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

Chloe Marshall
Sannah Gulamani
Aurora Bel
Gary Morgan

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Abstract

This review addresses the question: How are signed languages learned by adult hearing learners? While there has been much research on second language learners of spoken languages, there has been far less work in signed languages. Comparing sign and spoken second language acquisition allows us to investigate whether learning patterns are general (across the visual and oral modalities) or specific (in only one of the modalities), and hence furthers our understanding of second language acquisition (SLA). The paper integrates current sign language learning research into the wider field of SLA by focusing on two areas: 1. does 'transfer' occur between the spoken first language and signed second language, and 2. what kind of learning patterns are the same across language modalities versus unique to each modality?

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

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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 buyed 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.

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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

90   signed L2)? Is SLA of signed languages constrained by domain-general processes or different

91   processes unique to the visual-manual modality? If signed language SLA follows similar stages

92   and evokes similar learner strategies and mechanisms as proposed for spoken language SLA (i.e.

93   modality-similar SLA) it would confirm general patterns of SLA beyond the unitary modality

94   (i.e., observed across signed and spoken languages). Finally, Section 4 draws together some

95   conclusions and offers possible future directions for the field.

96

97   **2. Modality issues relevant for sign SLA**

98   When learners are exposed for the first time to a new language, they begin to perceive and store

99   the sounds and sound patterns (phonological representations) of the target language. Learners of

100 signed languages need to do the same. In this section we outline the phonological structure of

101 signs, describe aspects of sign language linguistic organisation and the interface with wider

102 communicative systems that are important for hearing second language learners. While some

103 learners are deaf second sign language i.e. within the same modality (M1-L2) the current paper

104 focuses on the L2 acquisition of a signed language by hearing learners thus between different

105 modalities (M2-L2). For these learners, we describe the high amount of iconicity (i.e. motivated

106 links between visual form and meaning) in signs, and how this drives the overlap of signs and

107 gestures. We then document the possibility of expressing several grammatical elements

108 simultaneously on different articulators (i.e. hands, face, and body). This section on signed

109 languages covers several levels of linguistic organisation but is not exhaustive (see Pfau,

110 Steinbach & Woll, 2012 for a comprehensive overview). These aspects are selected as they will

111 be necessary to interpret the results of the signed language SLA research studies reviewed in the

112 following sections.

6

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

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127

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

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150 BOOK   WORK   SISTER
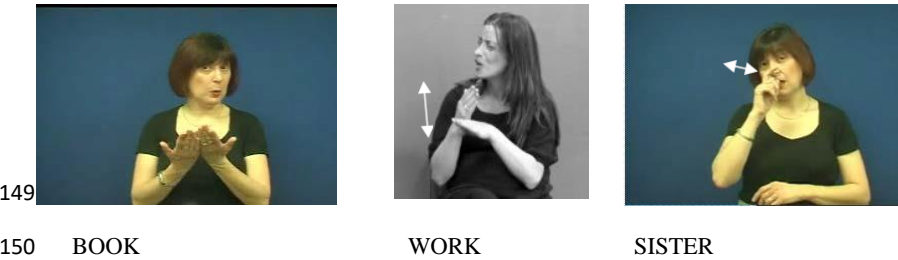
151

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

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

167

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

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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.

194

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,

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209 in BSL the V-handshape in figure 3 represents a person and how it moves and is located. Once

210 the sign for BOY has been signed, a subsequent mention of this referent can be tied as an

211 anaphor to the V-hand classifier handshape. Classifiers have been studied in only a handful of

212 SLA contexts (e.g. Janke & Marshall, 2015) and the findings of this research will be reviewed in

213 section 3.1.

214

215 A second issue related to gesture and iconicity is that speakers sometimes move their hands

216 around to express location and movement of objects in their co-speech gesture for referential

217 purposes (Perniss & Ozyürek, 2015). Perniss & Ozyürek (2015) compared German co-speech

218 gesture and German Sign Language (DGS) in this domain and found qualitative similarities and

219 differences between sign language and co-speech gesture for reference tracking in discourse. The

220 authors argued that similiarites were driven by the shared affordances of the visual modality.

221 Thus, the visual modality requires hearing L2 learners to re-use already present communicative

222 resources in order to learn how signed language classifiers function. Up to this point we have

223 described simultaneity as an aspect of expressive language competence. There is an additional

224 role in learning however for receptive competence. When a signer sees a sign produced by

225 another person it is visually reversed from the point of view of their own production of the same

226 sign. For example when perceiving the sign BOOK in figure 2 a signer sees the back of the

227 hands while in production they see the palm of the hands. Shield and Meier (2018) point out that

228 this has implications for how learners represent a sign they have learned. Shield and Meier

229 (2018) showed that sign language learners improved their ability at mentally reversing a visual

230 representation when compared to non-signers suggesting sign exposure has an impact on

231 cognitive visual-spatial skills. Non-signers made significantly more perspective-taking errors in

232 their imitation of gestures than either intermediate or advanced signers. In a related study,

233 Watkins and Thompson (2017) provided evidence that both left- and right-handed participants

234 identified signs produced by right-handed models more quickly because both left and right-

235 handed signers are required to comprehend right-handed signing more than left-handed signing.

236 Thus sign language learners will require some degree of visual perspective taking ability (Shield

237 & Meier, 2018).

238

239 In summary, sign language learning by hearing adults offers a range of opportunities and

240 challenges for the learner related to the switch in modality it entails. On the one hand, sign

241 meanings might be easier to guess and remember because of their close form-meaning

242 relationship and similarities with learners' own gestures. On the other hand, the articulation of

243 language across different parts of the body and in space is very different to how spoken

244 languages are used. This section has highlighted those areas of the linguistic organisation of

245 signed languages which are relevant for interpreting SLA research. As described at the end of

246 section 1, the exploration of SLA of signed languages provides a novel learning paradigm with

247 respect to the existence of transfer and domain-general processes. In the next section we describe

248 a range of studies of signed language SLA in these two domains.

249

250 **3. Sign language learning: transfer and general learner patterns**

251 3.1 Transfer

252 A common feature of SLA is the influence of the native language, i.e. transfer (Gass & Selinker,

253 2008). How does transfer work in the SLA of signed languages? Hearing L2 learners of a

254 signed language have to master a novel phonological system perceived in the visual and

255   produced in the manual modality. In comparison, learners of L2 spoken languages adjust their L1

256   phonological repertoire to include the L2 sounds that partially overlap, as well as master sounds

257   that are not in their language, and this can lead to a foreign accent. Some researchers have argued

258   that because phonology from the L1 cannot transfer across modalities it is not possible for a

259   hearing adult learner of signed languages to have a foreign 'accent' (Rosen, 2004). However,

260   mastering the intricacies of sign phonology will bring to bear other demands, e.g. fine motor

261   control (Mirus, Rathmann & Meier, 2001). More specifically, Mirus et al. (2001) found that sign

262   hearing adult language learners used more proximal joints (i.e. those closer to the body) when

263   attempting to sign and also that they signed more slowly. Thus it is possible that while a sign

264   learner may not have a recognisable foreign (i.e. other) language accent, their difficulties in

265   initial articulation of signs may identify them as being 'hearing' or 'learner' (i.e. non-native)

266   signers.

267

268   During the process of learning of sign languages, L2 signers usually adopt certain features, such

269   as word orders of their L1, and even use the spoken L1 and signed L2 at the same time. If the

270   learner's L1 is English then this is known as Sign Supported English (SSE) or 'learner signing'

271   (Chen-Pichler & Koulidobrova, 2015). Signing and speaking at the same time is uniquely

272   possible in sign SLA because each language is articulated in a different modality. While signed

273   languages are independent from the spoken languages used around them, they do borrow from

274   them. For example, many signed languages have a system of manually articulated letters in order

275   to visually 'fingerspell' on the hands a word used in the surrounding spoken language e.g. 'CAR

276   v-o-l-v-o'. Here the BSL sign CAR is followed by the brand word 'Volvo' spelt on the hands of

277   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.

285

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).

298

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

324   produced iconic signs less accurately because of their access to gestures. As iconic signs and

325   iconic gestures often resemble one another, learners may have retrieved the gesture rather than

326   the sign.

327

328   Other researchers have reported similar negative effects in sign articulation where some of the

329   learners' errors can be traced back to their gestures (Ortega & Özyürek, 2013). There is general

330   consensus among researchers that spoken language transfer is more likely to occur at lower

331   levels of proficiency (Odlin, 1989; Poulisse & Bongaerts, 1994). Following this assumption,

332   presumably once further sign learning has taken place, iconicity can be used but without it

333   transferring via gestures. Nevertheless, as Odlin (1989) points out, certain types of transfer in

334   spoken language, such as cognate vocabulary use, occur even at high levels of proficiency.

335   Although evidence of this type of transfer comes from spoken language data, we cautiously

336   suggest that even learners with good command of a signed language might transfer gestures

337   when attempting to describe constructions that involve elements of both sign and gesture (for

338   example, the classifier system; Marshall & Morgan, 2015).

339

340   A final example of transfer is seen in the acquisition of classifiers signs where both Woll (2012)

341   and Janke and Marshall (2017) argue that beginner L2 learners may recruit gesture and

342   pantomime. Smith et al. (2010) reported many errors in the selection and orientation of

343   handshapes to denote objects by BSL learners in spontaneous conversation involving classifiers.

344   Learners were able to produce hand formations to stand in for objects in space (i.e., a fist for a

345   car, a flat hand for a person) which looked 'sign-like' but not the accepted handshapes for these

346   referents in BSL.

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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

370 signer targets. Marshall and Morgan (2015) concluded that gesture knowledge was partially used

371 by sign learners to produce classifier sentences but lengthy exposure to BSL was required in

372 order to go beyond this first stage and acquire the full complexity of the language. Some authors

373 have indicated that for any pre-existing experience to transfer it is important that the learner goes

374 through a reanalysis stage in which previous gesture knowledge is processed as being

375 linguistically meaningful (Taub, Galvan, Piner & Mather, 2008).

376

377 Janke and Marshall (2017) subsequently argued that learners have to converge on the

378 conventionalised classifier system that forms part of the grammar of the language being learned

379 by selecting from all the handshapes they are physically able to articulate. In this study 30 sign-

380 naïve hearing adults were tested on Marshall and Morgan's task. All used some handshapes that

381 were different from those used by native BSL signers and the intermediate learners, but there

382 was a lot overlap also. However, the sign-naïve hearing adults had much less consistency e.g.

383 using 4-5 different handshapes to represent the same object across the different trials in the task,

384 whereas fluent signers used just a single handshape. The findings suggest that a key challenge

385 when learning classifiers might be reducing from a very large set of gestural resources, rather

386 than supplementing a restricted one. An interesting observation on the use of classifiers and

387 potential transfer effects is that if we distinguish between production and comprehension there

388 seems to be a negative transfer (e.g., wrong handshapes) in production and a positive transfer of

389 gesture knowledge in comprehension.

390

391 The studies reviewed in this section report transfer from L1 to L2. Much more research is

392 required on transfer as this is an important process in SLA of signed languages. Similarly, it will

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393 be necessary to carry out studies on larger numbers of learners, as well as combine observational

394 and experimental data. There is an additional area of research which should be pursued, namely

395 that acquisition of a new language (L2) affects the first (L1). Casey, Emmorey and Larrabee

396 (2012) reported that learning a signed language influenced co-speech gesture that accompanied

397 the learners' spoken L1. Learners of ASL felt that they gestured more when they were speaking

398 English, and a longitudinal study confirmed this perception. The sign learners produced more

399 iconic gestures in their co-speech gesture, and they also used a greater number of differing

400 handshapes when gesturing.

401

402 3.2 Domain generality

403 In investigating how signed languages are learned as second languages we turn to general

404 learning patterns seen across modalities. In the general SLA literature difficulties can occur for

405 learners because of proposed processing costs (Miestamo, 2009) that lead to errors, as well as

406 conscious/intentional strategies on the part of the learner. Two important aspects which can be

407 studied in SLA of signed language are the following:

408 - Simplification: Learners often use simpler forms and constructions instead of more

409   complex ones. E.g. the use of simple present 'John eats' instead of the present perfect

410   continuous 'John has been eating' (Trudgill, 2011).

411 - Over-redundancy: Learners can over-use a lexical form or construction to avoid

412   ambiguity or decrease cognitive load e.g. 'The lady bought a dress. The lady bought

413   some shoes' (Sorace, Serratrice, Filiaci, & Baldo, 2009).

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

415

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

21

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.

445
446
447

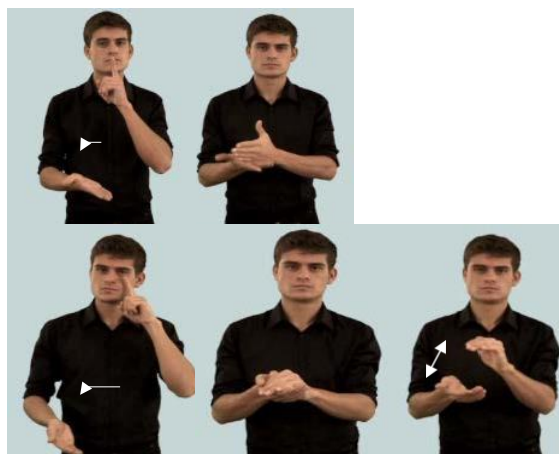448   I/ME   ALLOW   YEAR

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

455 Figure 6.

456

457

458 PROMISE

459

460

461 LOOK-AFTER

462

463

464 PROMISE, two-handed sign, two different handshapes, one handshape change in the dominant

465 hand, movement in the dominant hand;

466 LOOK-AFTER, one handed sign to start with then changes to double-handed, two different

467 handshapes occur during the production of the sign, handshape change in the dominant hand,

468 movement in the dominant hand: movement is different in the one-handed compared to the

469 double-handed sign.

470

471 Ortega and Morgan (2015) asked sign learners to copy different signs. They found that two-

472 handed signs (ALLOW, YEAR, PROMISE & LOOK-AFTER) were articulated less accurately

473 than one-handed signs (I/ME), and two-handed signs in which both hands have symmetrical

474 movements (ALLOW) were executed more accurately than two-handed signs in which both

475 move independently (PROMISE & LOOK-AFTER). Furthermore, and with respect to location,

476 signs that were performed in the signing space in front of the learner were articulated less

477 accurately than signs which make some contact with the body. It is possible that the

23

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

24

501   methods is required to add to these interesting initial studies. Future studies should control

502   elicitation procedures and tasks, both from the production and comprehension perspectives.

503

504   The wider SLA literature describes learners dropping or mis-ordering required elements during

505   acquisition. In signed languages the face is an important non-manual marker of several

506   grammatical functions. For example, one of the non-manual markers of questions is movement

507   of the eyebrows. Research has found that the grammatical use of non-manuals is relatively

508   limited among early and intermediate L2 learners (Schönström & Mesch, 2014). An example

509   from their data is that L2 learners did not raise the eyebrows in order to indicate wh-questions

510   non-manually but instead used the manual question signs WHAT etc. Unfortunately, the authors

511   did not report quantitative statistics for this observation. The authors reported that learners

512   largely focused on how to articulate manual signs while in fact not looking at the teacher.

513   Signing SLA learners have to become familiar with using facial expressions to convey particular

514   grammatical contrasts that in spoken languages would be conveyed by changes in intonation and

515   they have to learn how these non-markers work simultaneously with the manual lexicon. A

516   possible reason why these non-manual elements are challenging is that learners cannot visually

517   perceive their own faces whilst signing. Smith et al. (2010) reported timing difficulties with

518   articulating the manual and non-manual part simultaneously, whereby the non-manual was

519   articulated before the manual part when it should have occurred throughout the whole phrase.

520   Although we have included these as errors of simplification it is also possible that as

521   grammatical markers expressed on the face are not part of the learners' L1 they are thus harder to

522   learn.

523

25

524 Finally, a common pattern in second language learning is the issue of 'redundancy' in the use of

525 referring expressions e.g. 'The lady bought a dress. The lady bought some shoes'.

526

527 L2 learners of pro-drop (null-subject) languages even with an advanced level command of the

528 target language will produce overt subjects in contexts where native speakers would not have

529 produced them (Sorace & Filiaci, 2006). There are now a small number of papers examining

530 how hearing adult learners of sign learn to use referring expressions (Bel, Ortells & Morgan,

531 2015; Frederiksen & Mayberry, 2019; Gulamani, Marshall & Morgan, 2020; Perniss & Özyürek

532 2015). Bel et al.'s (2015) study involved 13 advanced adult learners of Catalan Sign Language

533 (LSC) who were enrolled on a sign language interpreter training course and had experienced 600

534 hours of formal exposure to LSC. Eleven deaf native LSC-signers acted as controls. Participants

535 were required to view a three-minute silent film about conflicts at school and were subsequently

536 instructed to tell a new story to camera about a similar experience they knew involving a friend

537 or classmate during their childhood or teenage years. This task was devised to encourage

538 participants to introduce third-person characters in their productions and make use of spatial

539 locations. Bel et al. (2015) found, as has previously reported for spoken language studies, that

540 the L2 signers had a tendency to oversupply overt arguments. Learners used overt pronouns more

541 frequently than their native-signing comparison group, including in contexts of referent

542 maintenance when a null pronoun would have sufficed. Thus Bel et al. (2015) argued that the

543 complexity of the task was resolved by learner signers in modality-similar ways to that argued

544 for spoken language L2 users. The added redundancy, while it seemed to free up cognitive

545 resources, had the effect of reducing the sign learners' fluency as judged by native signers.

546 **4. General conclusions and future directions**

26

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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