (Ortega & Özyürek, 2013).

299 It has been argued that iconicity also influences the accuracy of sign production in L2 learners
300 through transfer of iconic gestures from the larger culture of the L1. Ortega and Morgan (2015)

301 used a sign repetition task in which beginner learners had to imitate as accurately as possible a
302 set of iconic and non-iconic signs (viewed with English translations and balanced for sign
303 language phonological complexity). Contrary to expectation, it was found that iconic signs were
304 articulated less accurately than arbitrary signs. For example, after seeing the sign TO-WRITE
305 learners repeated the sign but changed the handshape and movement and instead articulated what
306 they did when they actually write (See figure 4).

307

308 Figure 4 Iconic sign repetition



315 Target: TO-WRITE Learner: Handshape and movement error
316 (example from Ortega and Morgan, 2015)

317

318 Ortega and Morgan (2015) argued that iconicity afforded learners direct access to the meaning of
319 a sign, which led them to focus less on the exact phonological form. The beginner learners still
320 produced a sign with the same meaning (via its iconic motivation) but not necessarily with the
321 same phonological form as the target. In contrast, when they repeated non-iconic signs, learners
322 had to focus more on forms, because they could not be linked to meanings via iconicity, and this
323 led to increased accuracy. An alternative but not mutually exclusive explanation is that learners

produced iconic signs less accurately because of their access to gestures. As iconic signs and iconic gestures often resemble one another, learners may have retrieved the gesture rather than the sign.

Other researchers have reported similar negative effects in sign articulation where some of the learners' errors can be traced back to their gestures (Ortega & Özyürek, 2013). There is general consensus among researchers that spoken language transfer is more likely to occur at lower levels of proficiency (Odlin, 1989; Poullisse & Bongaerts, 1994). Following this assumption, presumably once further sign learning has taken place, iconicity can be used but without it transferring via gestures. Nevertheless, as Odlin (1989) points out, certain types of transfer in spoken language, such as cognate vocabulary use, occur even at high levels of proficiency. Although evidence of this type of transfer comes from spoken language data, we cautiously suggest that even learners with good command of a signed language might transfer gestures when attempting to describe constructions that involve elements of both sign and gesture (for example, the classifier system; Marshall & Morgan, 2015).

A final example of transfer is seen in the acquisition of classifiers signs where both Woll (2012) and Janke and Marshall (2017) argue that beginner L2 learners may recruit gesture and pantomime. Smith et al. (2010) reported many errors in the selection and orientation of handshapes to denote objects by BSL learners in spontaneous conversation involving classifiers. Learners were able to produce hand formations to stand in for objects in space (i.e., a fist for a car, a flat hand for a person) which looked 'sign-like' but not the accepted handshapes for these referents in BSL.

347
348 Marshall and Morgan (2015) measured experimentally the difficulties that intermediate-level
349 learners (1-3 years of exposure) face with classifiers and also asked whether learners' pre-
350 existing repertoire of gesture and ability to understand iconicity could, as Woll (2012) suggested,
351 facilitate their acquisition. Marshall and Morgan (2015) focused on spatial relationships, which
352 in sign languages are represented in a very iconic way using the hands, and which one might
353 therefore predict to be easy for adult learners to acquire. In a test of matching classifier sentences
354 in BSL with pictures, learners were indeed highly accurate in understanding handshape, location
355 and orientation information. More surprisingly, Marshall and Morgan (2015) reported the same
356 pattern of high comprehension in sign-naïve participants (adults with no prior knowledge of a
357 signed language). The authors argued that the sign-naïve participants were able to bring their
358 general visuo-spatial abilities to the task of understanding BSL classifiers. This type of transfer
359 would not be available to assist understanding grammatically complex constructions in spoken
360 languages.

361
362 As Smith et al. (2010) had suggested, Marshall and Morgan (2015) went on to ask whether
363 visual-spatial skills aid the production of classifiers. The same intermediate level learners were
364 asked to describe spatial arrays in pictures using BSL, and their productions were compared to
365 those of native deaf signers. The question was whether the different components of the classifiers
366 – handshape, location and orientation – would be produced equally well. Hearing intermediate
367 level learners produced an interesting set of constructions. This group of learners knew that they
368 should use their hands to represent objects and were highly accurate at signing location and
369 orientation information, but they had more difficulty choosing the same handshapes as the native

signer targets. Marshall and Morgan (2015) concluded that gesture knowledge was partially used by sign learners to produce classifier sentences but lengthy exposure to BSL was required in order to go beyond this first stage and acquire the full complexity of the language. Some authors have indicated that for any pre-existing experience to transfer it is important that the learner goes through a reanalysis stage in which previous gesture knowledge is processed as being linguistically meaningful (Taub, Galvan, Piner & Mather, 2008).

Janke and Marshall (2017) subsequently argued that learners have to converge on the conventionalised classifier system that forms part of the grammar of the language being learned by selecting from all the handshapes they are physically able to articulate. In this study 30 sign-naïve hearing adults were tested on Marshall and Morgan's task. All used some handshapes that were different from those used by native BSL signers and the intermediate learners, but there was a lot overlap also. However, the sign-naïve hearing adults had much less consistency e.g. using 4-5 different handshapes to represent the same object across the different trials in the task, whereas fluent signers used just a single handshape. The findings suggest that a key challenge when learning classifiers might be reducing from a very large set of gestural resources, rather than supplementing a restricted one. An interesting observation on the use of classifiers and potential transfer effects is that if we distinguish between production and comprehension there seems to be a negative transfer (e.g., wrong handshapes) in production and a positive transfer of gesture knowledge in comprehension.

The studies reviewed in this section report transfer from L1 to L2. Much more research is required on transfer as this is an important process in SLA of signed languages. Similarly, it will

be necessary to carry out studies on larger numbers of learners, as well as combine observational and experimental data. There is an additional area of research which should be pursued, namely that acquisition of a new language (L2) affects the first (L1). Casey, Emmorey and Larrabee (2012) reported that learning a signed language influenced co-speech gesture that accompanied the learners' spoken L1. Learners of ASL felt that they gestured more when they were speaking English, and a longitudinal study confirmed this perception. The sign learners produced more iconic gestures in their co-speech gesture, and they also used a greater number of differing handshapes when gesturing.

3.2 Domain generality

In investigating how signed languages are learned as second languages we turn to general learning patterns seen across modalities. In the general SLA literature difficulties can occur for learners because of proposed processing costs (Miestamo, 2009) that lead to errors, as well as conscious/intentional strategies on the part of the learner. Two important aspects which can be studied in SLA of signed language are the following:

- Simplification: Learners often use simpler forms and constructions instead of more complex ones. E.g. the use of simple present 'John eats' instead of the present perfect continuous 'John has been eating' (Trudgill, 2011).
- Over-redundancy: Learners can over-use a lexical form or construction to avoid ambiguity or decrease cognitive load e.g. 'The lady bought a dress. The lady bought some shoes' (Sorace, Serratrice, Filiaci, & Baldo, 2009).

Documenting how sign languages are learnt might reveal similar general L2 learner patterns.

416 A well-documented feature of SLA is phonological simplification processes. For example,
417 marked sounds like [θ, ð] are replaced by more common ones like [t, d], and consonant clusters
418 are reduced. In sign learning this is can be seen in changes made to the sub-lexical organisation.
419 For example, the handshape required in the BSL sign SHEEP involves a fist with an extended
420 pinkie finger. Adult L2 learners often produce this sign with a fist but omit the pinkie finger, thus
421 simplifying the articulation. In seminal work, Mirus, Rathmann, and Meier (2001) and Rosen
422 (2004) examined production errors in ASL phonology made by beginning L2 adult learners due
423 to poor motor dexterity. Although adults have a fully developed motor system to perform
424 complex movements with their arms and hands, the particular types of movements required for
425 signing are initially unpractised and lead to errors (Woll, 2012). These were proximalisation
426 (making signs with joints closer to the body than in the target), substitutions of handshapes,
427 displacements of signs to the wrong locations, additions of extraneous ‘practice’ movements and
428 deletions of movements. Production errors were also tied to difficulties in visually perceiving
429 signs, include the mirroring of hand movements (producing signs as perceived in the input i.e. on
430 the wrong side of the body), addition and deletion of parts of the sign difficult to see (e.g. on top
431 of the head).

432

433 Smith et al. (2010) reported one of the few examples of longitudinal data for BSL sign
434 phonology in L2 acquisition. Learners were asked to articulate a list of 20 signs at the beginning
435 of the BSL course (after 2 hours of exposure) and at the end (after 24 hours of exposure).
436 Beginner learners found handshape most difficult to produce accurately, followed by movement
437 and location, and during learning accuracy across all these parameters improved from 36% to
438 79% (Smith et al., 2010). A second methodology used in the sign language learning literature is

439 to ask learners to copy signs with different levels of phonological difficulty and observe what
440 errors they make. Signs are not all equal in phonological complexity e.g. in the number of hands
441 with which they are articulated (1 or 2), the number of movement components they include, and
442 the motoric complexity of the handshape (Brentari, 1999). See figures 5 and 6 of BSL signs with
443 the simplest to the most complex phonological structure

444 Figure 5.



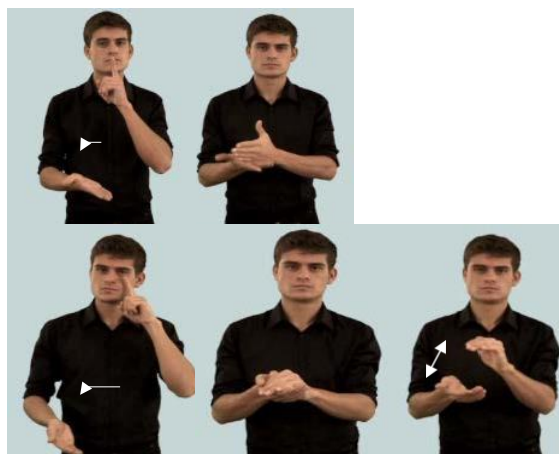
448 I/ME ALLOW YEAR

449 I/ME, one- handed sign, one handshape, one location, no movement;
450 ALLOW, double-handed sign, symmetrical, one handshape, one location, movement in both
451 hands;
452 YEAR, two-handed sign, two different handshapes, movement in the dominant hand.

453

454

Figure 6.



PROMISE, two-handed sign, two different handshapes, one handshape change in the dominant hand, movement in the dominant hand;

LOOK-AFTER, one handed sign to start with then changes to double-handed, two different handshapes occur during the production of the sign, handshape change in the dominant hand, movement in the dominant hand: movement is different in the one-handed compared to the double-handed sign.

Ortega and Morgan (2015) asked sign learners to copy different signs. They found that two-handed signs (ALLOW, YEAR, PROMISE & LOOK-AFTER) were articulated less accurately than one-handed signs (I/ME), and two-handed signs in which both hands have symmetrical movements (ALLOW) were executed more accurately than two-handed signs in which both move independently (PROMISE & LOOK-AFTER). Furthermore, and with respect to location, signs that were performed in the signing space in front of the learner were articulated less accurately than signs which make some contact with the body. It is possible that the

478 proprioceptive feedback of a sign that requires contact on the body eased learner cognitive load
479 when producing the location parameter. The authors concluded that the more phonological
480 constituents a sign has, the more difficult it will be for learners to process and articulate
481 accurately, and this findings follows patterns reported in the wider SLA literature (Epstein,
482 Flynn, & Martohardjono, 1996).

483

484 Williams and Newman (2016) reported differences in ASL phonological accuracy based on both
485 learners' proficiency and input variability (input from a learner or a native signer). This study
486 adds another level of complexity to previous accounts of accuracy in learners by describing some
487 differences, especially for handshape perception (described as the most difficult parameter to
488 master in previous research), based on learner and target properties. Learners made more
489 movement errors for sentences signed by other learners relative to those by the native signer.

490 An innovative study, building on the earlier studies of learner errors carried out by Mirus et al.
491 (2001) and Rosen (2004), attempted to calculate learners' ability to produce accurate ASL
492 signing using an instrumentation methodology. Hilger, Loucks, Quinto-Pozos and Dye (2015)
493 investigated production variability and the development of motor control. Production variability
494 was characterized through a Spatio Temporal Index (STI - Smith et al., 1995) which is a measure
495 of stability and variability in kinematic movements. Motion capture apparatus was used to
496 acquire wrist displacement data across eight target signs embedded in carrier phrases. The STI
497 values of deaf fluent signers and beginner hearing learners at three different ASL experience
498 levels were compared. As predicted, deaf fluent signers showed significantly lower STI values
499 than the hearing learners and stability increased with increased language use as in spoken
500 language accuracy measures. Future research using combined naturalistic and instrumentation

methods is required to add to these interesting initial studies. Future studies should control elicitation procedures and tasks, both from the production and comprehension perspectives.

The wider SLA literature describes learners dropping or mis-ordering required elements during acquisition. In signed languages the face is an important non-manual marker of several grammatical functions. For example, one of the non-manual markers of questions is movement of the eyebrows. Research has found that the grammatical use of non-manuals is relatively limited among early and intermediate L2 learners (Schönström & Mesch, 2014). An example from their data is that L2 learners did not raise the eyebrows in order to indicate wh-questions non-manually but instead used the manual question signs WHAT etc. Unfortunately, the authors did not report quantitative statistics for this observation. The authors reported that learners largely focused on how to articulate manual signs while in fact not looking at the teacher. Signing SLA learners have to become familiar with using facial expressions to convey particular grammatical contrasts that in spoken languages would be conveyed by changes in intonation and they have to learn how these non-markers work simultaneously with the manual lexicon. A possible reason why these non-manual elements are challenging is that learners cannot visually perceive their own faces whilst signing. Smith et al. (2010) reported timing difficulties with articulating the manual and non-manual part simultaneously, whereby the non-manual was articulated before the manual part when it should have occurred throughout the whole phrase. Although we have included these as errors of simplification it is also possible that as grammatical markers expressed on the face are not part of the learners' L1 they are thus harder to learn.

Finally, a common pattern in second language learning is the issue of ‘redundancy’ in the use of referring expressions e.g. ‘The lady bought a dress. The lady bought some shoes’.

L2 learners of pro-drop (null-subject) languages even with an advanced level command of the target language will produce overt subjects in contexts where native speakers would not have produced them (Sorace & Filiaci, 2006). There are now a small number of papers examining how hearing adult learners of sign learn to use referring expressions (Bel, Ortells & Morgan, 2015; Frederiksen & Mayberry, 2019; Gulamani, Marshall & Morgan, 2020; Perniss & Özyürek 2015). Bel et al.’s (2015) study involved 13 advanced adult learners of Catalan Sign Language (LSC) who were enrolled on a sign language interpreter training course and had experienced 600 hours of formal exposure to LSC. Eleven deaf native LSC-signers acted as controls. Participants were required to view a three-minute silent film about conflicts at school and were subsequently instructed to tell a new story to camera about a similar experience they knew involving a friend or classmate during their childhood or teenage years. This task was devised to encourage participants to introduce third-person characters in their productions and make use of spatial locations. Bel et al. (2015) found, as has previously reported for spoken language studies, that the L2 signers had a tendency to oversupply overt arguments. Learners used overt pronouns more frequently than their native-signing comparison group, including in contexts of referent maintenance when a null pronoun would have sufficed. Thus Bel et al. (2015) argued that the complexity of the task was resolved by learner signers in modality-similar ways to that argued for spoken language L2 users. The added redundancy, while it seemed to free up cognitive resources, had the effect of reducing the sign learners’ fluency as judged by native signers.

4. General conclusions and future directions

547 The aims of this review were to describe sign language SLA research and begin to integrate these
548 results into wider SLA theory and literature. We chose to do this by using two general and well-
549 researched topics in SLA: transfer and general learner patterns. Although these domains are
550 broad-ranging, they constitute fundamental topics in SLA research. We see that the sign learning
551 research fits into these topics naturally and provokes several interesting issues worthy of further
552 discussion. In general, we see that the research on SLA in sign is compatible with patterns and
553 data previously reported solely in the spoken modality. While there are modality-specific issues
554 e.g. transfer of gestures rather than phonemes/words, and visual reversals in perception and
555 production of signs, by and large these appear to be about *how* general SLA mechanisms are
556 instantiated.

557 The mechanisms we have reviewed in this paper centre around the reduction of processing cost
558 (Miestamo, 2009) by SLA learners of sign through simplifications (Trudgill, 2011) and over-
559 redundancy (Sorace, Serratrice, Filiaci, and Baldo, 2009). This supports our position that SLA
560 across modalities is driven by some of the same language and learner component features.

561
562 This review, while touching on a broad and central range of topics, illustrates that in many
563 domains there is a clear need to carry out much more research to arrive at more informed
564 patterns and mechanisms of signed language SLA. There are several areas of SLA research up to
565 this point less tested on sign language learners. We point out some of these future directions.
566 There is less research devoted to the development of signed language comprehension in adult
567 learners than there has been on signed language production. For example, unlike learning new
568 spoken words, signed language learners are required to use visual perspective-taking skills to
569 perceive new signs as they see the visual reversal when looking at someone else produce a sign

570 compared to what they themselves produce (Shield and Meier, 2018). Future research in signed
571 language SLA should look more at the relationship between expressive and receptive language in
572 L2 sign acquisition, and how is it influenced by the visual-spatial modality. In other aspects of
573 SLA there is also no work on how different types of exposure or learning setting (classroom
574 versus incidental learning) influence SLA of sign. A similarly unexplored area is the age of the
575 learner. While there is much debate about sensitive periods in the acquisition of spoken and
576 signed languages there has been no work on whether age influences hearing adults SLA of sign
577 language. It is our hope that future interaction between sign language and SLA research on these
578 future topics will enrich both disciplines.
579

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