Breaking into sign language: Adult hearing learners use their visuo-spatial and gestural abilities to acquire spatial expressions

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Introduction

There is an assumption in psycholinguistics that linguistic labels are, for the most part, arbitrary (Perniss, Thompson & Vigliocco, 2010). Such arbitrariness between form and meaning, while giving freedom to the expansion of the lexicon arguably makes learning mapping relations between phonological form and meaning more challenging. Imagine an English-speaking adult who is learning French. She hears the sentence 'il y a un verre sur le livre', and knows 'il y a' (there is), 'un verre' (a glass) and 'le livre' (the book), but does not yet know the meaning of 'sur'. Without a supporting context (e.g. a picture), the spatial relationship between the glass and the book that is encoded by 'sur' is opaque. Her morphological and syntactic bootstrapping might narrow it down to a preposition, and she might already know some prepositions whose meanings she can eliminate from the meaning of 'sur'. She might also know that some spatial relationships are more plausible than others. But that is all. It is certainly inconceivable that she would be able to come up with the word 'sur' herself to express this spatial relationship if she has not previously encountered it.

For the same adult learning British Sign Language (BSL), the spatial relationship is more transparent because it is highly iconic and looks like how space is represented in co-speech gestures (Casey, 2003; Liddell, 2003; Kendon, 2004). Hearing people who are asked to use gestures to describe motion events will use icocnity on their hands and will exhibit rudiments of a spatial gestural system (Singleton, Goldin-Meadow, & McNeill, 1995). Iconicity in signed languages can be defined as a visually-motivated relationship between the form of the sign and the form of the referent. Figure 1a, illustrates the expression 'the glass on a book' in

BSL, there is a certain degree of iconic mapping in the configuration that the hands adopt, with a curved handshape representing the curved shape of the glass, and a broad flat handshape representing the broad flat surface of the book. Taub (2001) has termed this mapping 'shape-to-shape' iconicity. Strikingly, the two hands (termed 'classifier handshapes') map the real-world relationship between the referents shown in figure 1b, in what Emmorey terms 'the confluence of language and space' (Emmorey, 1996, p.171). One can imagine that the construction illustrated in figure 1a would be relatively easy for learners of BSL to understand, and even to create themselves because of the overlap between how the hands represent space in gesture and sign. It is this prediction that we set out to test in this paper.

More specifically, we investigate the following research question: does the strong visual motivation of spatial expressions in sign language make them easy for hearing adults to learn? Adults, after all, have well-developed visuo-spatial and gestural abilities that they could potentially recruit to helping them to 'break in' to such expressions. The manual modality affords both appreciation of and ability to express meanings, far more than in the spoken modality. A viewer of sign language can grasp some of the significance of a signed message, via an ability to see gesture or pantomime similarities and this makes it possible for an individual to invent gestural symbols that can be understood immediately (Singleton, Morford & Goldin-Meadow, 1993). Are learners able to recruit these skills for comprehension and production of spatial expressions in BSL And how does signing differ in learners and native signers? By studying how learners recruit gesture when learning sign, we capture a small part of the conventionalisation process that occurs in the birth and evolution of a sign language.

Singleton, Morford and Goldin-Meadow, (1993) and Schembri, Jones and Burnham (2005) both compared the description of motion events in the voice-off gestures of hearing people who knew no sign and deaf users of different sign languages. Both studies report a large overlap in the expression of movement in gesture and sign (70%) but differences between gesture and sign in how the hands represented objects (20%). Signers had many more fine-grained differences in how they described objects than voice-off gestures. This is not suprising as the non-signers had little previous experience or resources to create these gesture forms. Non-signers were also far more vague in their gesturing performing idiosyncratic pantomimes and non-specific pointing gestures. Non signers have a fully acquired first language to draw upon in their gesturing. English is replete with spatial prepositions ‘on’, next to’, under’ etc as well as spatial deixis ‘here’, ‘there’. Both Signelton et al, 1993 and Schembri et al 2005, noted that non signers often attempted to tranlate prepositions and deicitic terms into gestures which lef to this non-specific or redundant pointing.

An interesting question arises when we study individuals who have had more experience of trying to use the hands to talk about space. Learners of a sign language have both their natural gesture ability but also interestingly they have partly mastered a sign language which gives them some advantages over non-signers. They also have a fully acquired spoken language with which to draw from. How they blend these visual two systems during the course of their learning to become fluent signers can reveal how gesture and signing coalesce as well as diverge. There is a sparse literature on adult learning of signed languages, and it focuses on iconicity at the lexical level (Campbell, Martin & White, 1992; Lieberth & Gamble, 1991; Ortega, 2012; Baus, Carreiras, & Emmorey, 2012). Lieberth & Gamble (1991) investigated non-signers' recognition and retention of iconic and non-iconic (arbitrary) noun signs in American Sign Language (ASL), using a short-term and a long-term memory task. Both iconic and non-iconic signs were retained over a short and a long period of time, but there was a significant decrease in the number of non-iconic signs retained as the period of time after training increased, suggesting participants were more able to assimilate the iconic signs into existing semantic networks.

Campbell et al (1992) tested learners of BSL and non-signers in a recognition task, whereby participants were asked which signs in a set had been previously presented. For both groups recognition accuracy was related to the degree of sign iconicity, the extent to which a sign was related to a gesture-based meanings (i.e. the thumbs-down symbol for 'bad') and to natural actions (i.e. 'smoking a cigarette'). Signs that were iconic and that overlapped with gestures were recognised more than the converse.

Ortega (2012) asked adults with no previous knowledge of BSL to repeat iconic and non-iconic signs. Iconicity, rather than facilitating repetition accuracy, actually hindered it. At first blush this might seem contrary to Campbell et al's results. The argument was similar however, iconicity was activating similar looking gestures which then interfered with the stored representation of the sign and reduced repetition accuracy.

Finally, Baus et al (2012) taught non-signers iconic and non-iconic verbs in ASL and then got them to perform translation tasks from English to ASL and from ASL to English. In both versions of the task, participants translated iconic signs more rapidly than non-iconic signs.

These four studies converge in demonstrating that iconicity is relevant to learners of signed languages. They all, however, focused on single, lexically-stored signs. To the best of our knowledge, the current study is the first systematic investigation of the acquisition of spatial expressions in adult hearing learners of sign. There is a small number of studies detailing the acquisition of classifiers in children exposed to a sign language from birth (Morgan, Pyers, etc).

Examination of the process of breaking into sign language via iconicity and gestural knowledge can reveal both the overlap between these two forms of communication in the visual modality and the transition learners make from using gestures to acquiring a signed language.

Entity classifiers are used to represent different classes of noun objects, which have been previously mentioned in discourse, and to represent how these objects are positioned in space (also known as ‘semantic classifiers’, Supalla, 1986, and ‘whole entity classifiers’, Zwitserlood, 2012). Thus classifiers express locative meanings and encode the distribution of objects in space (‘distributive plurals’). Whereas the components of lexical signs, namely handshape, orientation, and location at the phonological level are not meaningful, they do express meaning in classifier constructions, and so are morphological (Supalla, 1982, 1986; Emmorey, 2003; Zwitserlood, 2012). This should be clear from the now familiar example in figure 1a. The handshapes have the meaning of “object from the class of curved entities” (in this particular case, “glass”), and “object from the class of broad and flat entities” (i.e. “book”). The orientation of the hand shows that the glass is oriented upright, rather than on its side. The location of the curved hand relative to the flat hand shows that the glass is on the book, and not under it, or next to it, or in any other spatial relationship with it.

The comprehension of locative and distributive classifier constructions therefore involves interpreting which handshapes refer to which entities previously mentioned in discourse (Zwitserlood, 2012).) Comprehension also involves interpreting how the hands’ orientation and location relative to one another map onto the spatial relationship of these entities in the real world. Conversely, production involves selecting the correct classifier handshape for the class of entities to which each referent belongs, and orienting and locating the hands correctly relative to one another.

It is possible that the directness or relative iconicity of the world to classifier mapping will assist learners in both comprehension and production. However, the degree of iconicity across location, orientation and handshape differs, meaning that acquisition might not be equally straightforward across the three parameters. Based on cross-linguistic evidence, it appears that the mapping is most direct for location and least direct for handshape, with orientation falling between those two.

Location has the most direct mapping. No sign language has been reported (to the best of our knowledge) where, for example, an ‘on’ relationship between two objects is expressed by a ‘next to’ relationship of the hands, or ‘below’ by an ‘in front’ of relationship. Instead, the mapping is direct and transparent, and does not vary cross-linguistically, and so, we argue, is likely to be understood and expressed accurately by learners of BSL.

Handshape categories, in contrast, are more abstract and less iconic (Aronoff, Meir, Padden & Sandler, 2003), and highly schematized and more conventionalised (Taub, 2001). Consistent with this view, they demonstrate cross-linguistic differences (Zeshan, 2003; Zwitserlood, 2012). For example, in Hong Kong Sign Language the classifier handshape for AEROPLANE consists of the extended thumb, middle finger and little finger, while in ASL the AEROPLANE classifier consists of an extended thumb, index finger and little finger. In BSL, neither of those handshapes exists in the phonological inventory, and AEROPLANE is represented by the Y handshape (extended thumb and little finger). Languages also differ in how they carve up semantic space to classify entities. For example, ASL has a broad “object” class represented by the A upright handshape, which can be used for an object as large as a building or as small as a vase on a shelf (Aronoff, et al, 2003). There is no similar class of objects, represented by a single handshape, in BSL. Similarly the broad class of vehicles (apart from AEROPLANE), which is represented in ASL by the 3-handshape, has no exact counterpart in BSL. Most vehicles in BSL are represented by a flat B handshape, which is not specific to vehicles but is used for broad and flat entities more generally.

Furthermore, the number of entity classifiers varies cross-linguistically. Zeshan (2003) argues that Indo-Pakistani sign language has just two entity classifiers – PERSON and LEGS. Another language, Adamorobe Sign Language, is claimed not to use entity classifiers at all (Nyst, 2007), suggesting that a system of entity classifiers is not a universal feature of natural sign languages.

In summary, cross-linguistic evidence demonstrates that entity classifier handshapes are conventionalised and therefore that learners need to acquire these conventions, in contrast to location. For the third parameter, orientation, the prediction is less clear. Brentari (2007) has argued that there are restrictions on the types of orientation relations that can be expressed by entity classifiers (unlike handling classifiers, whereby the hand refers to how an object is handled or manipulated), which suggests that iconicity is constrained by the grammar, and that these conventionalisations have to be learnt. However, cross-linguistic differences in orientation have not the best of our knowledge been reported. This suggests that the mapping between hand orientation and the orientation of objects in the real world might be relatively direct in the same way as it is for location, and therefore that orientation might be similarly easy for learners to understand and produce.

The current study investigated the use of entity classifier constructions by hearing adult learners of sign, whose native language is spoken. Presumably adult speakers can bring both co-speech gesture and general visuo-spatial abilities to the task of learning sign. Firstly, it is evident that many signs and sign communication strategies are conventionalised gestures recruited from the co-speech gestures used by the hearing community (Boyes Braem, Pizzuto & Volterra, Singleton, Goldin Meadow & McNeill (1995), Senghas, 2003). This does not mean that gestures and signs are identical: there are clear differences. For example, Brentari, Coppola, Mazzoni, & Goldin-Meadow (2012) showed that signers and speakers (all non-signers) used different handshapes when describing the location of stationary and moving objects in space using just their hands. While non-signers were able to do the task without speech, the handshapes that they used carried less phonological complexity compared to signers; a finding that Brentari et al (2012) argue comes from the creation of a conventionalised system in signed languages. Nevertheless, co-speech gesture might provide a starting point for expressing spatial relationships in sign.

Secondly intact visuo-spatial cognition would seem to be a pre-requisite for learning classifier constructions, since studies of individuals with damaged non-verbal visual spatial cognition show that they have difficulties in learning classifier constructions (Morgan, Woll, Smith & Tsimpli, 2002; Smith, Tsimpli, Morgan & Woll, 2010). Given that one can reasonably expect healthy hearing adults to have good visuo-spatial cognitive skills, these too might help them break into classifier constructions.

In this study we investigated two types of classifier constructions where the referents are stationary, namely locatives (i.e. X IS AT Y), and distributive plurals. We had three specific research questions, namely (1) Does iconicity help learners of BSL to comprehend and produce entity classifier constructions? (2) Does iconicity help even non-signers to comprehend entity classifier constructions? (3) Which components of entity classifier constructions are easiest for learners to comprehend and produce? Our predictions were that (1) iconicity would help learners of BSL to comprehend and produce entity classifier constructions, (2) that even non-signers would be able to use iconicity to help them comprehend entity entity classifier constructions, and (3), with respect to the different components of entity classifier constructions, location would be easiest, handshape hardest, and orientation in between.

Experiment 1. Comprehension task

The first task tested the comprehension of entity classifier constructions signed by a native signer. The ability of both BSL learners and non-signers was investigated, in order to determine (1) whether learners of sign comprehend entity classifier constructions with high degrees of accuracy; (2) whether iconicity helps even non-signers to comprehend entity classifier constructions; and (3) which components of entity classifier constructions are easiest for learners and non-signers to comprehend.

Method

Participants

24 hearing adults participated. 12 (2 male) reported having never learnt any sign language, and their encounter with BSL, if any, was limited, to seeing BSL interpreters on TV. The mean age of this ‘non-signer’ group was 31.6 years (SD = 6.1; range = 23-41). The remaining 12 participants (2 male) were learners of BSL. The mean age of this ‘learner’ group was 28.6 years (SD 5.8, range 22-44), a non-significant difference by independent samples t-test compared to the non-signer group, $t(22) = 1.305$, $p = 0.206$. Learners had been learning BSL for between one and three years, taking classes no more frequently than once a week. Five were working alongside Deaf colleagues and therefore using BSL on a daily basis, but 7 were not using BSL regularly, apart from attending classes and Deaf events (such as theatre and art gallery talks).

Procedure

The task was a picture-selection task, presented on a laptop. Four pictures appeared simultaneously at the top of the screen, numbered 1 to 4 (see figure X…). Participants were tested individually. Once participants had had the opportunity to look at all the pictures, they clicked on a video clip below the pictures in order to watch a BSL signer sign the classifier construction for one of the pictures. They were allowed to watch the video only once, unless there had been a very obvious distraction during the video, for example if participants or the experimenter sneezed, or if there was sudden noise outside the testing room. Having watched the video, participants then had to select the picture that matched what had been signed, by saying out loud the number of the picture. This response was recorded by the experimenter. Participants moved onto the next set when they were ready.

Three practice sets, testing individual vocabulary items rather than classifier constructions, were presented at the beginning, in order to get participants used to working the video clips and calling out the number of the matching picture. Participants were offered a short break halfway through. The task took approximately 15 minutes to complete.

Stimuli

Give example of stimulus sentence and pictures.

We tested two types of classifier construction that involve entity classifiers: verbs of location (i.e. X IS AT Y), and distributive plural forms. There were 84 sets of pictures and signed sentences in total. 12 were distributive plurals, where objects pictures were identical but varied in distribution (location and/or orientation). The remaining 72 sets pictured just 2 (or occasionally 3) objects:12 sets varied in handshape only, 12 in orientation only, 12 in location only, 12 in handshape and orientation, 12 in handshape and location, and 12 in orientation and location. For example, in Figure X…

Results

The results are shown in Table 1. A 2 (classifier type: locative, distributive) x 2 (group: learners, non-signers) ANOVA revealed a significant effect of classifier type, $F(1,22) = 21.913$, $p<0.001$, $\eta_p^2 = 0.499$, and a significant effect of group, $F(1,22) = 31.503$, $p<0.001$, $\eta_p^2 = 0.589$, but no significant interaction, $F(1,22) = 0.439$, $p = 0.515$, $\eta_p^2 = 0.020$. These results reflect higher performance by the learners, and greater accuracy for distributives. It should be noted that all the non-signers performed considerably more accurately than chance levels (25%).

INSERT TABLE 1 ABOUT HERE

For the verbs of location, we next investigated whether any phonological parameter was more prone to error, and whether the two groups made different proportions of errors on the different phonological parameters. For verbs of location, a 3 (error: handshape, orientation, location) x 2 (group: learners, non-signers) the interaction between participant group and error type was not significant, $F(2,44) = 0.224$, $p = 0.801$, $\eta_p^2 = 0.010$. Nor was there a significant effect of error, $F(2,44) = 0.777$, $p = 0.466$, $\eta_p^2 = 0.034$. Therefore no phonological parameter was more likely to cause a comprehension error than any other, and this was the case for both groups.

Interim discussion

That the non-signers did so well and that their pattern of performance did not differ in any way from learners of BSL indicates that much in entity classifier constructions can be understood using general visuo-spatial skills and without any formal introduction to sign language. However, the finding that learners of BSL performed better than non-signers shows that language experience also plays a role in successful comprehension. It should also be noted that the learners performed very accurately with this task (and reported finding it extremely easy), in contrast to their considerably less accurate performance on the production task that we present next (which the majority reported finding very challenging)

Experiment 2. Production task

This second experiment asked learners of BSL (but not non-signers) to describe pictures which had been shown to elicit entity classifier constructions in native signers. Please note that although we report this experiment second, it was actually the first experiment to be carried out by the learners of BSL. We wanted them to produce their own classifier constructions in the production task without being influenced by the signer that they would be watching in the comprehension task. Our aims were to investigate (1) whether learners of sign produce entity classifier constructions with high levels of accuracy, and (2) which components of entity classifier constructions are easiest for them to produce.

Methodology

Participants

The same 12 (2 male) learners of BSL from Experiment 1 participated in this experiment.

Procedure

Participants were shown two pictures in quick succession on a laptop screen. Each picture featured two or more objects, whose location or orientation, or both, had changed in the second picture. The first picture was presented for 3 seconds, and then the second for 3 seconds, after which participants saw a big black question mark on a white screen. This was the cue for them to explain in BSL what was different between the two pictures, i.e. what had changed.

We tested two types of classifier construction that involve entity classifiers: verbs of location (i.e. X IS AT Y), and distributive plural forms. For the verbs of location there were three conditions: (1) change of location, (2) change of orientation, (3) change of both location and orientation. There were 10 items in each condition. There also 10 items in the distributive plural condition, giving a total of 40 items altogether.

Coding:

Learners' productions were scored for accuracy in comparison to the productions of four adult native signers of BSL (three deaf and one hearing). When we asked the native signers to describe the pictures in BSL, we did not tell them the purpose of the task or the particular constructions that we were interested in. Nevertheless, each of the 40 stimulus items elicited entity classifiers from each of the signers, with little variation in production. Our learners' productions were judged correct if they matched one or more of the native signers' productions.

Each learner's classifier construction was given a score of 1 if it matched at least one of the native signers' productions, and 0 if it did not, with the highest possible score being 40. Individual parameters of the classifier, i.e. handshape, orientation and location, were also scored, and coded as either correct or incorrect. Handshape errors could be subdivided into two types: no classifier handshape ('omission'), and a substituted handshape ('substitution').

For distributive constructions, two additional errors were possible: anchor errors and movement errors. … We coded using ELAN software. All the data was coded independently by two coders with advanced BSL skills, and any areas of disagreement were discussed until consensus was reached.

It became clear during data collection that learners, in addition to producing classifiers, were using two additional strategies: pointing, and lexical prepositional signs. We therefore coded these too.

Results

One signer found the task particularly difficult and was not able to produce any classifier handshapes when describing the pictures, so testing was terminated before the end and her data were not used. The remaining 11 signers completed the task, and their data are presented in Table 2 and analysed here.

INSERT TABLE 2 ABOUT HERE

Correct items and items containing classifiers

Locatives: Learners of BSL produced 32.43% (SD = 28.63) of the locative items correctly, as judged in comparison to native signers. This mean percentage was low, and there was considerable individual variation. However, the learners did actually use at least one entity classifier in 78.18% (SD = 22.90) of their responses. Again, there was considerable variation between signers. Nevertheless, the percentage of responses containing entity classifiers was significantly higher than the number of responses that were correct overall (paired samples t-test, $t(10) = 8.759$, $p < 0.001$).

Distributives: Learners of BSL produced 25.45% (SD = 15.08) of the distributive items correctly, as judged in comparison to native signers. However, learners used at least one entity classifier in 71.82% (SD = 16.01) of their responses. The percentage of responses containing entity classifiers was significantly higher than the number of responses that were correct overall (paired samples t-test, $t(10) = 19.007$, $p < 0.001$).

Comparison between locatives and distributives: There was no significant difference in the percentage of correct responses for locatives and distributives, $t(10) = 1.142$, $p = 0.280$. Nor was there any significant difference in the percentage of locatives and distributives that included an entity classifier, $t(10) = 1.154$, $p = 0.275$.

Thus it appears that learners of BSL are generally aware that they need to use entity classifiers for encoding locative and distributive relations, but they have difficulty in doing so accurately. Distributives are not significantly more difficult than locatives.

Error analysis

Next, the percentage of errors on each phonological parameter (handshape, orientation and location) was examined, for locatives and distributives separately.

Locatives: Learners made handshape errors on 58.80% of items (SD = 30.10). They made orientation errors on fewer items, 19.10% (SD = 9.43), and location errors on still fewer items, 9.37% (SD = 6.47). The differences between all error types were significant when tested by paired samples t-tests (for handshape versus orientation, $t(10) = 5.559$, $p < 0.001$; for handshape versus location, $t(10) = 5.876$, $p < 0.001$; for orientation versus location, $t(10) = 4.276$, $p = 0.002$.

Distributives: Learners made handshape errors on 50.91% of items (SD = 22.56). They made orientation errors on fewer items, 15.45% (SD = 10.36), and location errors on still fewer items, 8.18% (SD = 7.51). The differences between handshape and the two other error types were significant when tested by paired samples t-tests (for handshape versus orientation, $t(10) = 6.500$, $p < 0.001$; for handshape versus location, $t(10) = 6.456$, $p < 0.001$). For orientation versus location the difference missed significance, $t(10) = 1.896$, $p = 0.087$.

There were two other error types that were possible for distributives but not for locatives, namely anchor errors and movement errors. 33.64% (SD = 6.74) of items had an anchor error, and 29.09% (SD = 14.46) of items had a movement error. We note that these error levels are significantly lower than the percentage of handshape errors: $t(10) = 2.297$, $p = 0.044$ for the comparison between handshape and anchor errors, and $t(10) = 3.387$, $p = 0.007$ for the comparison between handshape and movement errors. Orientation errors were, however, significantly lower: $t(10) = 4.451$, $p = 0.001$ for the difference between orientation and anchor errors, and $t(10) = 2.887$, $p = 0.016$ for the difference between orientation and movement errors.

Hence for locatives the pattern of errors (in order of decreasing number of errors) is handshape > orientation > locative, for distributives it is handshape > anchor, movement > orientation, location.

Because handshape errors were the most common for both locatives and distributives, on over half of items, we now investigate in more detail the types of errors made. Errors were of two types: omissions and substitutions. For locatives, omissions of at least one classifier handshape occurred for 37.58% (SD = 30.92) of items, and substitutions for 29.09% (SD = 11.06) of items. This difference was not statistically significant, $t(10) = 0.891$, $p = 0.394$. For distributives, there were omissions of at least one classifier handshape for 20.91% (SD = 18.68) of items, and substitutions for 32.73% (SD = 14.89) of items. This difference was not significantly different, $t(10) = 1.759$, $p = 0.109$.

A variety of replacement handshapes were involved in substitution errors. Our impression when we were coding the data was that the handshape that was used most often to replace others was B (i.e. a flat handshape). However, on going through the fully coded dataset this observation proved impossible to test statistically, as the stimuli were not designed to elicit equal numbers of the different handshapes. It should also be noted that handshapes other than B were used in substitutions.

On occasion, learners were uncertain which handshape to use and would try out more than one when describing a pair of pictures. For example, when describing two pictures where a man and a woman stand close together facing one another, then are shown far away and facing away from one another, one learner used two B handshapes to represent the people in the first picture (incorrectly), but two G handshapes (correctly). When describing a picture of a toothbrush in a cup, another learner used a G handshape (correctly) followed by a Y handshape (incorrectly) and finally an A handshape (incorrectly).

Some learners appeared to prefer to use a particular handshape over others, which meant that they encoded objects from several different classes using the same handshape, rather than differentiating them. However, all learners differentiated to some extent: none used just one handshape for the entire set of objects.

Strategies for encoding orientation and location when no classifier handshape was used

For locatives, learners were able to represent orientation and location information even when they did not produce a classifier handshape. They did so using two strategies: pointing, and using lexical prepositions. With respect to pointing, 9 of the 11 signers used points to encode location for at least one item, and 5 out of the 11 used points to encode orientation on at least one item. Signers used one or more location points for 37.88% (SD = 34.39) of items, and orientation points on just 4.55% (SD = 7.34) of items, a significant difference, $t(10) = 3.087$, $p = 0.011$. 6 signers used prepositions for encoding location in at least one of the items, and 3 used this strategy to a considerable extent (10, 17 and 20 times in the set of 30 items). Group mean = 15.76%, SD = 24.81. The lexical prepositions used included NEXT TO, ON and IN FRONT OF.

For distributives, there were no orientation points, and prepositions were rare and produced by only 2 participants (one participant produced 3 (NEXT TO x 3) and another produced 1 (ON)). Most participants (9 out of the 11) did produce location points however, with a group mean of 22.73% (SD = 18.49) of items containing at least one location point. Although this percentage is numerically lower than that of location points for locative items, the difference missed significance, $t(10) = 2.089$, $p = 0.063$.

Interim discussion

The production task was far more challenging for BSL learners than the comprehension experiment. While BSL learners were able to describe some locative information in verbs of location and distributive plurals they found the use of conventional BSL handshapes and orientations more problematic. Learners combined both sign and gestures. Alongside BSL classifier handshapes, learners also used index finger points to locations and some lexical preposition signs. In some of the descriptions there were handshape omissions and handshape substitutions. Learners appeared uncertain on occassions over which handhsapes to use, with several handshapes chosen to represent the same object, even within the same picture pairs, or indeed individual pictures. However, no learners used a single handshape to represent all objects, and therefore achieved some differentiation across different semantic classes.

General discussion

Previous studies have indicated that iconicity is a driving force behind the use of the hands in voice off gesturing as well as facilitating the learning and recall of lexical signs by hearing non-signers and learners. In two linked experiments we investigated whether iconicity continues to play a role in BSL learners' comprehension and production of entity classifier constructions for describing location information. Our research questions were threefold:

(1) Does iconicity continue to help learners of BSL to comprehend and produce entity classifier constructions? We predicted that it would happen but we were interested in what ways this occurs also.

(2) Does iconicity help even non-signers to comprehend entity classifier constructions? Again, we predicted that it would but we would like to know how as well.

(3) Which components of entity classifier constructions are easiest for BSL learners to comprehend and produce? Our prediction was that location would be easiest, handshape hardest, and orientation in between. This question relates to the systematic nature of a sign language grammar versus the ad hoc gestures. How do BSL learners of sign go further in the direction of fluent signers than the non signers?

We found that the comprehension task was competed with high levels of accuracy by non signers and learners of BSL. There is a considerable part of spatial expressions which can be understood via visuo-spatial, non-linguistic processing. The BSL learners were better at understanding these expressions than non signrtes however. Experience with BSL has allowed learners to go beyond raw visual spatial cognition. For both groups the errors were distributed evenly across the three parameters, handshape, orientation and location. Thus in perception each component of the classifier expression is equally accessible to non signers, as well as learners.

Turning to the production task, in contrast to comprehension, it was more difficult for learners of BSL, to match the native signers. Learners knew they had to use the hands to represent different objects, doing so for most of the trials across the test, but their overall levels of accuracy compared with native signers was low for both locatives and distributives. Additionally unlike for the comprehension task, the errors that they made were not distributed equally across handshape, orientation and location. As in previous studies of non signers' expression of motion events in gestures, BSL learners were good at expressing location but poorer at using specific handshapes. Schembri, et al, (2005) writes that both the signed and gestured descriptions of motion events by deaf and hearing individuals respectively, expressed imagistic aspects of thought (i.e., the mental representation of motion events) by means of forms created to conform to that imagery. For Schembri, et al, (2005) what distinguishes the two groups is that signers are able to do this more consistently. Handshape being expressed least accurately and location most accurately, fits in with the pattern we expected to find if classifier use was related to iconicity. Location is the most iconic component of entity classifier constructions, with a more direct mapping between the relative locations of objects in the real world and the relative locations of the hands in signing space. Handshape, however, is less iconic, because the mapping between the shapes of real objects and the shape adopted by the hands is less direct.

Furthermore, entity classifier handshapes are conventionalised, and our learners showed evidence that they were still learning these conventions, even after (in some cases) taking BSL classes for several years.

The previous research on non signers also described non specific gestures and spatial propositions in gestures for motion events. In BSL learners, we observed the continued recruitment of these two devices. In describing the locative and distributive pictures, we observed two types of handshape errors: omissions (i.e. no classifier handhsape was used at all) and substitutions (i.e. the wrong handshape was used). In the omission errors, the location and orientation could be successfully encoded, either through the use of prepositions or, more commonly, through the use of points. While points and prepositions do form part of BSL, none of our native signers used this strategy.

From gestures to signing in BSL learners

One proposal for how classifer expressions emerged in many sign languages is that they are grammaticalized forms of iconic gestures used by nonsigners (Duncan, 2003; Pfau & Steinbach, 2004; Zeshan, 2003). Once these classifiers are in the sign language they enter into syntagmatic relationships with other signs to form clauses and clause complexes. Schembri, et al, (2005) suggest the peculiar patterns of language transmission in deaf communities mean each generation may partly recreolize the language. This, coupled with the great capacity of the visual-gestural modality for iconic representation, may mean that some aspects of classifier constructions do not move far from their gestural origins.

In our classifier comprehension experiment the non signers were able to grasp the gestural origins of the spatial information expressed by the hands. These image provoking elements are candidate raw materials for the first forays into classifier signing we observe in BSL learners in our second experiment. BSL learners use their hands to describe space, including using points. But these devices need to be part of a coordinated system following particular linguistic conventions. Gesture provides the substrate or the tools that learners recruit to sign with initially but this system needs to be reorganised for further development towards the system used by native signers. In the BSL learners we see that they are moving from gestures to a coordinated sign language system. At this point they are in between the non signers and the native signers. This journey mirrors the grammaticalisation process argued for the BSL classifier system itself.

Where the gesture-signs hybrid lacks is to represent a set of objects in a coherent and systematic fashion. Each expression has a relationship to its referent but less relationship to other expressions. It is not a challenge to represent information in the visual modality what is difficult is the internal organisation of information in a set of contrastive handshapes. In conclusion, we argue that adult learners of BSL bring visuo-spatial knowledge and their gestural abilities to the tasks of understanding and producing constructions that contain entity classifiers. These abilities can be recruited for ‘breaking in’ to such constructions. The path they take as learners reflects how signing matures from gesture to language.

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Table 1. Results for the comprehension task

			Learners of BSL (N=12)	**Novices (N=12)**
% locatives correct		**Mean (SD)**	83.91 (7.09)	68.87 (10.25)
		Range	72.22 – 91.67	51.39 – 80.56
% distributives correct		**Mean (SD)**	93.75 (6.28)	81.95 (9.29)
		Range	83.33 - 100	66.67 – 91.67
Errors (mean totals)	**handshape**	**Mean (SD)**	3.58 (2.87)	7.67 (3.39)
		Range	0 - 10	4 – 15
	orientation	**Mean (SD)**	4.73 (3.52)	8.00 (3.91)
		Range	1 - 11	3 – 14
	location	**Mean (SD)**	4.33 (1.44)	8.25 (2.45)
		Range	2 - 6	6 - 13

Table 2. Results for the production task

		Locatives	Distributives
% items correct		32.43 (28.63)	25.45 (15.08)
% items including at least one classifier		78.18 (22.90)	71.82 (16.01)
Error types	**% handshape**	58.80 (30.10)	50.91 (22.56)
	% orientation	19.10 (9.43)	15.45 (10.36)
	% location	9.37 (6.47)	8.18 (7.51)
	% anchor	n/a	33.64 (6.74)
	% movement	n/a	29.09 (14.46)
Type of handshape error	**omission**	37.58 (30.92)	20.91 (18.68)
	substitution	29.09 (11.06)	32.73 (14.89)
Points	**location**	37.88 (34.39)	22.73 (18.49)
	orientation	4.55 (7.34)	0
Prepositions	**location**	15.76 (24.81)	3.64 (9.24)

Figure 1

1a. CL-CURVED-OBJECT-ON-CL-FLATOBJECT 1b. picture of glass on book – need to take

Appendix 1 Stimuli for comprehension experiment

Modify table: organise stimuli by condition, list 3 distractor pictures.

HS	4 (3a) person behind motorbike	1				
Dist	4 (38a) 2 rows cars, nose to tail	2				
HS	1 (1a) coin on notepad	3				
HS/Or	4 (19a) motorbike on side (on paper)	4				
HS/Loc	1 (25a) pencil on book	5				
Or/Loc	3 (36a) woman facing side of plane	6				
HS/Or	2 (20a) pen – between 2 teddies	7				
Dist	4 (37a) magazines top arc	8				
HS/Or	2 (21a) boy facing ahead, at front of plane	9				
Dist	3 (39a) colour pens random	10				
HS	2 (2a) car next to motorbike	11				
Dist	3 (40a) people in circle	12				
HS	1 (5a) orange next to policeman	13				
HS/Loc	2 (26a) teddy in front of motorbike	14				

Or	2 (8a) 2 cars facing, one overturned	15				
Loc	1 (13a) 2 books side by side, contact	16				
Dist	2 (42a) one row of oranges	17				
HS	3 (4a) pen on paper	18				
Or	1 (7a) plane facing house, right way up	19				
Loc	4 (16a) boy above cup	20				
Or/Loc	1 (35a) car facing pot, no contact	21				
HS	2 (6a) toothbrush behind video	22				
Or/Loc	3 (33a) boy to right of 2 cars, facing back	23				
Or	3 (12a) boy and p'man alongside, face fwd	24				
Loc	2 (14a) pens to left of 2 videos	25				
HS/Or	2 (24a) p'man in front of car, facing fwd	26				
Or/Loc	4 (32a) books alongside, contact at corner	27				
Or	3 (9a) t'brush pointing cup, upside down	28				
HS/Or	1 (23a) pen pointing apple	29				
Dist	3 (41a) books random	30				
Or/Loc	4 (34a) m'bike far from house standing up	31				
HS/Loc	4 (28a) cup close to photo	32				
Loc	3 (15a) teddy in front of car	33				
HS/Or	4 (22a) car on book, upside down	34				
Loc	1 (17a) man between 2 planes, close	35				
HS/Loc	3 (27a) p'man + house, bottom shelf	36				
Or	4 (10a) woman front of m'bike, bike upright	37				
HS/Loc	2 (30a) photo above cup	38				
Loc	2 (18a) m'bike alongside car, far	39				
Or/Loc	1 (31a) t'bush in front of pot, right way up	40				
HS/Loc	1 (29a) ruler to right of 1 car	41				

Or	1 (11a) 2 pens alongside, pointing diff ways	42				
Loc	3 (13b) 2 books alongside, no contact	43				
HS/Or	3 (20b) pen I between 2 coins	44				
Loc	2 (16b) boy + cup, top shelf	45				
Or	3 (12b) p'man behind boy	46				
HS/Loc	4 (26b) man behind motorbike	47				
HS/Or	1 (19b) plane on paper, right way up	48				
Loc	4 (18b) m'bike in front of car, contact	49				
HS/Loc	2 (30b) photo above plane	50				
HS/Or	1 (21b) boy facing front of car	51				
HS/Loc	1 (27b) cup + policeman, top shelf	52				
HS/Or	3 (22b) plane on book, upside down	53				
Or/Loc	1 (34b) m'bike close to house, on side	54				
Dist	1 (38b) cars in a row, alongside	55				
HS	4 (2b) car next to house	56				
HS/Loc	2 (28b) coin far from photo	57				
Loc	1 (15b) teddy next to car	58				
Or/Loc	2 (33b) boy between cars, facing left	59				
Dist	4 (37b) magazines in line, top to bottom	60				
HS	4 (1b) can on notepad	61				
Loc	3 (17b) man far to left of 2 planes	62				
Or/Loc	4 (32b) 2 books on top	63				
HS	1 (3b) m'bike on front of apple	64				
Or	3 (7b) plane alongside house, upside down	65				
Or/Loc	3 (31b) t'brush in beaker, upside down	66				
Dist	2 (39b) pens in two piles	67				
HS	2 (4b) pot on notepad	68				

Or/Loc	1 (36b) woman facing front of plane	69				
Or	2 (11b) 2 pens crossing	70				
Or/Loc	4 (35b) car contact pot, alongside	71				
Or	4 (8b) 2 cars alongside, one upside down	72				
Dist	1 (41b) books piled up	73				
HS	3 (5b) orange next to calculator	74				
Or	1 (9b) t'brush alongside cup, right way up	75				
Dist	2 (42b) 2 shelves oranges	76				
HS/Or	4 (23b) pen alongside coin	77				
HS	3 (6b) toothbrush behind plane	78				
Dist	2 (40b) people standing arc	79				
Or	2 (10b) girl next m'bike on side, alongside	80				
HS/Loc	3 (29b) ruler between planes	81				
HS/Or	4 (24b) policeman facing m'bike	82				
HS/Loc	4 (25b) orange next to book	83				
Loc	3 (14b) pen between videos, head to tail	84				

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