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Acquiring Word Class Distinctions in American Sign Language: Evidence from Handshape

Diane Brentari [a] , Marie Coppola [b] , Ashley Jung [c] & Susan Goldin-Meadow [d]

[a] University of Chicago, Department of Linguistics

[b] University of Connecticut, Departments of Psychology and Linguistics

[c] Purdue University, Department of Speech Language and Hearing Sciences

[d] University of Chicago, Department of Psychology
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Diane Brentari

University of Chicago, Department of Linguistics

Marie Coppola

University of Connecticut, Departments of Psychology and Linguistics

Ashley Jung

Purdue University, Department of Speech Language and Hearing Sciences

Susan Goldin-Meadow

University of Chicago, Department of Psychology

Handshape works differently in nouns versus a class of verbs in American Sign Language (ASL) and thus can serve as a cue to distinguish between these two word classes. Handshapes representing characteristics of the object itself (*object* handshapes) and handshapes representing how the object is handled (*handling* handshapes) appear in both nouns and a particular type of verb, classifier predicates, in ASL. When used as nouns, *object* and *handling* handshapes are phonemic—-that is, they are specified in dictionary entries and do not vary with grammatical context. In contrast, when used as classifier predicates, *object* and *handling* handshapes do vary with grammatical context for both morphological and syntactic reasons. We ask here when young deaf children learning ASL acquire the word class distinction signaled by handshape. Specifically, we determined the age at which children systematically vary *object* versus *handling* handshapes as a function of grammatical context in classifier predicates but not in the nouns that accompany those predicates. We asked 4–6-year-old children, 7–10-year-old children, and adults, all of whom were native ASL signers, to describe a series of vignettes designed to elicit *object* and *handling* handshapes in both nouns and classifier predicates. We found that all of the children behaved like adults with respect to all nouns, systematically varying *object* and *handling* handshapes as a function of type of item and *not* grammatical context. The children also behaved like adults with respect to certain classifiers, systematically varying handshape type as a function of grammatical context for items whose nouns have *handling* handshapes. The children differed from adults in that they did not systematically vary handshape as a function of grammatical context for items whose nouns have *object* handshapes. These findings extend previous work by showing that children require developmental time to acquire the full morphological system underlying classifier predicates in sign language, just as children acquiring complex morphology in spoken languages do. In addition, we show for the first time that children acquiring ASL treat *object*

Correspondence should be addressed to Diane Brentari, University of Chicago, Department of Linguistics, 1010 East 59th Street, Chicago, IL 60637-1512. E-mail: dbrentari@uchicago.edu

and *handling* handshapes differently as a function of their status as nouns vs. classifier predicates, and thus display a distinction between these word classes as early as 4 years of age.

INTRODUCTION

Children acquiring English must learn that some words function as nouns and others function as verbs. Initially, children respect the semantic categories of nouns for objects and verbs for events and do not mix the two, even if the same word can be used for both functions. For example, although the word 'brush' can be used as a noun or a verb in English, children at the earliest stages of development use the word either to refer to the instrument used for brushing (noun) or to the act of brushing (verb), but not both (Brown, 1973; Macnamara, 1982; Huttenlocher & Smiley, 1987, for spoken languages; Petitto, 1992, for sign languages). Sometime before age 5;0, children begin to produce the same word in both noun and verb contexts, using closed class markers to distinguish between the two uses; for example, "I want *the button*" (noun) versus "I want *to button* it" (verb); Clark, 1993). It is at this point that we can be certain that the child has acquired a grammatical distinction between noun and verb.

We ask here if, and (if so) when, children learning ASL as a native language acquire adult-like noun-verb distinctions based on form rather than semantic category. The early acquisition of a noun-verb distinction in ASL is often assumed since so many acquisition milestones follow the same time course in signed and spoken languages (Newport & Meier, 1985). However, this particular parallel has not been empirically demonstrated, in large part because the particular type of motion that marks the noun-verb distinction in many pairs of signs (Supalla & Newport, 1978) is a relatively late acquisition in ASL-learning children (Meier, Mauk, Cheek, & Moreland, 2008). As a result, we focus our analyses on a set of handshapes that are acquired relatively early in sign language (Kantor, 1980; Boyes Braem, 1990; Conlin, Mirus, Mauk, & Meier, 2000; Marentette & Mayberry 2000; Fish, Moren, Hoffmeister, & Schick, 2003) to explore the acquisition of a noun-verb distinction in ASL.

Distinguishing between word classes in spoken and signed languages

A lexicon includes all of the words in a language regardless of their origin. For our purposes, the lexicon is defined as the vocabulary of a given language and the material needed to construct the different kinds of words in it: phonemic elements and their constraints on distribution, as well as rules for combining morphemes into words. Languages often group words together into classes within the lexicon based on historical origin, morphological behavior, or phonological behavior (cf. Anderson, 1992; Itô & Mester, 1995a, b). These classes pattern differently within a language and, to become proficient users of a language, children need to understand these different patterns within the language they are learning.

As mentioned earlier, at the word level, children acquiring English must learn that some words function as nouns and others function as verbs, and that one way to identify the class of a word is to observe whether the word undergoes a particular set of morphological changes. To take a specific example, tense in English is expressed on verbs and not on nouns. As a result, even though the word 'place' can function as a noun or verb in English, speakers are able to distinguish between the two uses in the sentences in (1) by noticing that the verb 'place' changes

in present versus past grammatical contexts (e.g., 'she places' vs. 'she placed'), but the noun 'place' does not.

The form of a verb changes in present vs. past grammatical contexts, the form of a noun does not:

(1) Use of the English stem "place" as a noun and verb.

	Noun (no variation)	*Predicate (variation)*
a. Present	Her *place (noun)* is third from the end.	She *plac**es** (verb)* third from the end every time.
b. Past	Her *place (noun)* was third from the end.	She *plac**ed** (verb)* third from the end every time.

At the sublexical level, children acquiring English must also learn that some sounds function as phonemes (in the lexical items that comprise the word classes) and as morphemes (in the grammatical elements that distinguish among the classes)—'rose' ('z' as a phoneme) vs. 'rows' ('z' as a morpheme marking the plural)—and that sounds behave differently in the two contexts. For example, English /z/ vs. /s/ creates a phonemic contrast (i.e., a minimal pair) when the sounds are phonemes in a stem ('news' vs. 'noose') but not when they are morphemes. Rather, when [z] and [s] are morphemes marking the plural, they are subject to a phonological rule—the plural morpheme is voiced [z] in 'plays' but rather because the morpheme follows a voiceless consonant /t/, it is voiceless [s] in 'plates.' Similarly, when English /d/ and /t/ are phonemes in a stem, the phonemic contrast can create a minimal pair ('mad' vs. 'mat') but not when they are morphemes. When [d] and [t] are morphemes marking the past tense, they are subject to the same phonological rule found in the plural—the past tense morpheme in English is voiced [d] in 'played' but because in 'placed' the morpheme follows the voiceless /s/—i.e., the orthographic 'c'—it is pronounced [t] rather than [d]. Thus, it is possible to tell the difference between sounds in a morpheme versus a lexical stem in English because the sounds are subject to a phonological rule (and thus vary) when they are morphemes, but are not subject to the same phonological rule (and thus do not vary) when they are stems.

Distributional patterns at the lexical and sublexical levels are present in sign languages as well as spoken languages. For example, children acquiring a language such as American Sign Language (ASL) must learn that handshapes can be distributed differently in lexical versus grammatical contexts. The same handshape can be used phonologically in a lexical item (e.g., in a noun) where handshape is invariant across grammatical contexts but can also be used morphologically in a predicate (e.g., in a class of predicates called classifiers) where handshape varies as a function of grammatical context. To master ASL grammar, children must learn that handshape is treated differently when it functions as part of a stem (and thus does not vary with grammatical context) versus when it functions as a morphological marking (and thus does vary with grammatical context). We ask when children learning ASL begin to display this pattern in their signs and thus demonstrate a distinction between two types of word classes—nouns and classifier predicates. To clarify how handshape works in ASL, we begin by providing background on the architecture of the ASL lexicon and the role that handshape plays in it.

Handshape variation in the sign language lexicon

Figure 1 displays the relationship among components in the ASL lexicon (based on Brentari & Padden's, 2001, architecture, following similar models for spoken languages proposed by Itô &

*Iconically
Unmotivated
Handshape*

SUNDAY
Core lexicon
noun

foreign
lexicon

NATIVE LEXICON

core

spatial lexicon

*Iconically
Motivated
Handshapes*

BOOK
Core lexicon
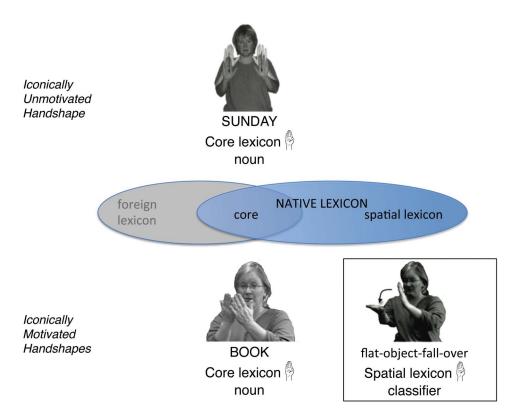noun

flat-object-fall-over
Spatial lexicon
classifier

FIGURE 1   Examples of noniconic and iconic handshapes in the native
lexicon, and cases where handshape is used phonemically and where it is
used morphemically. Note that the same iconically motivated handshape
can be used both phonemically (in the lexical noun, BOOK) and mor-
phemically (in the classifier predicate 'flat-object-fall-over,' boxed in
black). The same handshape is used non-iconically in the noun SUNDAY
(color figure available online).

Mester, 1995a, b). We focus here on handshapes in two types of ASL vocabulary items, those
in the core and spatial lexicons (the foreign lexicon will not be considered in this paper). Nouns
are *core vocabulary items* that consist of a stem (e.g., SUNDAY, BOOK in Figure 1) whose
handshape does not change as a function of grammatical context. Classifier predicates are *spa-
tial vocabulary items* that express the location and movement of objects and that consist of a
polymorphemic stem containing a root movement and a handshape affix (e.g., 'flat-object-fall-
over' in Figure 1), which *does* change according to grammatical context. Another relevant factor
that is evident in Figure 1 is that some handshapes in ASL are purely arbitrary (as in the noun
SUNDAY, Figure 1), whereas others are iconic (as in BOOK, a noun, and 'flat-object-fall-over,'
a classifier predicate, Figure 1). Our focus in this paper is on handshapes that are iconically
motivated. We will thus not consider arbitrary handshapes any further.

We explore here the acquisition of the lexical (phonological) and grammatical (morphological)
uses of two types of iconic handshapes in ASL: (1) *object* handshapes, which represent properties

of an object, and (2) *handling* handshapes, which represent how an object is handled or manipulated. Importantly, the same *object* and *handling* handshapes can be found in the core and spatial lexicons of ASL. For example, the *object* handshape ⍭ is found in BOOK (Figure 1, bottom left), a core lexical item, and in 'flat-object-fall-over,' a spatial lexical item (Figure 1, bottom right). As we will describe in the next section, there are ways of determining whether a handshape is a noun in the core lexicon and thus operating lexically (phonologically), or a classifier predicate in the spatial lexicon and thus operating grammatically (morphologically).

Classifier predicates.   Classifier constructions are spatial verbs that are polymorphemic complexes with a verbal root signifying movement (Supalla, 1982; Shepard-Kegl, 1985; Schick, 1987; Emmorey, 2003; Benedicto & Brentari, 2004). Handshape is an affix on the root and typically conveys information about the semantic class, size, and/or shape of the moving object. There are several types of classifiers in ASL, but only three are relevant to our current study:

1. Whole entity classifiers, in which the handshape represents the object as a whole rather than its parts (Engberg-Pedersen, 1993; Benedicto & Brentari, 2004), for example, 3-handshape for vehicle (✋, thumb, index, and middle finger extended), B-handshape (⍭, a flat palm) for book, ILY-handshape (🤟, thumb, index, and little fingers extended with the middle and ring fingers closed) for aircraft, 1-handshape (☝, index finger extended) for long-thin-object.
2. Size-and-shape specifiers (SASSs), in which the handshape represents a subset of the properties of an object (Supalla, 1982), for example, a curved 1-handshape (👌, index finger and thumb curved) representing a flat, round object. Both whole entity classifiers and SASSs are referred to as *object* classifiers throughout this paper.
3. *Handling* classifiers, in which the handshape represents the hand that manipulates the object (Supalla, 1982), for example, the closed X-handshape (☝, thumb placed over the curled index finger) representing the way a small thin object is handled.

Object and *handling* classifiers are illustrated in Figure 2. Note that the place of articulation and movement are the same in the two signs. The only difference is the handshape—the *object* handshape (on the left) represents the book as it moves; the *handling* handshape (on the right) represents the way the book is handled as it is moved.

Object and *handling* handshapes in classifier predicates have stable, discrete, and productive meanings, and thus are morphological affixes (Supalla, 1982). *Object* and *handling* handshapes also exhibit syntactic alternations, for example, a transitive-intransitive opposition in the syntax (Benedicto & Brentari, 2004). *Object* classifiers are associated with the grammatical object (the internal argument) of a clause; they are produced when there is no agent and the object moves on its own or is situated in a particular location, that is, in No-Agent events. In contrast, *handling* classifiers are associated with the grammatical subject (the agent) of a clause; they are produced when an agent handles or moves an object to a location, that is, in Agent events. The crucial point is that the particular item involved in an event is not relevant in deciding whether the handshape in a classifier predicate should be *object* or *handling.* No matter what the item is, the classifier predicate representing that item will have an *object* handshape in No-Agent events and a *handling* handshape in Agent events.

BOOK 'flat-object:⍦'+MOVE
'A book fell on its side.'

BOOK 'handle-flat-object:⬱'+MOVE
'[Someone] put a book on its side.'

FIGURE 2 Examples of *object* and *handling* handshapes used in a classifier predicate in ASL. Left: The circled hand is an *object* handshape representing the shape of the book that is moving. Right: the circled hand is a *handling* handshape representing how the book is handled as it is moved. The hand not circled in both examples represents a second book on the shelf.

Nouns.   In nouns, handshapes are exclusively phonological (Stokoe, 1960) and combine with other phonological elements to form stems. Two nouns that differ only in handshape also differ in meaning and thus constitute a minimal pair (e.g., the sign WASH resembles the sign SUNDAY in all respects except that it uses an A-handshape ⍫ rather than a B-handshape ⍦). As noted earlier, the handshape features of nouns often have no meaning (e.g., the B-handshape ⍦ in SUNDAY is not iconically related to its referent). However, handshape is iconically motivated in some nouns (e.g., the B-handshape ⍦ in BOOK captures the flat-wide feature of its referent in its form).

Our focus here is on nouns whose handshapes also appear in classifier predicates. For example, the sign LOLLIPOP, a noun in ASL, is produced with a closed X-handshape ⍩, which captures features of the hand as it holds the lollipop—a *handling* handshape. This closed-X handshape also appears as the *handling* handshape in the classifier predicate 'put-down-lollipop,' used in Agent contexts. As another example, the sign AIRPLANE, a noun in ASL, is produced with the so-called ILY-handshape ⍸, which captures the shape of the airplane—an *object* handshape. This ILY-handshape also appears as the *object* handshape in the classifier predicate 'airplane-falls-over,' used in No-Agent contexts. The same *object* and *handling* handshapes can thus be found in core nouns and in classifier predicates.

Importantly, however, *object* and *handling* handshapes are used differently in nouns vs. classifier predicates, thus providing a way to distinguish between these two word classes. In particular, handshape does *not* vary with grammatical context in nouns; for example, the *handling* handshape ⍩ is used in the noun LOLLIPOP, and the *object* handshape ⍸ is used in the noun AIRPLANE, whether these nouns are used in a No-Agent or an Agent context. In contrast, as described earlier, handshape varies systematically with grammatical context in classifier predicates; for example, the *handling* handshape ⍩ is used in the classifier predicate describing a lollipop in an Agent context (i.e., in 'put-down-lollipop'), but the *object* handshape ⍦ is used in the classifier predicate describing a lollipop in a No-Agent context (i.e., in 'lollipop falls-over').

Thus, the handshape used in a noun does *not* change as a function of the event that the signer is describing, whereas the handshape used in a classifier predicate does.

The goal of this paper is to determine when children acquiring ASL as a native language learn that handshape in classifier predicates varies systematically as a function of grammatical context, but handshape in core nouns does not—that is, when do children display systematic differences in how they treat noun versus classifier predicate word classes, thus displaying a distinction between nouns and verbs based on form rather than semantic category?

The acquisition of principled variation in handshape in nouns versus classifier predicates

To our knowledge, no one has examined whether young ASL-learners use principled handshape variation differently in *core nouns* vs. *classifier predicates*. Previous research has examined whether ASL-learning children at the earliest stages of language development use the same handshapes in lexical and predicate contexts, and has found that producing a handshape correctly in a lexical context does not guarantee that a child can use the same handshape correctly in a classifier context. For example, a 3-year-old child learning ASL can routinely used the V-hand in the lexical verb SEE, while not being able to reliably produce it in the classifier predicate 'legs' ✌+STAND (Kantor, 1980).

However, our central question is broader. No previous studies have described the ASL-learning child's ability to distinguish *lexical nouns* from *classifier predicates*. We do so here by comparing how handshapes are used in lexical nouns with how the same handshapes are used in classifier predicates produced along with those nouns. Our goal is to compare how handshape is used in these two distinct word classes (nouns vs. predicates) to explore a fundamental aspect of grammatical development.

There is an extensive literature on handshape use *within* classifier predicates in ASL. In general, this work shows that classifier predicates are learned morpheme by morpheme (rather than as unsegmented wholes) over a long period of development (Ellenberger & Steyaert, 1978; Kantor, 1980; Newport, 1981; Supalla, 1982; Schick, 1987), and that handshape use in these predicates requires many years to develop (Newport, 1981; Newport & Meier, 1985; Lillo-Martin, 1999, 2009; Singleton & Newport, 2004). The majority of the studies of classifier predicates in ASL-learning children have not examined handshape *variation* in these signs, as their focus has been exclusively on *object* handshapes in No-Agent contexts (e.g., Fish et al., 2003; Kantor, 1980; Newport, 1981; Supalla, 1982). For example, Supalla (1982) studied three ASL-learning children over a six-month period (ages 3;6, 4;0, and 5;6 when testing began) and found that, overall, the children produced the correct *object* handshape a majority of the time (table 16, p. 92). When they failed to use a correct *object* classifier, the children most often used a phonologically simpler *object* handshape (a B-hand or index finger) and, less often, a whole body gesture, a finger tip tracing a path, or an incorrect handshape from a frozen lexical item. Rarely did any of the children substitute a *handling* handshape for an *object* handshape, a response that would be incorrect, as all of the items were shown in No-Agent events where only *object* handshapes are appropriate (Supalla, 1982, table 15, p. 90).

There are, however, two studies that have included both *object* and *handling* handshapes as their focus. In the first, Slobin et al. (2003) analyzed spontaneous productions of *object* and

handling handshapes in children learning either ASL or Sign Language of the Netherlands (NGT), starting at age 1;3. They found evidence of both types of handshapes as early as age 2;5. But since the context in which the children produced their signs was not controlled, it was difficult to determine whether a handshape was being produced in a noun or a classifier predicate, a crucial distinction for the question we want to address. In the second study, Schick (1987) elicited signs from 24 ASL-learning children (ages 4;5 to 9;0) using controlled stimuli comparable to those used by Supalla (1982). However, Schick's stimuli included not only those designed to elicit *object* classifiers (both semantic and size-and-shape), but also stimuli designed to elicit *handling* classifiers. She also controlled for the complexity of the handshape forms in the classifiers, dividing targeted productions into 'simple' handshapes (forms produced with one hand or with two hands both displaying the same handshape) and 'complex' handshapes (forms produced with two hands but with the two hands displaying different forms). She found that, although the forms the children used were correct a majority of the time for both *object* and *handling* handshapes, at every age, children were more likely to produce correct *object* handshapes than *handling* handshapes (table 5.3, p. 78) and the complexity of a handshape's form played a role in whether it was produced correctly. Note, however, that in order to truly master handshape in classifier predicates, children need to be able to use an *object* handshape when describing an item that moves or is positioned on its own without an agent (i.e., in No-Agent contexts), and a *handling* handshape when describing *that same item* when an agent moves or positions it (i.e., in Agent contexts). The stimuli in our study were designed with this contrast in mind.

Our research thus builds on previous findings in the literature in a number of ways. To our knowledge, this is the first study of the acquisition of word classes in sign languages based on structure rather than on conceptual notions such as 'object' and 'action.' In order to determine the deaf child's acquisition of ASL noun vs. verb classes, we investigated the age at which ASL-learning children begin to treat handshape differently in nouns vs. classifier predicates, thus demonstrating a distinction between the two word classes. To facilitate comparison between nouns and classifier predicates, we selected handshapes that are routinely used in both contexts. Because handshapes in classifier predicates are iconically motivated, we used nouns whose handshapes are iconically motivated, in particular, handshapes that capture an aspect of the referent, either a physical characteristic of the referent (nouns with *object* handshapes) or the way in which the referent is handled (nouns with *handling* handshapes). In addition, we selected target signs (nouns and classifier predicates) that have a 1-handed form—phonologically 'simple' according to Schick's (1987) criteria—thus avoiding any differences that might arise as a function of production difficulties. Finally, we used stimuli designed to elicit contrasting handshapes—the same objects shown in the No-Agent events were shown in the Agent events, allowing us to determine whether children systematically vary the handshapes they use to represent objects as a function of the context in which the appear. The targeted forms in our study were thus near-minimal pairs—the stimuli were designed to elicit signs that differ only in whether the agent is (Agent context) or is not (No-Agent context) represented in the handshape.

A fully 'adult' ASL system makes the distinction between nouns (lexical, phonemic use of handshape) and classifier predicates (grammatical, morphosyntactic use of handshape) by using the same handshape in a noun whether that noun appears in a No-Agent or Agent context, while at the same time varying the handshape of the classifier that accompanies the noun, using an *object* handshape in No-Agent contexts and a *handling* handshape in Agent contexts. We explored the development of this distinction in deaf ASL-learning children ages 4–11, as this is the period

during which children have been found to make significant progress in their use of ASL classifiers (e.g., Fish et al., 2003; Kantor, 1980; Newport, 1981; Supalla, 1982; Schick, 1987). We also asked adults to perform the same task, thus providing us with a standard against which to assess child performance.

METHODS

Participants

Three adults and nine children participated in this study. All were native signers of ASL; that is, they had two deaf parents and had been exposed to ASL from birth. The three adults (ages 32, 37, and 52) were from the greater Chicago metropolitan area and are actively involved in the Deaf community. The nine children attended the Indiana School for the Deaf during the period when this study was conducted, and all came from families in which both deaf parents use ASL as the primary language in the home. Three children formed the younger group (ages 4;1 to 6;3, mean age = 5;2) and six children formed the older group (ages 7;8 to 10;6, mean age = 9;1). All but two children (one in the younger group, GA, and one in the older group, PD, see Table 1) participated in the study for more than one year. Two children in the younger group and three of the six children in the older group were tested in three successive years; two in the older group were tested in two successive years. The same task was administered at each testing session, and we found no differences across sessions within a child. Consequently, the data for each child were combined into a single score.

Stimuli and Procedures

The stimuli were short animated vignettes of items either stationary or moving by themselves (No-Agent condition) or the same items being moved in space (Agent condition). Eleven items were used in the vignettes (airplanes, books, coins, cigars, lollipops, marbles, pens, strings, tapes,

TABLE 1
The ages of the children who participated in the study at each testing session. Note that all but two children (GA and PD) were tested more than once

Child	4 years	5 years	6 years	7 years	8 years	9 years	10 years
BA	x	x	x				
BZ	x	x	x				
GA	x						
MJ				x	x		
MR				x	x	x	
PI					x	x	x
WL					x	x	x
SD					x	x	
PD							x

television sets, and tweezers). We focused our analyses on two items whose citation forms in an ASL dictionary (Stokoe, Casterline, & Croneberg, 1965) have *object* handshapes (airplane, book) and two whose handshapes in the dictionary have *handling* handshapes (lollipop, pen). The stimulus items exhibited a range of colors, shapes, and sizes, and each was portrayed in two types of events: (1) No-Agent events depicting a stationary item or an item moving on its own without an agent (five vignettes for each item—object on table; object on table upside down; multiple objects on table in a row; multiple objects on table in a random arrangement; object falling); (2) Agent events depicting an item being moved by the hand of an agent (five vignettes for each item—put object on table; put object on table upside down; put multiple objects on table in a row; put multiple objects on table in a random arrangement; use object for its typical function, i.e., play with the toy airplane, write with the pen, read the book, eat the lollipop). There were thus 10 vignettes for each of four items, 40 vignettes in all. Typical handshapes expected in the nouns and classifier predicates for these four objects are displayed in Figure 3.[1]

Participants were asked in ASL to describe what they saw on the screen. The vignettes were presented in blocks (all of the events involving one item were presented together, No-Agent events, followed by Agent events); the same order was used for all participants. The three experimenters who collected the data were hearing signers; two were native signers, and one had been signing for five years.[2] Data collection sessions were videotaped, either at the University of Chicago, at the Indiana School for the Deaf, or in the participant's home, depending on the preference of the participant (or the participant's parents).

Coding

The videos of the participants' signs were captured using iMovie and clipped into individual files, one file for each vignette description. The video files containing the participants' responses were transcribed using ELAN (EUDICO Linguistic Annotator), a tool developed at the Max Planck Institute for Psycholinguistics, Nijmegen, for the analysis of language, sign language, and gesture.

We divided the descriptions that the participants gave for each vignette into nouns and classifier predicates. One way nouns can be distinguished from classifier predicates in our task is by their location in signing space. Because all of the vignettes in our study show items on a table or being put on a table, we were able to use the location and orientation of the sign to categorize it as a classifier predicate or noun. If the participant used an orientation that mirrored the movement or arrangement in the vignette, the sign was considered a classifier predicate; classifier predicates were typically produced in a specific location within a single plane, or in relation to a secondary object, most often in the horizontal plane of the signing space (reflecting the fact that the objects

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[1]The citation forms of the nouns LOLLIPOP and AIRPLANE are 1-handed, BOOK is 2-handed (in which the handshape is the same on both hands), and PEN has an acceptable 1-handed and 2-handed form (in which the nondominant hand is the ground).

[2]The non-native signer collected the data during the first year when the children were the youngest. We compared those data with data collected from the same children in subsequent years by the native signers. We found no difference between the performances of the children across sessions, and thus were able to eliminate signing status of the experimenter (native vs. nonnative) as a possible experimental confound.
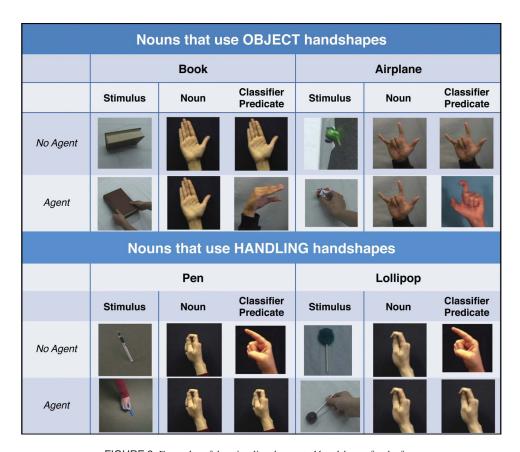
FIGURE 3 Examples of the stimuli and expected handshapes for the four objects used in the No-Agent condition (e.g., 'object on table') and Agent condition (e.g., 'put object on table'): book (top left), airplane (top right), pen (bottom left), and lollipop (bottom right); each condition displays the handshape expected for the noun and for the classifier predicates (color figure available online).

in our stimuli were placed on a table). If the participant produced the sign on the body or at a nonspecific location in one of the three planes of neutral space,[3] the sign was considered a noun.

Nouns and classifier predicates were then categorized according to type of handshape: (1) *object* handshapes captured features of the item they represented, either the whole item or size and shape dimensions of the item, and (2) *handling* handshapes captured features of the hand manipulating the item. The following types of responses were excluded from the analyses because their handshapes could not easily be categorized as *object* or *handling*: (a) Nouns containing

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[3]There are three planes in the signing space: the horizontal plane, the vertical plane, and the mid-sagittal plane (Brentari, 1998).

handshapes derived from fingerspelling (e.g., #P-E-N), N = 10[4]; (b) Predicates with a neutral handshape (a lax B- or a 1-handshape that traced the movement of the object), N = 4; (c) Frozen lexical verbs used instead of classifier predicates; these substitutions occurred in No-Agent events but never in Agent events. The 4–6 year olds used frozen verbs in 14% of their descriptions (e.g., FALL, THROW); the 7–10-year-olds used them in only 3%, and the adults never used them. Substituting a frozen verb for a classifier predicate has been previously reported in ASL-learning children as a characteristic of early development (Newport, 1981; Supalla, 1982).

A second coder transcribed a subset of the data to establish reliability. The two coders agreed on 90% of decisions categorizing signs as nouns or classifier predicates, and categorizing handshapes in those signs as *object* or *handling*. Disagreements were discussed until consensus was achieved.

The mean number of *object* and *handling* handshapes used in nouns and classifier predicates was calculated first for individuals and then for each group.[5] Because of the small sample size, we used non-parametric tests to statistically assess differences among participant groups. It is important to note that even though the number of participants in our sample was relatively small, the total number of observations analyzed was not. In total, 1,328 handshapes were included in the analyses that follow.

RESULTS

Figures 4 and 5 display our central findings, contrasting the proportion of nouns (top graphs) and the proportion of classifier predicates (bottom graphs) that contain *object* handshapes (grey bars) versus *handling* handshapes (black bars) as a function of type of event (No-Agent vs. Agent). Figure 4 displays the data for items whose nouns have *handling* handshapes (lollipop, pen); Figure 5 displays the data for items whose nouns have *object* handshapes (airplane, book).
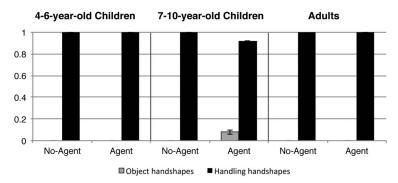
Handshapes in nouns

We begin with the nouns that the signers produced. The first point to note is that both adults and children used the appropriate handshape type in the nouns they produced for all four items— *handling* handshapes for lollipop and pen (black bars in the top graphs in Figure 4) and *object* handshapes for airplane and book (grey bars in the top graphs in Figure 5). The second important point is that none of the signers varied the handshape of the noun as a function of grammatical context; that is, they used the *handling* handshape for lollipop and pen and the *object* handshape for airplane and book whether the item appeared in a No-Agent context or an Agent context.

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[4]We also eliminated the few nouns produced by participants that were not the nouns we were trying to elicit. One younger child used the noun CAR instead of AIRPLANE. In both of these examples, the substituted noun has a *handling* handshape; the noun we were trying to elicit has an *object* handshape.

[5]At times, the adults produced more than one type of classifier handshape in response to an Agent event. The adults first used a correct *handling* handshape, followed by an *object* handshape describing the final spatial arrangement of the object(s). All three adults produced responses of this type and did so, on average, four out of 20 times. These responses were counted as *handling* responses. The 4–6-year-olds never produced responses of this type and the 7–10-year-olds produced them only seven times over all three years of data collection.

Nouns with *handling* handshapes (*lollipop* and *pen*)

Classifiers accompanying nouns with *handling* handshapes (*lollipop* and *pen*)

FIGURE 4   Variation in handshape as a function of grammatical context (No-Agent vs. Agent) in nouns and the accompanying classifier predicates. The graphs display the mean proportion of *object* and *handling* handshapes that the three groups of signers produced for *lollipop* and *pen*, both nouns that take a *handling* handshape. The top graphs show that all three age groups correctly used *handling* handshapes (black bars) in the nouns for the item no matter what context the item appeared in. The bottom graphs show that all age groups systematically varied handshape type in the classifier predicates as a function of grammatical context—*object* handshapes in No-Agent events (grey bars in bottom graph on right), and *handling* handshapes in Agent events (black bar in bottom graph on right).

Not only did the adults and children both use the correct *type* (*object* vs. *handling*) of handshape in their nouns, but they also used the same *specific* handshapes in the nouns they produced for all four items. All three groups used the closed X-handshape 👌, the *handling* handshape found in the noun citation forms for lollipop and pen, and the ILY handshape 🤟 and B-handshape ✋, the *object* handshape found in the citation forms for airplane and book, respectively. Thus, children as young as 4 years, like adult signers, do not vary the handshapes they produce in their
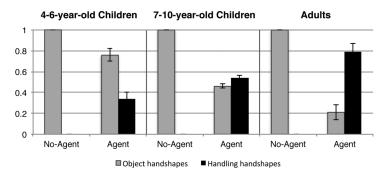
FIGURE 5 Variation in handshape as a function of grammatical context (No-Agent vs. Agent) in nouns and the accompanying classifier predicates. The graphs display the mean proportion of *object* and *handling* handshapes that the three groups of signers produced for *airplane* and *book*, both nouns that take an *object* handshape. The top graphs show that all three age groups correctly used *object* handshapes (grey bars) in the nouns for the item no matter what context the item appeared in. The bottom graphs show that the adults systematically varied handshape type in the classifier predicates as a function of grammatical context—*object* handshapes in No-Agent events (grey bars in bottom graph on right), *handling* handshapes in Agent events (black bar in bottom graph on right). Neither group of children had mastered the adult classifier pattern (bottom graphs on left and middle).

nouns as a function of grammatical context, and instead use the *object* or *handling* handshape found in the citation form of a noun in both No-Agent and Agent contexts.

Handshapes in classifier predicates

We next focus on the handshapes the adults produced in their classifier predicates, as they provide the standard against which we will assess the children's responses. As expected, the adults used

object handshapes (grey bars) in No-Agent events and *handling* handshapes (black bars) in Agent events, independent of whether the same item, when used as a noun, had a *handling* handshape (graph on the right in the bottom of Figure 4) or an *object* handshape (graph on the right in the bottom of Figure 5). Note, however, that the adults showed more variability in Agent contexts than in No-Agent contexts; that is, at times, they produced *object* handshapes in Agent contexts, but they never produced *handling* handshapes in No-Agent contexts.

We turn next to the child data for classifier predicates. The graphs on the left in Figures 4 and 5 present the data for the 4–6 year olds, and the middle graphs present data for the 7–10-year-olds. Focusing first on items whose nouns have *handling* handshapes (lollipop and pen, Figure 4), we find that, like the adults, both groups of children produced *object* handshapes in No-Agent contexts and *handling* handshapes in Agent contexts. Moreover, the children displayed the same variability in Agent contexts as the adults. The signers produced a correct *handling* handshape in Agent contexts 77% (4–6-year-old children), 82% (7–10-year-old children), and 82% (adults) of the time, producing an incorrect *object* handshape in the remaining responses. There were no significant differences across the age groups in the proportion of *handling* handshapes produced for these items in Agent contexts, Kruskal-Wallis, df(2), H = 0.42, p = .811. Note that, like the adults, the children never produced *handling* handshapes in No-Agent contexts.

Interestingly, the children did *not* behave like adults in terms of the classifiers they produced for items whose nouns have *object* handshapes (airplane and book, Figure 5). Although the children produced the expected *object* handshape 100% of the time in No-Agent contexts, they did not use the appropriate handshape in Agent contexts. That is, unlike the adults who used the expected *handling* handshape 79% of the time, the 4–6-year-old children used the *handling* handshape only 34% of the time, and the 7–10-year-old children used it 64% of the time. There was a significant difference across age groups in the proportion of *handling* handshapes produced in Agent contexts, Kruskal-Wallis, df(2), H = 8.69, p = .013. A Least Significant Difference post-hoc analysis indicated that the younger children differed significantly from the adults, LSD = 8.7, p < .01; the child groups did not differ from each other, nor did the older children differ from the adults.

In addition to using the same *types* (*object* vs. *handling*) of handshapes in classifier predicates, children and adults also used the same *specific* handshapes. All three groups used the closed X-handshape 🤏, the *handling* handshape found in the noun citation forms for lollipop and pen, in Agent contexts (33% 4–6-year-olds, 42% 7–10-year-olds, 58% adults). But all three groups also used a variety of other acceptable *handling* handshapes—the O-handshape 👌, F-handshape ✋, and open F-handshape ✋—in Agent contexts (31%, 42%, 24%, respectively).[6] When the participants produced an incorrect form in Agent contexts, they used the 1-handshape ☝, an *object* handshape (13%, 18%, and 18%, respectively). All three age groups also used the 1-handshape ☝ in the classifier predicates describing lollipop and pen in No-Agent contexts, where it was appropriate, and did so 100% of the time in this context. Thus, none of the three age groups ever used the *handling* handshape found in the citation noun for lollipop and pen in the classifiers they produced in No-Agent contexts (where it would have been incorrect), but they did use it in Agent contexts (where it was correct), along with a variety of other acceptable *handling* handshapes.

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[6]Note that the variety of acceptable handshapes that the participants in our study used in Agent contexts suggests that classifier predicates cannot easily be described as frozen lexical items, as has been suggested in the literature (Liddell, 2003).

Turning to the specific handshapes produced for airplane and book, we found that all three age groups used the ILY handshape ☝ and B-handshape ☝, the *object* handshapes found in the citation forms for airplane and book, respectively, in the classifier predicates they produced in No-Agent contexts, where the handshape is acceptable (88% 4–6-year-olds,[7] 98% 7–10-year-olds, and 100% adults). All three groups used the curved 1-handshape ☝ for handling airplanes and the open-flat B-handshape ☝ for handling books in Agent contexts (24%, 54%, and 89%, respectively), both of which are acceptable in this context. When producing an incorrect form in this context, all three groups used the *object* handshape found in the nouns for airplane ☝ and book ☝ (69%, 44%, and 21%, respectively). Thus, the signers used the *object* handshape found in the citation nouns for airplane and book whenever they produced classifiers in No-Agent contexts (where the handshapes are correct), but the children—and even, at times, the adults—also used the citation handshapes in Agent contexts (where they are not correct).

DISCUSSION

Acquisition of word classes: Nouns vs. classifier predicates

The goal of our study was to determine when children acquiring ASL as a native language begin to systematically distinguish between classifier predicates and nouns. Specifically, we asked when children learn that *object* vs. *handling* handshapes in classifier predicates vary in a principled way as a function of grammatical context, but the same handshapes in core nouns do not.

To answer this question, it is clear that we need two sets of contrasts: (1) we need to compare core nouns to classifier predicates and (2) we need to compare how *object* versus *handling* handshapes are used within each of these word classes. No previous study of ASL-learning children has made these relevant contrasts in the same data set. As an example, no studies have directly compared *core nouns* to *classifier predicates* on any dimension, let alone handshape variation. Existing studies that have compared the core lexicon to the spatial lexicon typically focus on only one word class, *verbs*, for example, showing that young ASL-learning children often substitute core verbs for classifier predicates (cf. Newport, 1981; Supalla, 1982). Moreover, most of the studies that have explored handshape within classifier predicates focus on only one type of handshape, *object* handshapes (Fish et al., 2003; Kantor, 1980; Newport, 1981; Supalla, 1982). Finally, existing studies that do contrast *object* handshapes with *handling* handshapes in predicate classifiers (Schick, 1987; Slobin et al., 2003) do not examine the contrast in core nouns.

The design of our study allowed us to determine whether there is principled variation in the handshapes children use in their classifier predicates, compared to their core nouns. We found that, even at age 4, children systematically vary handshape as a function of grammatical context in their classifier predicates, but not in their core nouns. Children use *object* handshapes in a No-Agent context in which an item moves or is positioned on its own, but *handling* handshapes in an Agent context in which the *same item* is moved or positioned by an agent in their classifier

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[7]When they did not use the citation form for airplane, the 4–6-year-olds used the structurally simpler B-handshape, as has been previously described by Supalla (1982).

predicates. Importantly, however, these same children at the same time do *not* vary the handshapes they use in their nouns as a function of No-Agent versus Agent contexts. Many milestones in ASL acquisition occur on the same timetable as comparable milestones in spoken languages (Newport & Meier, 1985), so this result is not unexpected; however, these findings provide the first empirical evidence that ASL-learning children as young as 4 make a systematic distinction between these two word classes (nouns vs. classifier predicates).

Handshape is only one dimension along which nouns and predicates vary in ASL. For example, some core lexical items, including many that use iconic handshapes, use a systematic change in movement to derive a noun from a verb. Supalla and Newport (1978) refer to lexical items of this sort as noun-verb pairs. For example, the noun BOOK (see Figure 1) differs from its corresponding verb OPEN-BOOK in terms of movement: the noun contains a repeated, tense movement; the verb contains a single movement. All noun-verb pairs in ASL can be characterized by this systematic difference in movement. As a result, another potential way to explore whether children make a distinction between noun and verb classes is to examine their productive control over movement in noun-verb pairs. Unfortunately it is not clear whether 4-year-old children have control over the relevant type of movement. Meier et al. (2008) found that 8- to 17-month-old children learning ASL as a native language often made errors on signs that required a single cycle of movement, typically producing multiple cycles instead. This behavior may well persist for several years, which would leave handshape as one of the earliest behaviors that children can use to display a distinction between noun and verb word classes.

Acquisition of handshape variation in classifier predicates interacts with type of noun

One of the surprising findings of our study is that children's acquisition of handshape in classifier predicates interacts with the type of noun the classifier accompanies. The 4- to 6-year-old children were able to systematically vary handshape in classifier predicates, using *object* handshapes in No-Agent contexts and *handling* handshapes in Agent contexts, for objects whose nouns contain a *handling* handshape (lollipop, pen). They did not, however, vary handshape in classifier predicates for objects whose nouns contain an *object* handshape (book, airplane)—instead, they overused the *object* handshape, producing it not only in No-Agent contexts but also in Agent contexts (where the *handling* object is needed). The question is why.

Note that the problem is not with the *handling* handshape itself, as the youngest children were able to produce *handling* handshapes for objects like lollipop and pen. Nor is the problem a motor one, as the children are overusing the ILY handshape ✌, which is relatively difficult to produce. Our findings are thus consistent with Kantor (1980) and Fish et al. (2003), who argue that a motoric explanation is not sufficient to explain the acquisition of handshapes in classifiers.

It is possible that the children's substitution of *object* handshapes for *handling* handshapes in Agent contexts is a more extreme example of a bias that we observed in the adult signers. In particular, the adults displayed an *object* handshape bias in the following sense—they always used *object* handshapes in classifier predicates describing No-Agent events (as expected), but they were less consistent in their use of *handling* handshapes in classifier predicates describing Agent events and, at times, substituted *object* handshapes for *handling* handshapes. The association between *handling* handshapes and Agent events thus appears to be less robust than the association

between *object* handshapes and No-Agent events, even for adults. One explanation for this over-use of *object* handshapes might be that it is always possible to describe the end-state of a moving act (rather than the act itself). If a signer chooses to interpret a vignette in this way, an *object* handshape rather than a *handling* handshape would be appropriate.

An alternative explanation is that overextending *object* handshapes to Agent contexts may be an instance of the *object handshape bias* that has been found to characterize ASL in general. Sign languages differ in the type of handshape they tend to use in instrumental nouns (Aronoff, Meir, Padden, & Sandler, 2009; Padden, 2010). For example, there are two iconic forms that could potentially be used to sign TOOTHBRUSH: one signed with an extended 1-handshape ✋, capturing features of the brush as it applies the polish (*object* handshape); another signed with a bent 1-handshape ✋, capturing features of the hand holding the toothbrush (*handling* handshape). Some sign languages, including ASL, have a tendency to use the *object* handshape in their instru-mental nouns; other sign languages (e.g., British Sign Language, Japanese Sign Language, Israeli Sign Language) are more likely to use the *handling* handshape. Perhaps the ASL signers in our study overgeneralized this *object handshape bias* from the noun lexicon to classifiers produced in an Agent context. This hypothesis could be tested by repeating our experimental paradigm with signers of languages that have been found to have a *handling handshape bias* in their noun lexicons. If the hypothesis is correct, we would expect signers of these languages to show less variability in *handling* handshapes in Agent contexts than we have found in ASL signers, or to overextend the *handling* handshape (which is appropriate in Agent contexts) to No-Agent contexts, reflecting their *handling handshape bias*.

As a methodological aside, our findings on the adults underscore the importance of including expert signers in acquisition studies to serve as a baseline against which child performance can be assessed. We expected adults to show a perfect association between handshape type and gram-matical context in classifiers—*object* handshapes in No-Agent contexts and *handling* handshapes in Agent contexts. However, that is not what we found. It is the pattern adults actually produce that we need to use as the standard for child performance.

Children, even 4-year-olds, display the same bias to overextend *object* handshapes to Agent contexts. The children's responses for objects whose nouns contain *handling* handshapes (lol-lipop and pen) mirrored the adult's responses—they always used *object* handshapes when the classifier predicate described No-Agent events, and they were less consistent in their use of *han-dling* handshapes when the classifier predicate described Agent events and, at times, substituted *object* handshapes for *handling* handshapes. The bias was particularly extreme for items whose nouns contain *object* handshapes (airplane and book)—the 4-year-old children again always used *object* handshapes for No-Agent contexts, but they used *handling* handshapes for Agent contexts only 22% of the time, preferring instead to use *object* handshapes. Perhaps the children have extended the *object handshape bias* that characterizes ASL to all classifiers, although we still need to explain why this extension might be more extreme for nouns with *object* handshapes than for nouns with *handling* handshapes.

One possibility is that the children "borrowed" the *object* handshape from the noun citation form for airplane and book and extended it to the classifier (a strategy first described in young learners by Supalla, 1982, and in late learners by Newport, 1981). This strategy would result in correct responses for airplane and book in No-Agent contexts (which is what we find) and in incorrect responses for airplane and book in Agent contexts (which is also what we find in 69% of the 4–6-year-olds' responses and even in 44% of the 7–10-year-olds' responses and 21% of

the adults' responses).[8] The borrowing strategy can thus account for the children's successes, and their failures, on airplane and book. Note, however, that the borrowing strategy cannot account for the children's responses to lollipop and pen. The children used the *handling* handshape found in the citation form for lollipop and pen in Agent contexts only about half of the time; the rest of the time they used other, equally acceptable *handling* handshapes. Moreover, they never overgeneralized the *handling* handshape in the citation form for lollipop and pen to No-Agent contexts—they always used correct *object* handshapes. Thus, although the borrowing strategy can account for the children's responses (both successes and failures) on airplane and book (both *object* handshape nouns), the borrowing strategy cannot account for their responses (primarily successes) on lollipop and pen (both *handling* handshape nouns) and thus is, at best, a partial (and likely incorrect) explanation for our findings.

Whatever the explanation for the children's errors on classifiers that accompany nouns with *object* handshapes, our findings underscore the fact that handshape variation in classifier predicates needs to be examined in conjunction with the type of noun that accompanies the predicate. The interaction we found between type of noun and handshape variation in classifier predicates (i.e., successful variation for nouns with *handling* handshapes but not with *object* handshapes) is a particularly striking example of how interdependent the acquisition process can be. Moreover, our findings suggest that, once acquired, a handshape is not necessarily accessible for all purposes. In this regard, it is important to point out that the prolonged time required to master handshapes in classifiers that we have observed is not unique to our experimental paradigm. Others have found that acquiring complex morphology in ASL, particularly handshape, requires an extended period of time (Fish et al., 2003; Kantor, 1980; Newport, 1981; Schick, 1987; Singleton & Newport, 2004; Supalla, 1982). Moreover, complex morphology has been found to be a relatively late acquisition in spoken languages as well (e.g., Ravid & Schiff, 2009; Levinger-Gottlieb, 2007; MacWhinney, 1978; Slobin, 1997), suggesting that the mechanisms responsible for this prolonged period of development may not be tied to modality and may instead call upon more general cognitive processes.

In sum, we describe here, to our knowledge for the first time, the use of handshapes for nouns contrasted with handshapes for classifier predicates in ASL signers from 4 years to adults. We have found that ASL-learning children as young as 4 years systematically vary handshape as a function of grammatical context in their classifier predicates, and do not vary handshape in the nouns that accompany those classifiers. These children are apparently sensitive (for at least some items) to the fact that nouns and classifier predicates have different functions and therefore different phonological and morphological properties, a fundamental property of the language they are learning.

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[8]As mentioned earlier, it is possible that the participants are choosing to describe the end-state of the moving act (rather than the act itself) and using an *object* handshape to do so. However, it is not at all clear why children would describe end-states more often than adults, particularly since young children generally focus on actions rather than states (Slobin, 1985).

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