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Emerging Lexicon for Objects in Central Taurus Sign Language

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Abstract: This paper investigates object-based and action-based iconic strategies and combinations of them to refer to everyday objects in the lexicon of an emerging village sign language, namely Central Taurus Sign Language (CTSL) of Turkey. CTSL naturally emerged in the absence of an accessible language model within the last half century. It provides a vantage point for how languages emerge, because it is relatively young and its very first creators are still alive today. Participants from two successive age cohorts were tested in two studies: (1) CTSL signers viewed 26 everyday objects in isolation and labeled them to an addressee in a picture-naming task, and (2) CTSL signers viewed 16 everyday objects in isolation and labeled them to an addressee before they viewed the same objects in context being acted upon by a human agent in short video clips and described the event in the clips to a communicative partner. The overall results show that the CTSL signers equally favored object-based and action-based iconic strategies with no significant difference across cohorts in the implementation of iconic strategies in both studies. However, there were significant differences in the implementation of iconic strategies in response to objects presented in isolation vs. context. Additionally, the CTSL-2 signers produced significantly longer sign strings than the CTSL-1 signers when objects were presented in isolation and significantly more combinatorial sign strings than the CTSL-1 signers. When objects were presented in context, both cohorts produced significantly shorter sign strings and more single-sign strings in the overall responses. The CTSL-2 signers still produced significantly more combinatorial sign strings in context. The two studies together portray the type and combination of iconic strategies in isolation vs. context in the emerging lexicon of a language system in its initial stages.

Keywords: Central Taurus Sign Language; village sign language; emerging lexicon; object descriptions; iconic representations

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1. Introduction

1.1. Iconic Representations in the Manual Systems

The affordances of the body and hands allow iconic representations of linguistic information in manual systems. The non-arbitrary form-meaning mappings of the real-world entities is a ubiquitous property of sign languages that can be observed at many levels of linguistic organization (e.g., Klima and Bellugi 1979; Emmorey 2014; Lepic and Padden 2017; Perniss et al. 2010; Padden et al. 2013; and Taub 2001). For example, iconicity plays a role in the large proportion of a signed lexicon (Pietrandrea 2002); the path, manner and location of a sign are frequently iconic (Senghas et al. 2004); information delivery in the event structure, such as telicity, can be iconic (Wilbur 2003); and the way sign languages use or encode space can have iconic motivations (e.g., Padden 2016; Perniss 2007; and Vermeerbergen 2006).

The non-arbitrary nature of iconic forms may seem to be straightforward for perception and production. However, they are not readily accessible to individuals having no prior experience with communication in the manual modality (e.g., Klima and Bellugi 1979; Ortega et al. 2017; and Pizzuto and Volterra 2000). Taub (2001) proposed that there are a least several sub-processes that are essential in inventing an iconic form, such as recognizing

associations between concepts and a variety of sensory (visual, auditory, and kinesthetic) images, selecting a candidate image representative of the target concept and schematizing and encoding the selected image using a phonologically valid linguistic form. From among many possible candidates as a representative image of the target concept, *which iconic forms are recognized as more salient for selection?*

Previous investigations in the lexicons of manual systems (improvised gestural systems and emerging and established sign languages) presented evidence for the systematic variation in the use of *action-based* or *object-based* iconic forms across semantic categories and event structures. These iconic forms have been discussed under a variety of terms so far, focusing on the representational role of the hands, either representing the agentive role of the signer or a salient property of the referent (e.g., Brentari et al. 2012; Ergin and Brentari 2017; Meir et al. 2013; Müller 2013; Müller et al. 2013; Ortega and Özyürek 2020; Padden et al. 2013, 2015; and Supalla 1982). Among the iconic modes of representation defined in the manual modality are, for example, *acting*, depicting how objects are manipulated (Müller 2013), and *object*-depicting entities through the shape, dimensions, or outline of an object with no action representations involved (Padden et al. 2013). Padden et al. (2013) further elaborated on the iconic patterning for lexical signs for handheld man-made artifacts ("tool") by dividing them into two groups—*handling*, representing an agent manipulating the target tool by handling it, and *instrument*, representing the manipulated tool itself—and presenting evidence for distinct iconic patterning across semantic categories in the use of these iconic forms. For example, "hammer" in American Sign Language (ASL) is expressed with a *handling* type handshape showing how a hammer is grasped, along with the typical downward repeating movement depicting the canonical action associated with this object. "Toothbrush" in ASL is expressed with an *instrument* type handshape with the index finger extended while the hand moves sideways back and forth near the mouth, as in the action of brushing one's teeth. Padden et al. (2013) reported that in response to stimuli involving the images of common objects such as clothes, utensils, cosmetic products, and tools, the signers of ASL, Al-Sayyid Bedouin Sign Language (ABSL), and New Zealand Sign Language (NZSL) tend to produce instrument strategies more frequently as opposed to handling strategies, whereas American and Bedouin non-signing gesturers display the opposite pattern. These findings indicate that *first*, despite speaking different languages and living in different regions of the world, non-signing gesturers display similar cognitive tendencies, and the types of iconic strategies they use systematically differ from the ones used by signers. *Second*, instrument forms as iconic strategies may be an important linguistic tool to expand the lexicon of sign languages by adding more handshape distinctions as opposed to the gestural ones produced in an improvised fashion. Similar to the findings of Padden et al. (2013), in a cross-linguistic analysis on a total of eight established and emerging sign languages, including Central Taurus Sign Language (CTSL), Hwang et al. (2017) reported recurring patterns for naming entities, even if they individually varied in imagistic form: *handling* and *instrument* forms (both involve a manipulative action) are used for tools, whereas *object* forms (i.e., static forms with no action involved) are more often used for fruits and vegetables. Hou (2018) reported similar grouping of iconic strategies for tools and foods in San Juan Quiahije Chatino Sign Language. Tools, as a category of stimuli, seem to strongly elicit forms exhibiting human agency, whereas this is less prevalent in semantic categories like fruits and vegetables.

Other studies on emerging sign languages report systematic variation across event structures. For example, Ergin and Brentari (2017) reported that CTSL signers favor *object* strategies depicting the form of an object over *handling* strategies depicting an action associated with the target object in non-agentive contexts, as opposed to agentive ones. When the object is acting on its own or not acting at all in a non-agentive context, such as "The lollipop is on the table", CTSL signers tend to use object-based iconic strategies (i.e., object handshapes) to represent the form of a lollipop. When the object is being acted upon by an agent, as in "The man puts the lollipop on the table", they tend to use action-based iconic strategies (i.e., handling handshapes) more frequently. Moreover, Ergin and Brentari (2017)

reported that the use of these strategies may evolve over time in that CTSL in its first generation[1] favored handling strategies over object strategies, but as of the second generation, it evolved into a system favoring object strategies over handling strategies. Using the same stimuli, Goldin-Meadow et al. (2015) also reported systematic opposition between non-agentive and agentive contexts in the use of *object* vs. *handling* strategies by Nicaraguan homesigners, the cohort 1 and cohort 2 signers of Nicaraguan Sign Language (NSL), and a group of American Sign Language (ASL) signers. All four groups, including homesigners, used object-based iconic strategies almost exclusively in non-agentive contexts and used handling strategies more frequently in agentive contexts, suggesting that systematically varying morphological constructs are fundamental properties of language that appear under a variety of environmental conditions. Another important finding of this study is the consistency of these iconic handshape types being wider for ASL and NSL signers in comparison with the homesigners. In other words, individuals using a shared sign system with others are more consistent in the type of iconic strategies they use across agentive vs. non-agentive contexts than those using a non-shared system. In addition, as in the case of CTSL, Goldin-Meadow et al. (2015) reported generational differences in the use of these iconic strategies. NSL cohort 2 and the ASL signers produced more handling handshapes than object handshapes in their predicates in agentive contexts as opposed to NSL cohort 1 and homesigners, which suggests that these iconic strategies may evolve and stabilize over time as a system matures.

An important finding of the previous studies is that sign languages exhibit cross-linguistic differences in terms of iconic patterning. For instance, in a comprehensive study conducted on 11 sign languages, Nyst et al. (2021) reported cross-linguistic differences across languages in the use of handling vs. object strategies in response to the images of 10 common objects. Adamorobe, Nanabin, and Ghanaian Sign Language exhibit a preference for object handshapes. Ivory Coast, Malian, and Portugese Sign Language exhibit a preference for handling handshapes. Kenyan, Ethiopian, Guinea-Bissau, and Boukako Sign Language as well as the Sign Language of the Netherlands, is a middle group without a strong preference for either handshape[2]. In addition, sign languages may display differences in the developmental paths they take. For example, while CTSL begins with handling strategies and evolves into a system favoring object strategies over time, NSL follows the opposite path (Ergin and Brentari 2017 and Goldin-Meadow et al. 2015, respectively). In summation, despite showing certain tendencies across semantic categories (i.e., foods elicit object-based iconic forms and tools elicit action-based iconic forms), there seem to be language-specific tendencies across languages, leading to variation.

The patterning of iconic forms across semantic categories and event structures is not only a property of emerging and established signed lexicons. Recent evidence from the improvised gestures of hearing adults shows alignments between sign languages and gestural communication in that there are systematic variations in the use of iconic gestural forms, possibly shaped by similar cognitive tendencies. For example, Schembri et al. (2005) detected similar movements and locations for the manual productions of non-signing Australians and signers of Australian Sign Language in response to a task involving classifier predicates of motion, but their choice of handshapes differs significantly. In addition, in a pantomime generation task in which participants were asked to produce gestures for written words they were presented on a computer screen, Ortega et al. (2017) showed that Dutch speakers' gestures share varying degrees of form overlap with the signs from the Sign Language of the Netherlands (full, partial, or no overlap). Moreover, hearing participants guessed the meanings of signs with full and partial overlap more accurately, and they assigned these signs higher iconicity ratings than signs with no overlap. These findings suggest that deaf and hearing adults converge in their iconic depictions for some concepts (e.g., TO-CUT, TO-SAW, or LAPTOP), possibly as an outcome of the shared conceptual knowledge and manual-visual modality. Furthermore, Ortega and Özyürek (2020) found systematicity in the implementation of iconic strategies in the gestural forms of various concepts. They showed that action-based iconic forms (i.e., *acting*) through

reenacting the motion of the action associated with the target object were favored to refer to manipulable objects, whereas object-based forms such as recreation the form of an object (i.e., hand *representing* the object) and tracing its shape with the hands (i.e., *drawing*) were favored to refer to the static state and non-manipulable nature of an object, respectively.

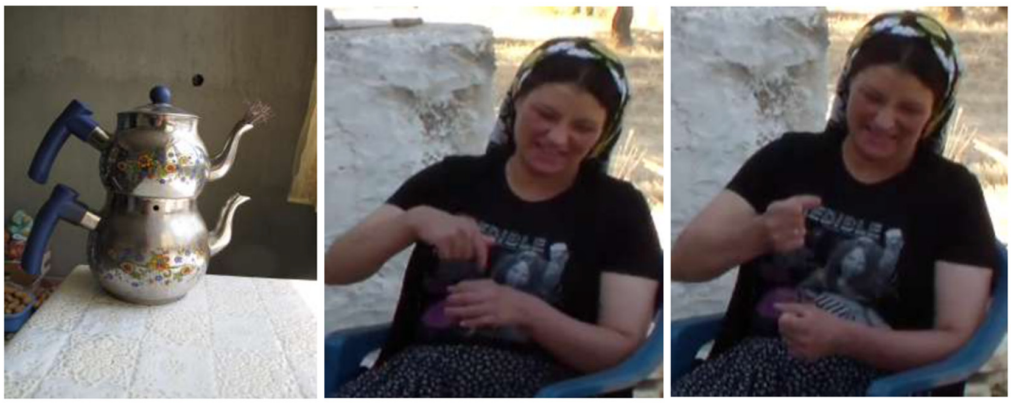
In addition, several previous studies argued that action simulations are the precursors of manual iconic forms (Cook and Tanenhaus 2009 and Hostetter and Alibali 2008), with some recent empirical support for action-based iconic representations to be the building blocks of an emerging lexicon in the manual modality. For example, Ortega and Özyürek (2020) presented evidence for an overwhelming tendency for the use of action-based forms, implying that *acting* might be a building block of an emerging lexicon in the manual modality. Similarly, Ortega et al. (2014) claimed that action-based iconic forms are developmental milestones in the language acquisition process and present evidence for action-based signs to be favored more in children-adult interactions and object-based (perceptual) signs to be favored more in adult-adult interactions.

In summation, these findings provide us with insight into the systematic tendency in the use of certain *action-based* or *object-based* iconic features to refer to a certain type of referents and possible pathways for iconic forms to become linguistic tools over time in the manual modality. Specifically, the findings in favor of the dominance of action-based iconic forms in the gestural productions are intriguing in that they trigger further questions regarding the perception of real-world referents and the invention of iconic forms representing them. *Are the object-based iconic forms or the action-based iconic forms recognized as more salient for selection for iconic representations? What forms the building blocks of an emerging lexicon in the manual modality?*

1.2. Combination of Signs and İconic Strategies

Using multi-sign strings such as compounds in order to distinguish concepts across semantic categories is a common property of sign languages (e.g., BLUE ^ SPOT for "bruise" in ASL (Klima and Bellugi 1979)). Evidence from emerging sign languages indicates that this mechanism is present in the initial stages of a language, and some combinations of signs used for object descriptions are systematic (e.g., Ergin et al. 2021; Meir et al. 2010; and Tkachman and Sandler 2013). Ergin et al. (2021) reported that CTSL signers frequently use multi-sign strings to refer to entities from various semantic categories (e.g., everyday objects, utensils, and fruits and vegetables). While some of these multi-sign descriptions are relatively conventionalized compounds (e.g., TEA ^ ONE-ON-ANOTHER for "teapot"), others have the flavor of idiosyncratically longer descriptions (e.g., TEA ^ POUR-FROM-HANDLE ^ ONE-ON-ANOTHER, FLAME ^ PUT-ON ^ ONE-ON-ANOTHER). When expressing a systematic compound[3], CTSL seems to be following a certain pattern in terms of sequencing its constituents. Tea, an action involving an iconic constituent delivering information about the function of the object, frequently precedes the constituent signaling the static form or the size or shape of the target object (ONE-ON-ANOTHER) (Figure 1).

Similar results have been reported in Israeli Sign Language (ISL) and Al-Sayyid Bedouin Sign Language (ABSL): the constituents involving the size or shape (i.e., static form) information of the target object occupied the final positions in the compounds (e.g., CHICKEN ^ OVAL-OBJECT for "egg" in ABSL or LIPSTICK ^ SMALL-OBJECT for "lipstick" in ISL). However, in its initial stages, when a language does not have a conventionalized lexical item for a referent, longer descriptions become inevitable (e.g., WRITE ^ ROW ^ MONTH ^ ROW ^ WRITE for "calendar" in ABSL) (Meir et al. 2010; and Sandler et al. 2011). Similarly, Tkachman and Sandler (2013) reported a high tendency in both ISL and ABSL to produce compounds and longer sign strings in response to picture stimuli of unfamiliar objects which did not have a conventionalized lexical item in ISL or ABSL. Morgan (2015) also found that some compounds in Kenyan Sign Language such as BLACK ^ PEAR-SHAPE ("avocado") display a systematic order among their components, but other multi-sign strings involve longer sequences with constituents in variable orders and with some items repeated multiple times.



(**a**) (**b**) (**c**)

Figure 1. (**a**) A Turkish teapot. (**b**) The sign for TEA. (**c**) The sign for ONE-ON-ANOTHER.

The findings from Zinacantec Family Homesign (Z) show that compounding is present even in a first-generation language. In response to the picture of a chicken, Z signers first start with using a size and shape specifier depicting how a Zinacantec typically handles a chicken, thereby demonstrating its size and shape, followed by an action depicting how Zinacantecs kill a chicken: a quick jerk to break its neck (Haviland 2013, p. 321). Despite having conventionalized lexical items such as CHICKEN, Haviland (2013) reported that Z signers are not always consistent. For example, for a small SLEDGEHAMMER, a Z signer may produce multi-sign strings starting with a handling handshape showing how a hammer is held, which also indicates the size of the target object, followed by a pounding action and completing with four full vertical strokes. On another occasion, in response to the picture of two ordinary hammers, the same Z signer may produce three distinct vertical pounding movements.

To sum up, using more than one sign or word to refer to real-world referents is a ubiquitous feature of natural languages. Evidence from emerging sign languages and homesign systems suggests that this feature springs up quickly in the initial stages of a language. While rarely used daily objects elicit idiosyncratically longer sequences of constituents (e.g., see Ergin et al. 2021 for "gas tank" variants in CTSL), more frequently used objects (e.g., "teapot" in CTSL) tend to elicit shorter sign strings or systematically ordered compounds. Whether there are generational differences in the combinatorial use of sign strings to refer to everyday objects and whether presenting stimuli in isolation vs. context affects the combinatorial structures remain open questions.

1.3. The Focus of This Study

Previous studies mentioned in Sections 1.1 and 1.2 mainly focused on either object-based (i.e., static iconic forms with no action involved) or action-based iconic forms and presented evidence for systematic variation of them across semantic categories or distinct event structures. This study aims to investigate the *action*, *object*, and simultaneous use of *action* and *object* as iconic strategies (see the coding procedure in Section 2.1) and their combinations used for referring to everyday objects across generations in the emerging lexicon of Central Taurus Sign Language. The motivation for this investigation is to understand (1) whether a language in its initial stages favors *action*, *object*, or simultaneous production of *action* and *object* strategies as a more salient property to represent a target object iconically, (2) whether there are generational differences in the use of these strategies and their combinations, and (3) whether signers modulate their use of these strategies and their combinations in response to stimuli presented in isolation vs. context.

Section 1.4 introduces Central Taurus Sign Language (CTSL). Section 2 presents the design and results of study 1, which investigates CTSL responses when the target objects are presented in isolation. Section 3 presents study 2, which compares the CTSL responses when the target objects are presented in isolation vs. context.

1.4. Central Taurus Sign Language

Central Taurus Sign Language (CTSL) is a village sign language which emerged spontaneously over the past 50 years or so in the absence of a conventionalized linguistic model. It developed in a geographically isolated area with little or no influence from Turkish Sign Language (TiD). It is mainly used in a small village located in the Central Taurus Mountain Range of southern Turkey. The deaf individuals, comprising approximately 4.6% of the village population, are connected to each other by birth or through marriage (see Supplementary S1 for the family tree). The high incidence of deafness in the village (compared with a typical incidence of deafness of approximately 0.5%) is an outcome of recessive deafness in the community and the prevalence of consanguineous marriages in families with deaf individuals. CTSL has about 25 deaf signers today, 17 of whom use CTSL as their sole language, whereas others can use Turkish Sign Language at varying proficiency levels. In addition, there are approximately 80 hearing Turkish speakers who also have some degree of fluency in CTSL.

In order to track the developmental trajectory of the language, we identify three cohorts of signers in the community. CTSL-1 is the first cohort of signers, who were born as the first deaf child in their family and who therefore would have had little or no linguistic input early in life (n = 9; age range = 49–61). CTSL-2 is the second cohort, comprising the deaf and younger siblings of cohort 1 signers. They would have had more linguistic input because they had at least one older sibling who signed (n = 8; age range = 42–54). CTSL-3 is the third cohort of deaf signers from the younger generation: children of CTSL-1 and CTSL-2 signers (n = 4; age range = 24–30) (see Ergin 2017; Ergin and Brentari 2017; Ergin et al. 2018, 2020, 2021). There were also four deaf children who constituted a potential fourth cohort, though their linguistic behavior has not been documented yet.

2. Study 1

The goal of this study is to investigate object-based and action-based iconic strategies and their combinations across generations when the target objects are presented in isolation.

2.1. Materials and Methods

Participants. Ten deaf signers from 2 successive age cohorts (5 CTSL-1 signers: M_{age} = 51.8, age range = 43–55; 5 CTSL-2 signers: M_{age} = 41.4, age range = 35–44[4]) were tested. All of the participants used CTSL as their sole language, and the CTSL-2 signers were the younger siblings of the CTSL-1 signers.

Stimuli and Procedure. The deaf CTSL signers were tested in a *picture-naming task*. They viewed stimuli involving pictures of 26 everyday objects (Table 1) on a computer screen and labeled them for another deaf addressee or a hearing family member fluent in CTSL. A previous investigation of CTSL revealed systematic opposition across semantic categories such as tools and fruits and vegetables, which frequently elicit *handling* or *instrument* (cf. simultaneous *action* and *object* in the current coding scheme) and *object* strategies in CTSL, respectively (Hwang et al. 2017). In order not to create a bias for certain iconic strategies in the cumulative results, these semantic categories were not used in the current stimuli set. Instead, a variety of everyday objects that were not previously studied in CTSL for iconic representations were included in the stimuli set. All of the stimuli items were presented in isolation (i.e., non-agentive context) in a single randomized block (see Supplementary S2 for the pictures of the stimuli items). The data were collected in August 2013.

Table 1. List of objects used in study 1.

box	fork	motor vehicle	spoon
bread board	gas tank	pen	stove
broom	game cards	plate	string
car	glass	pot	telephone
cologne	glasses	sieve	teapot
cooking pot	iron	soap	video camera
copper vessel	matches		

Coding Procedure. The responses to the stimuli were transcribed using ELAN, a tool developed at the Max Planck Institute for Psycholinguistics in Nijmegen, for analysis of the spoken language, sign language, and gestures (Crasborn and Sloetjes 2008) and coded[5] based on the following the criteria defining the iconic representations of the target stimuli items.

Action: In this strategy, the signer's hand represents a hand performing an action (cf. "acting" by Müller 2013). For example, for CAR, the sign that represents holding the steering wheel with both hands and controlling it by moving the hands up and down in opposite directions is coded as an "action".

Object: The hand represents the object itself or represents an aspect of the target object, such as its dimensions, size, or shape (Ergin and Brentari 2017 and Padden et al. 2013). There is no motion representing an action. For instance, COOKING POT, a sign involving two C-static handshapes representing the **shape** of the pot, is coded as an "object" sign. A sign representing the **size** of an object, as well as the simultaneous depiction of shape and size, is also coded as an "object" sign[6]. Object signs depicting the size or shape of an object can be either one-handed or two-handed (e.g., GLASS, an L-handshape after DRINK to represent the size of the glass, or STICK, with two extended index fingers showing the length of the stick). Finally, signs involving the hand or hands in any configuration **tracing**[7] the outline of an object is also coded as an "object" sign (e.g., BREAD BOARD, with two flat hands moving horizontally outward to trace the surface of a bread board, or DRESS, with the flat dominant hand facing upward and tracing the length of the dress or the length of its sleeves on the signer's body).

Note that the goal was to understand whether it was the object-based or the action-based iconic representations that were more salient to be selected for iconic representations. That is why the object category was not divided into further subcategories (e.g., size, shape, and tracing), but all static forms depicting the physical property of the target object as a whole or an aspect of it (e.g., size) were evaluated under the "object" category.

Action and Object: In this strategy, action and object strategies are used simultaneously. If it is a one-handed sign, the dominant hand is used either as an instrument or an agent handling the object and simultaneously performing the action associated with that instrument (e.g., BROOM, with extended widespread fingers representing the object and simultaneously producing vertical right-to-left movement of the hand representing the sweeping action, or GLASS, where the C-handshape represents handling the object or its shape, and the motion represents bringing the glass to the mouth for drinking) (cf. "instrument" and "handling" by Padden et al. 2013 and "handling" by Ergin and Brentari 2017).

If it is a two-handed sign, both hands are simultaneously used to represent an object with the non-dominant hand and to depict an action performed on that object with the dominant hand (e.g., MATCH, where the dominant hand represents the action of swiping a matchstick, and the non-dominant hand represents the surface of a match box, where the action takes place).

Deictic: Gestures involving showing, pointing, or touching the objects in the immediate physical environment with or without the object present are coded as "deictic" signs (e.g., SCARF, by touching the scarf one is wearing). The pointing can be with an open hand or extended index finger (Kita 2003).

Unrecognizable signs that did not fit any of the categories listed above were coded as "other" (e.g., MATCH, where the signer produces a sign with the index finger and thumb touching each other, but it is not clear whether the signer refers to the size of the match or he or she is holding the match).

Repeated signs in a response were ignored. For example, in a sign string like "action$_1$—deictic$_1$—action$_1$—deictic$_1$", the action sign and the deictic with the same form and function were repeated and therefore ignored. This response was counted as a two-sign string. Likewise, a string involving "object$_1$—action$_1$—action$_2$—object$_1$" was considered a three-sign string, as the same object sign was repeated at the end.

2.2. Results

Signers across cohorts differed in the number of signs to refer to objects. The CTSL-1 signers produced a total of 122 sign strings involving a total of 204 signs in all strings (repetitions excluded). The CTSL-2 signers produced 123 sign strings involving a total 274 signs in all strings. The overall most frequent strings were single signs (38.7%, e.g., CAR, SPOON, MATCHES, or GAME CARDS), followed by two-sign (36.3%, e.g., BREAD BOARD, GLASS, VIDEO CAMERA, or POT), three-sign (13.9%, e.g., COLOGNE), and four-sign or more strings (11%, e.g., COOKING POT). Overall, the CTSL-1 signers used significantly shorter strings of signs ($M_{\text{CTSL-1}} = 1.78$, $SD_{\text{CTSL-1}} = 0.62$) than the CTSL-2 signers ($M_{\text{CTSL-2}} = 2.25$, $SD_{\text{CTSL-2}} = 0.79$) ($t(25) = 2.60$ $p = 0.019$). In addition, the CTSL-1 signers produced significantly more single-sign responses than the CTSL-2 signers ($\chi^2(1) = 7.83$, $p = 0.0051$). In other words, the CTSL-2 signers relied more on the combinatorial strategies over single signs (Figure 2).

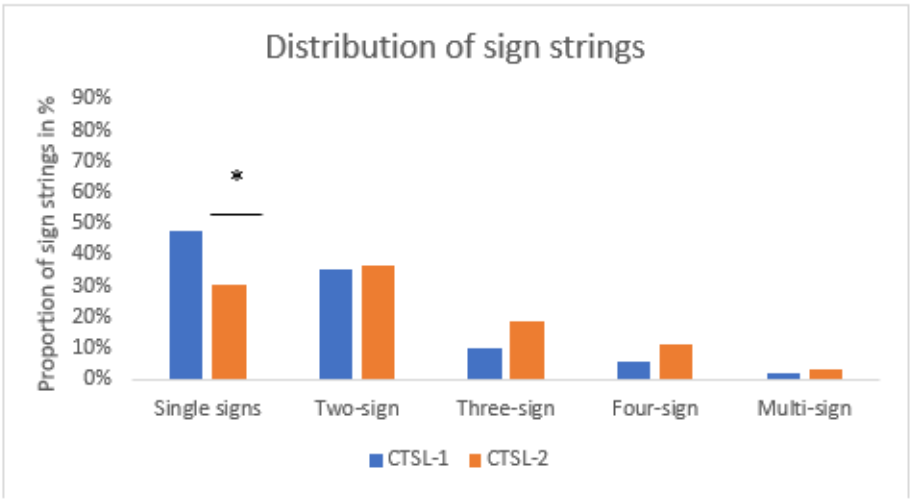


Figure 2. Distribution of sign strings. The *Y*-axis represents the proportional frequency of responses involving sign strings on the *X*-axis. The blue bars represent CTSL-1, and the orange bars represent CTSL-2 ($N_{\text{total}} = 245$, $N_{\text{CTSL-1}} = 122$, $N_{\text{CTSL-2}} = 123$).

While there was a difference in the number of signs and lengths of strings, there were no differences in the implementation of the iconic strategies across cohorts. In single-sign strings ($N_{\text{single-sign}} = 95$), the favored strategy was *action* (46.3% of instances), followed by the simultaneous production of *action* and *object* (35.8%) and *object* (17.9%) strategies. Among the remaining signs produced in the overall multi-sign strings ($N_{\text{total}} = 383$), a slightly different pattern was displayed: the favored strategy was *action* (37% of instances), closely followed by the *object* (34.6%), simultaneous production of *action* and *object* (17%), and *deictic* (7.8%) strategies. BOX, COLOGNE, CAR, CARDS, MOTOR VEHICLE, SIEVE, and SOAP frequently elicited components involving action-based iconic strategies, while COOKING POT, GLASSES, PLATE, and STOVE elicited components involving object-based strategies, and BROOM, CELLPHONE, FORK, GLASS, MATCHES, etc. frequently

elicited components involving simultaneous use of the object- and action-based strategies (Figure 3).

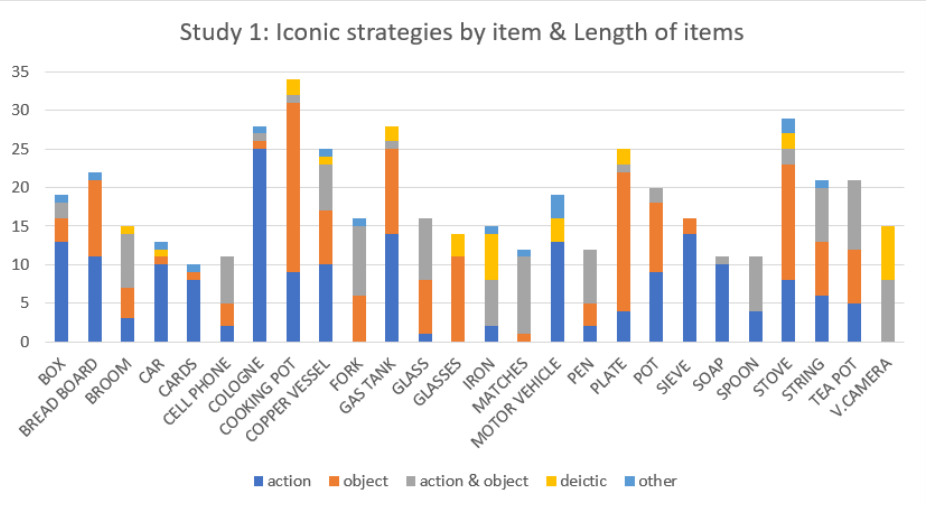


Figure 3. Distribution of iconic strategies by item. The *Y*-axis represents the number of occurrences of iconic strategies by items on the *X*-axis (N_{total} = 478, N_{CTSL-1} = 204, N_{CTSL-2} = 274). Shorter bars indicate shorter sign-strings, and taller bars indicate longer sign strings.

In two-sign strings ($n_{two-sign}$ = 89), *action* and *object* were equally favored (34.1% and 34.1% of instances, respectfully), followed by simultaneous *action* and *object* (19.9%) and *deictic* strategies (10.2%). The most common combination in two-sign strings involved an *object* strategy combined with an *action* strategy irrespective of their ordering (e.g., BREAD BOARD, GLASS, TEAPOT, or POT) or with a simultaneous *action* and *object* strategy to further disambiguate the target object (e.g., FORK or COPPER VESSEL). The other combinations involved strategies of $action_1$—$action_2$, $object_1$—$object_2$, action and object—deictic, etc., with no significant difference across cohorts in either the implementation of iconic strategies or ordering of the constituents in two-sign strings (Figure 4).

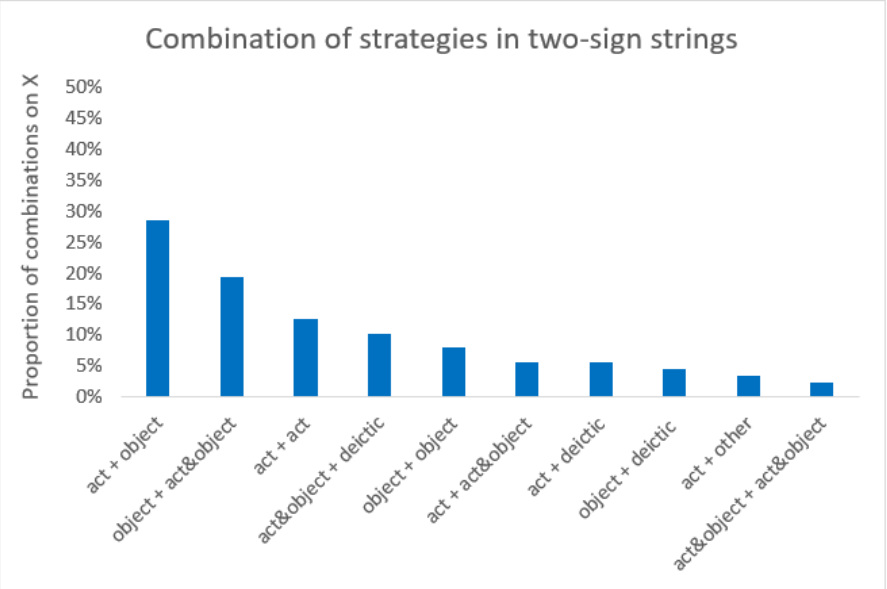


Figure 4. Combination of strategies used in two-sign strings. The *Y*-axis represents the proportional frequency of responses involving the combination of iconic representations on the *X*-axis (N_{total} = 88, 35.9% of all strings). The categories represent the constituents irrespective of their order (i.e., the bar for action + object also includes object + action combinations).

For instance, to refer to GLASS, the signers tended to reenact drinking (*action*) and then use an *object* sign denoting the dimensions of the target object (Figure 5). For CELLPHONE, they reenacted talking on the phone (*action*) simultaneously with an object sign representing the phone, and then they used an *object* sign representing the size of the object (Figure 6).

(**a**) (**b**) (**c**)

Figure 5. (**a**) Stimulus item used in the task. (**b**) Reenactment of drinking (*action*). (**c**) Size or dimensions of the target object (*object*). The *action* and *object* combination depicted in (**b**,**c**) refers to a GLASS.

(**a**) (**b**) (**c**)

Figure 6. (**a**) Stimulus item used in the task. (**b**) Cellphone (object) and depiction of the reenactment of talking on the phone (*action*). (**c**) Size of the cellphone (object). The *object—action* and *object* combination depicted in (**b**,**c**) refers to a CELLPHONE.

2.3. Summary and Conclusions

The goal of study 1 was to explore and investigate the developmental trajectory of an emerging lexicon in a language in its initial stages. The results show that the CTSL-1 signers produced significantly shorter responses and more single-sign strings for labeling everyday objects as opposed to the CTSL-2 signers, who produced more combinatorial responses, suggesting that the language became morphologically more complex over time. There were no significant differences across cohorts in implementing iconic strategies. The most common strategy produced by both cohorts in the entire task was *action*, followed by *object* and simultaneous implementation of *action* and *object* strategies. In two-sign strings, *action—object* was the most frequent combination, followed by the *object—action* and *object* combination, for both cohorts. These findings corroborate the previous studies suggesting that action simulations are the precursors of iconic forms in a manual lexicon (e.g., Cook and Tanenhaus 2009; Hostetter and Alibali 2008; and Ortega and Özyürek 2020).

The same types of iconic forms were present for CTSL-1, suggesting that they emerged quickly in the first generation of the language, whereas the combinatorial use of them waited until CTSL-2 to emerge. In line with the findings in other emerging sign languages (e.g., ABSL), more established sign languages (e.g., ASL), and also homesign systems, some lexical items were produced as compounds, whereas others elicited longer idiosyncratic sign strings (e.g., Tkachman and Sandler 2013; Klima and Bellugi 1979; Haviland 2013;

Morgan 2015; and Ergin et al. 2021). Going beyond the previous findings, this study shows that the lexical items becme more combinatorial and morphologically complex as of CTSL-2.

This study provideD us insight into the emerging lexicon of a newly developing language. However, it was limited in that the target objects were presented in isolation without context. This may have resulted in elicitation of longer descriptions for objects rather than shorter labels.

3. Study 2

Building upon the findings of study 1, study 2 investigated the emerging lexicon of CTSL in further detail with a new set of everyday objects presented in isolation and in context. The goal of this study was two-fold: (1) to replicate the findings in study 1 and (2) to investigate whether there were any similarities or differences between labeling everyday objects when they were presented in isolation vs. in context.

3.1. Materials and Methods

Participants. Eight deaf signers from 2 successive age cohorts (4 CTSL-1 signers: M_{age} = 48.7, age range = 44–54; Four CTSL-2 signers: M_{age} = 40.5, age range = 35–44) were tested. All signers used CTSL as their primary and only means of communication. The CTSL-1 signers were the older siblings of the CTSL-2 signers. The signers in studies 1 and 2 were the same individuals.

Stimuli and Procedure. Deaf CTSL signers were paired up with another deaf or hearing addressee fluent in CTSL. They were tested in two consecutive tasks. (1) As in study 1, the signers performed a *picture-naming task* for images of 16 everyday objects (Table 2) depicted in isolation (see Supplementary S3 for the images of the objects). Semantic categories such as tools and fruits and vegetables were intentionally avoided not to create a bias for *object* and simultaneous *object* and *action* strategies (see Hwang et al. 2017 and Ergin and Brentari 2017). The participants viewed the images on a computer screen and labeled them to an addressee. (2) The signers performed a *communicative task* in which they were asked to view short video clips involving the exact same objects (Table 2) and describe the event in the clips to an addressee, who then selected the corresponding picture from an array of three pictures (see Supplementary S4 for a sample trial in the task). All data were collected in August 2014.

Table 2. List of objects used in study 2.

ball	dress	glasses	washing basin
box	hat	plastic bag	suitcase
book	jacket	scarf	teapot
bottle	glass	stick	toy car

The stimuli items in task 2 involved a human agent performing a non-prototypical action on the target objects (Table 3). The rationale behind using non-prototypical actions was to minimize object incorporation into prototypical actions, which is a potential bias for the simultaneous use of object and action strategies (i.e., objects with actions like “reading a book”, “drinking from bottle”, “putting the jacket, hat, or dress on”, “pouring tea from a teapot”, etc. were intentionally avoided). Three stimuli items (i.e., a washing basin, plastic bag, and box) were used with their prototypical function as containers and not directly acted upon by an agent but rather as containers for objects acted upon by a human agent.

Table 3. List of contexts used in study 2.

Woman puts the **ball** inside the **plastic bag**	Woman puts the **glass** on the **table**
Man puts the onion in the **plastic bag**	Man puts the **glasses** on woman's face
Man puts the **teapot** into the **box**	The woman drops the **glasses**
Man throws the **hat**	Man is sewing the **jacket**
Man puts the **hat** on woman's head	Man takes off the **jacket**
Man picks up the small **book** on the table	Man takes the **bottle** from the woman
Toy car hits the **book**	**Bottle** falls on the woman
Man irons **dress**	Woman is trying to break the **stick**
Woman is washing the **dress** in the **washing basin**	Man is trying to open the **suitcase**
Woman is washing the **scarf** in the **washing basin**	

Coding Procedure. Coding procedure was the same as in study 2 (see Section 2.1).

3.2. Results

Picture-naming task. The CTSL-1 signers produced a total of 70 sign strings involving a total of 129 signs in all strings. The CTSL-2 signers produced 68 sign strings involving a total 163 signs in all strings (repetitions excluded). The overall most frequent strings were two-sign strings (41.3%, e.g., BOTTLE, WASHING BASIN, and GLASS), followed by single signs (31.1%, e.g., BOOK, BOX, and GLASSES) and three-sign (16.6%, e.g., TEAPOT and TOY CAR) and four-sign or more strings (10.9%, e.g., SUITCASE). This was a slightly different pattern from that in study 1, in which the frequency of single signs was higher than that for the two-sign strings. However, a similar pattern to the one in study 1 in the distribution of sign strings was observed: the CTSL-1 signers used significantly shorter strings of signs ($M_{CTSL\text{-}1}$ = 1.88, $SD_{CTSL\text{-}1}$ = 0.64) than the CTSL-2 signers ($M_{CTSL\text{-}2}$ = 2.37, $SD_{CTSL\text{-}2}$ = 0.59) ($t(15) = 2.131$, $p = 0.03$). In addition, the CTSL-1 signers produced significantly more single-sign strings than the CTSL-2 signers ($\chi^2(1) = 6.93$, $p = 0.0085$) (Figure 7).

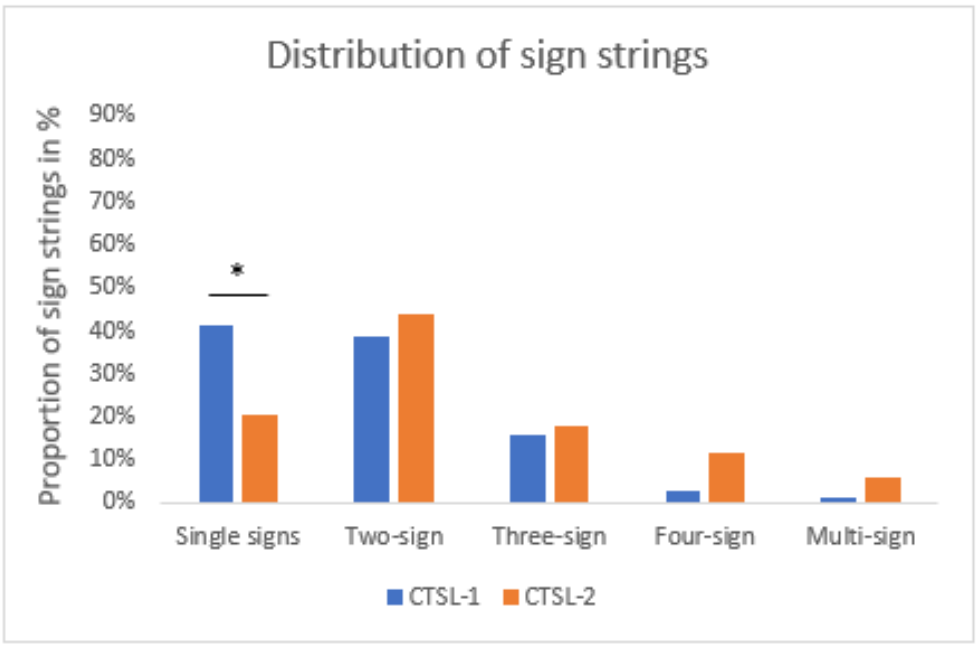


Figure 7. Distribution of sign strings. The *Y*-axis represents the proportional frequency of responses involving sign strings on the *X*-axis. The blue bars represent CTSL-1, and the orange bars represent CTSL-2 (N_{total} = 138, $N_{CTSL\text{-}1}$ = 70, $N_{CTSL\text{-}2}$ = 68). CTSL-1 produces significantly more single-sign strings than CTSL-2.

As in study 1, there were no significant differences in the implementation of the iconic strategies across cohorts. In the overall sign strings (N_{total} = 292), the primary strategy was *object* (42%, 8 of instances), followed by the *action* (26.7%), simultaneous production of *action* and *object* (20.9%), and *deictic* (6.8%) strategies. This was a slightly different pattern

than the one in study 1, in which *action* was favored over *object* as the primary strategy. DRESS, GLASS, GLASSES, and HAT frequently elicited object-based strategies, while BOX, PLASTIC BAG, WASHING BASIN, and SUITCASE frequently elicited action-based strategies combined with object ones or simultaneous use of action and object strategies.

In two-sign strings, a pattern similar to that in Study 1 was observed. The most common combination was *action—object*, followed by *object—action* and *object*, and *action—action* combinations (see Figures 8 and 9). BALL, DRESS, PLASTIC BAG, WASHING BASIN, SCARF, WATER BOTTLE, and GLASS frequently elicited two-sign (or more) strings.

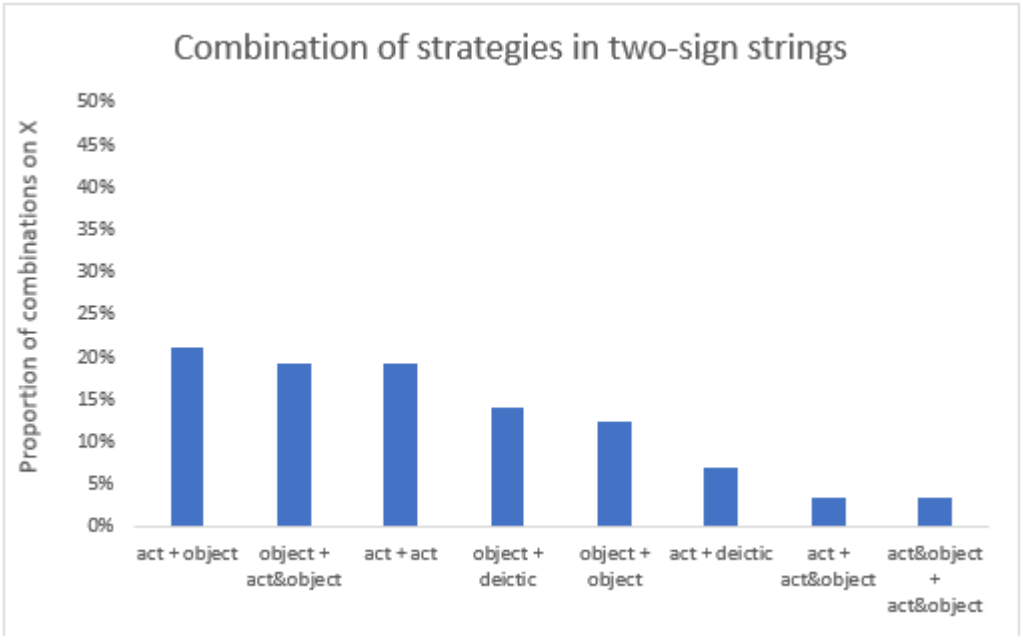


Figure 8. Combination of strategies used in two-sign strings. The *Y*-axis represents the proportional frequency of responses involving the combination of iconic representations on the *X*-axis (N_{total} = 57, 41.3% of all strings). The categories represent the constituents irrespective of their order (i.e., the bar for act + object also includes object + act combinations).

(**a**) (**b**) (**c**)

Figure 9. (**a**) Stimulus item used in the task. (**b**) Reenactment of washing (*action*). (**c**) Tracing of the circular shape (*object*). The *action-object* combination depicted in (**a**,**b**) refers to a WASHING BASIN.

Communicative task. The CTSL-1 signers produced a total of 84 sign strings involving a total of 101 signs in all strings. The CTSL-2 signers produced 111 sign strings involving a total 151 signs in all strings (repetitions excluded). The results show that an overwhelming majority of the overall productions in context were single signs (74.8%, e.g., GLASSES, HAT, JACKET, and BOOK), followed by two-sign strings (21%, e.g., PLASTIC BAG and WASHING BASIN) and three-sign strings (4.1%, e.g., SUITCASE and TOY CAR). Both the CTSL-1 and CTSL-2 signers used significantly shorter strings when the target objects (Tables 2 and 3) were presented in context as opposed to being presented in isolation (CTSL-1: $t(15) = 2.131$, $p = 0.001$; CTSL-2: $t(15) = 2.131$, $p < 0.001$). Figure 10 shows that

single-sign responses were a lot more frequent in context ($\chi^2(1) = 62.71$, $p < 0.0001$). Furthermore, responses involving two or three signs were significantly less frequent when the objects were presented in context (two-sign strings in context vs. in isolation ($\chi^2(1) = 15.93$, $p = 0.0001$) and three-sign strings in context vs. in isolation ($\chi^2(1) = 15.08$, $p = 0.0001$)). Multi-sign strings involving four or more signs were not produced in context (i.e., the signers tended to produce short labels for objects when they were presented in context, rather than producing longer descriptions as they did when they were presented in isolation).

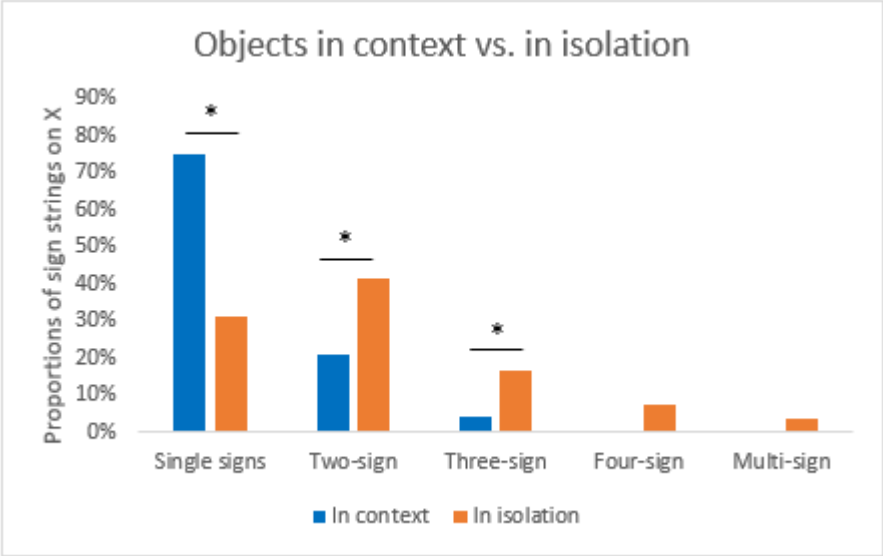


Figure 10. Sign strings produced for objects when they were presented in context vs. in isolation. The *Y*-axis represents the proportional frequency of sign strings on the *X*-axis. The blue bars represent responses produced for objects presented in context, and the orange bars represent responses produced for objects presented in isolation ($N_{context} = 195$, $N_{isolation} = 138$). CTSL-2 produces significantly longer sign strings than CTSL-1.

While there was a significant difference between the lengths of the responses for the CTSL-1 and CTSL-2 signers when objects were presented in isolation, there was no overall significant difference across cohorts when the same objects were presented in context ($M_{CTSL-1} = 1.23$, $SD_{CTSL-1} = 0.27$; $M_{CTSL-2} = 1.39$, $SD_{CTSL-2} = 0.32$; $t(15) = 2.131$, $p = 0.12$). Although the general tendency of both cohorts was to produce shorter responses in context with no overall significant difference in the lengths of the sign strings across cohorts, CTSL-1 still produced more single signs in context ($\chi^2(1) = 5.55$, $p = 0.018$), and CTSL-2 produced more two-sign strings ($\chi^2(1) = 5.63$, $p = 0.0176$), indicating more reliance on combinatorial responses to label objects not only in isolation but also in context (Figure 11). Items which were not always labeled with a single sign and still produced in combination with at least one more sign in context were PLASTIC BAG, TEAPOT, DRESS, BOTTLE, WASHING BASIN, TOY CAR, STICK, SUITCASE, and GLASS.

Overall, for the sign strings produced in context by both cohorts ($N_{total} = 252$), the primary strategy was *object* (53.1% of instances), followed by simultaneous production of *action* and *object* (30.1%), *action* (10.7%), and *deictic* (5.9%) strategies. As in the responses for the target items elicited in isolation, there was no significant difference across cohorts in the implementation of iconic strategies either. However, there were significant differences in the implementation of iconic strategies when the target objects were presented in isolation vs. context: action-based iconic representations were produced significantly less in context ($\chi^2(1) = 22.2$, $p < 0.0001$), and object-based and simultaneous action and object strategies were used significantly more ($\chi^2(1) = 5.73$, $p = 0.0167$ and $\chi^2(1) = 6.08$, $p = 0.0137$, respectively). Many objects involved an *action* component in response to objects presented in isolation (e.g., BALL, BOX, JACKET, PLASTIC BAG, WASHING BASIN,

SCARF, SUITCASE, TEAPOT, TOY CAR, and WATER BOTTLE) (Figure 12), whereas fewer objects involved an *action* component in response to an object presented in context (e.g., BALL, JACKET, PLASTIC BAG, SUITCASE, and TOY CAR) (Figure 13).

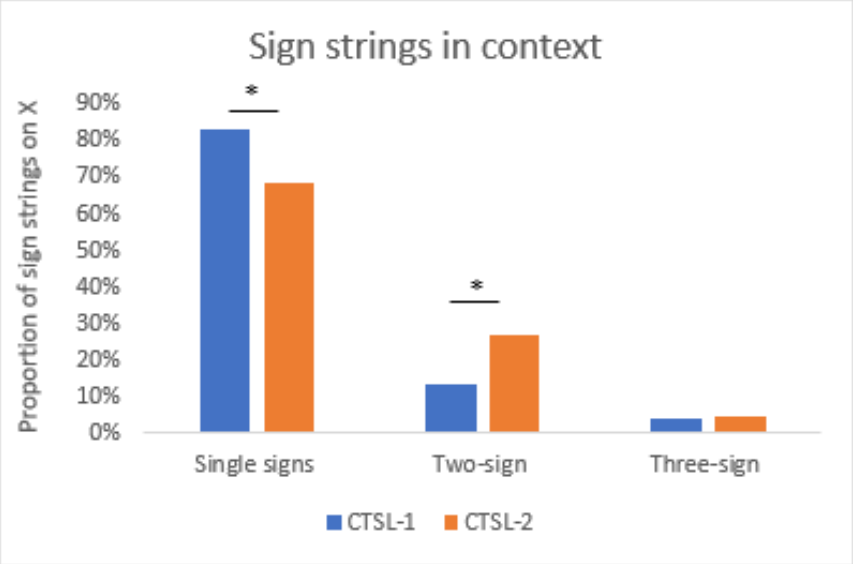


Figure 11. Sign strings produced by CTSL-1 and CTSL-2 for objects when they were presented in context. The *Y*-axis represents the proportional frequency of sign strings on the *X*-axis. The blue bars represent responses by CTSL-1, and the orange bars represent responses by CTSL-2 ($N_{CTSL\text{-}1t}$ = 84, $N_{CTSL\text{-}2}$ = 111). CTSL-2 produces significantly longer sign strings than CTSL-1.

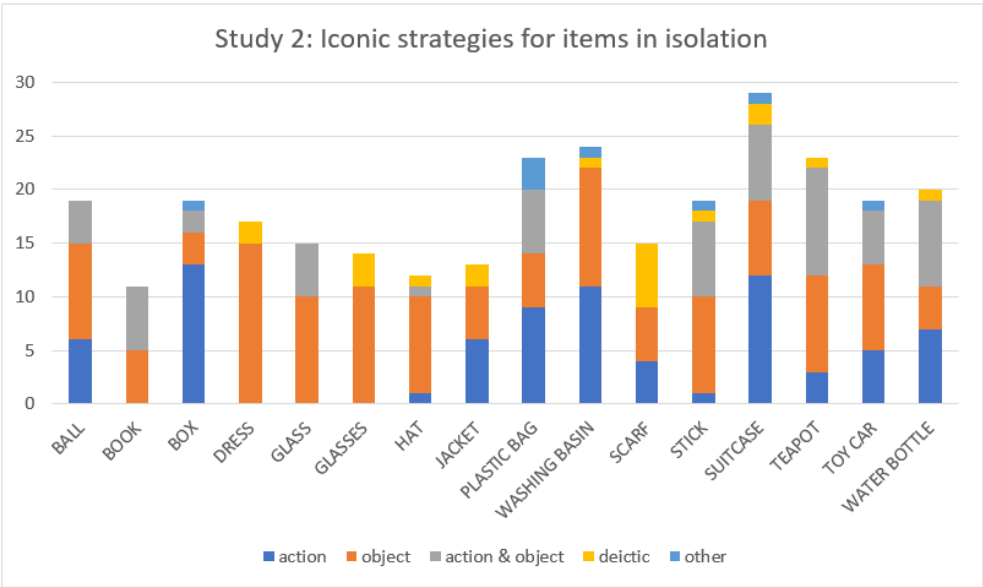


Figure 12. Iconic strategies by item when objects were presented in isolation. The *Y*-axis represents the number of occurrences of iconic strategies used in items on the *X*-axis ($N_{isolation}$ = 292).

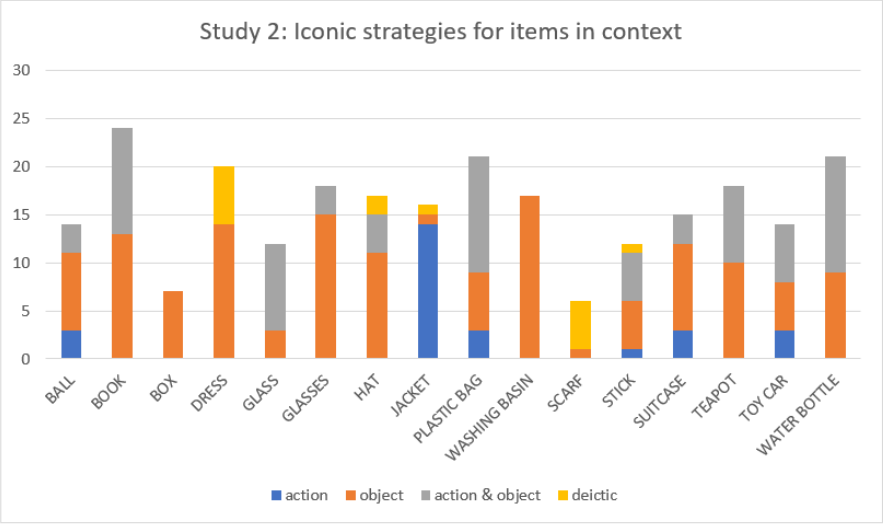


Figure 13. Iconic strategies by item when objects were presented in context. The *Y*-axis represents the number of ocurrences of iconic strategies used in items on the *X*-axis ($N_{context}$ = 252).

Some of the actual responses to the stimuli as they were produced by CTSL-1 signers in isolation vs. context were as follows:

(1) **STICK** [=FIRE ^ CUT ^ SIZE][8]

In (1), STICK, as produced in isolation by a CTSL-1 signer, was a three-sign string. The first sign had an action-based iconic form resembling blowing, which represents FIRE in CTSL (Figure 14b). This was followed by a simultaneous action and object sign for CUTTING, representing cutting wood. Both hands are flat in a cross-configuration, with the non-dominant hand standing still and the dominant hand making a repetitive downward and upward movement on the non-dominant hand (Figure 14c). The last component of the string was an object-based iconic sign depicting the size of the target object with both hands flat facing each other on a horizontal plane (Figure 14d). In sum, this is an object with a certain size that is cut and used for making fire.

(2) **STICK** [= FIRE ^ CUT] BREAK WOMAN BREAK

Eng. "Woman breaks or is trying to break the stick."

In (2), the same participant dropped the last component denoting the size of the object and produced a two-sign string for STICK in context (Figure 14b,c).

(**a**) (**b**) (**c**) (**d**)

Figure 14. (**a**) STICK produced in isolation by a CTSL-1 signer. (**b**) FIRE. (**c**) Action of CUTTING. (**d**) Size of the target object. All three together refer to the target object. For STICK in context, the first two components were preserved (**b**,**c**), and the last component depicting the size of the object (**d**) was dropped.

(3) **BALL** [= CIRCULAR SHAPE ^ BALL THROW]

In (3), another CTSL-1 signer produced BALL as a two-sign string in isolation. The first sign in the string denotes the circular shape of the object with both hands (Figure 15b).

The second sign is a simultaneous combination of the same iconic form with a repetitive forward and backward ball-throwing action in front of the body (Figure 15c).

(**a**) (**b**) (**c**)

Figure 15. (**a**) BALL produced in isolation by a CTSL-1 signer. (**b**) The circular shape of the object, and (**c**) depicts the simultaneous object and action of BALL THROWING. Together, they refer to the target object. For BALL in context, the first component (**b**) was preserved, and the second component (**c**) was dropped.

(4) **PLASTIC BAG** [= HOLD ˆ SPHERICAL SHAPE]

In (4), the same CTSL-1 signer produced PLASTIC-BAG in isolation as a compound involving the action of HOLDING with both hands on both sides of the target object (Figure 16b), followed by a two-handed sign depicting the size and spherical shape of the object (Figure 16c).

(5) PUT INSIDE WOMAN **BALL**[= CIRCULAR SHAPE] PUT INSIDE **PLASTIC BAG**[= HOLD] PUT INSIDE

Eng. "Woman puts the ball inside the plastic bag."

In (5), the CTSL-1 signer produced a reduced form for both BALL and PLASTIC BAG in context. The component containing the size and shape information of BALL was preserved, but the one containing an associated action was dropped. For PLASTIC BAG, the component denoting the action of HOLDING was preserved, and it was produced as a one-handed sign in context (Figure 16d), but the sign denoting the shape and size of the object was dropped (Figure 16c). In other words, there was no systematicity regarding which iconic form to preserve and which one to drop. In addition, further information regarding the physical form of BALL and PLASTIC BAG was incorporated into the main action: PUT INSIDE. The non-dominant hand represents a circular object with a container function (i.e., PLASTIC BAG), and the dominant hand represents another—the circular object (i.e., BALL)—and makes a movement toward the non-dominant hand to signal that the BALL goes into the PLASTIC BAG (Figure 16e).

(**a**) (**b**) (**c**) (**d**) (**e**)

Figure 16. (**a**) PLASTIC BAG produced in isolation by a CTSL-1 signer. (**b**) The action of HOLDING, and (**c**) depicts the spherical shape of the target object. Together, they refer to the target object. For PLASTIC BAG in context, (**d**) depicts the action of HOLDING, referring to the target object in a reduced form. (**e**) The action of PUTTING INSIDE, in which the reduced form of BALL and PLASTIC BAG are incorporated.

Some of the actual responses to the stimuli as they were produced by the CTSL-2 signers in isolation vs. context are as follows:

(6) **BALL** [= CIRCULAR SHAPE ^ BOUNCE]

In (6), similar to the response of the CTSL-1 signer (Figure 15), the CTSL-2 signer produced a compound involving an object-based iconic form in response to the image of a BALL (Figure 17b). This was followed by a simultaneous object and action sign signaling the shape of the target object incorporated in a bouncing action (Figure 17c). However, the imagistic forms of the iconic strategies the CTSL-2 signer used differed from the ones the CTSL-1 signer used. The CTSL-2 signer produced a one-handed circular shape to represent a specific smaller bouncing BALL, as was displayed in the stimulus.

(**a**) (**b**) (**c**)

Figure 17. (**a**) BALL produced in isolation by a CTSL-2 signer. (**b**) Circular shape of the object. (**c**) Simultaneous object and action of BALL BOUNCING. Together, they refer to the target object. For BALL in context, the first component (**b**) was preserved, and the second component (**c**) was dropped.

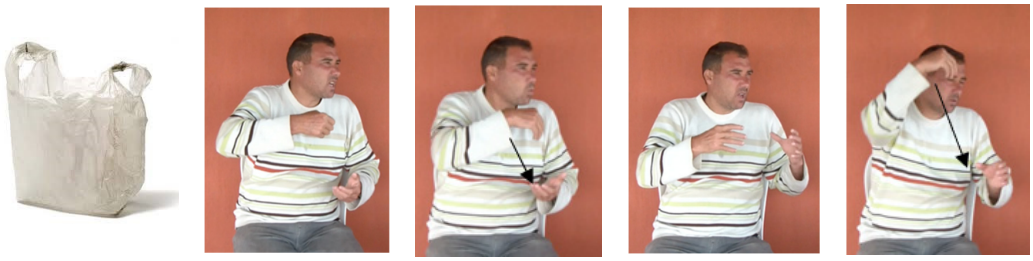
(7) **PLASTIC BAG** [= HOLD ^ PUT INSIDE ^ SIZE]

In (7), the CTSL-2 signer produced a three-sign string to refer to PLASTIC BAG in isolation. The first sign refers to the action of HOLDING a bag (Figure 18b). The second sign is a simultaneous action and object of putting something inside a container, with the non-dominant hand representing the container and the dominant hand representing the agent performing the action (Figure 18c). The third sign refers to the spherical shape and size of the target object, with two C-shaped hands facing each other on the horizontal plane (Figure 18d).

(8) WOMAN **PLASTIC BAG** [= PUT INSIDE ^ HOLD ^ SIZE] **BALL**[= CIRCULAR SHAPE] PUT INSIDE

Eng. "Woman puts the ball inside the plastic bag."

In (8), just as the CTSL-1 signer did, the CTSL-2 signer also dropped the second sign for BALL in context and produced only the first sign denoting the size and shape of the object. For PLASTIC BAG, the CTSL-2 signer kept all three signs of the sign string and produced all of them consistently in the same imagistic form (Figure 18b–d), but HOLD and PUT INSIDE came in varying orders. It is important to note that the first sign (i.e., PUT INSIDE) in the sign string referring to a component of PLASTIC BAG was different from the main action of the sentence (i.e., PUT INSIDE) in that it was smaller in form and involved only a brief movement of putting inside (Figure 18c). In contrast, PUT INSIDE as the main action of the sentence was bigger in form, with the movement of the dominant hand more emphasized and the function of the non-dominant hand as a container more visible (Figure 18e).



(**a**) (**b**) (**c**) (**d**) (**e**)

Figure 18. (**a**) PLASTIC BAG produced in isolation by a CTSL-2 signer. (**b**) Action of HOLDING. (**c**) The simultaneous action and object of PUT INSIDE. (**d**) Size and shape of the target object. All three together refer to the target object. For PLASTIC BAG in context, all three components were preservsed in context, but the first two components varied in order. (**e**) The main action for PUT INSIDE in the sentence, which is different in its form from the form of the PUT INSIDE sign in (**b**).

3.3. Summary and Conclusions

The goal of this study was to replicate the results from study 1 and investigate the lexical inventory of a newly emerging language when objects were presented in isolation vs. in context. In line with the findings from study 1, the CTSL-1 signers produced significantly shorter sign strings than the CTSL-2 signers when objects were presented in isolation. They also produced more single-sign strings than the CTSL-2 signers. There was no significant difference across cohorts in their implementation of iconic strategies in either study 1 or study 2. While the most frequent iconic strategy was *action* in the overall signs produced in study 1, it was the *object* strategy in study 2. In the two-sign strings, an *object* strategy was frequently combined with an *action* or a simultaneous *action* and *object* strategy. This pattern further corroborates the findings of the two-sign strings in study 1.

When objects were presented in context, the lengths of the strings overall were significantly shorter compared with the lengths of the strings elicited when objects were presented in isolation. This finding suggests that the signers gave longer descriptions for objects when they were presented in isolation rather than labeling them with a single sign, as they frequently did in context. In addition, no significant difference in the lengths of the sign strings across cohorts was found. Yet, the CTSL-1 signers still produced significantly more single-sign and significantly fewer combinatorial responses than the CTSL-2 signers. This shows that the CTSL-2 signers were not only more elaborate in giving descriptions for objects in isolation, but they were also more precise in disambiguating them with combinatorial structures in context. Finally, there was no difference either across cohorts in the implementation of iconic strategies or across the sign strings within both tasks. However, there were significant differences in the implementation of all iconic strategies across tasks. Fewer *action* strategies and more *object* and simultaneous *object* and *action* strategies were implemented when the target items were presented in context.

4. General Discussion

4.1. Object-Based or Action-Based Iconic Strategies: Which One Is More Salient?

One of the main goals in this study was to understand whether an imagistic *object* form, an *action* associated with the target object, or the simultaneous use of both is more salient to be selected for iconic representations of everyday objects. With this goal in mind, a set of everyday objects not previously studied for iconicity in CTSL was selected as the stimuli in study 1 and study 2. They were coded for iconic representations in five categories: *object*, *action*, simultaneous use of *object* and *action*, *deictic*, and *other*. Any iconic forms signaling the shape and size information either through a static phonological realization or tracing the shape of the target item were collapsed together under the object category, as they all referred to a physical feature of an object. In order to minimize a potential bias for certain iconic representations, semantic categories such as fruits and vegetables and tools were not used in the stimuli sets. In study 2, the target objects were presented with a

non-prototypical action (e.g., "hat" with "throw" or "glasses" with "drop") in context in order to prevent a potential bias for the simultaneous use of action and object strategies through object incorporations into prototypical actions.

Previous investigations on CTSL have revealed cross-linguistic similarities of iconic patterning in that CTSL uses more action-based iconic forms for tools, whereas more object-based iconic forms for semantic categories such as vegetables and fruits are used. Similar findings have been reported in the gestural productions of non-signers and signers of ASL, ABSL, ISL, German Sign Language (DGS), Japanese Sign Language (JSL) (Hwang et al. 2017), as well as San Juan Quiahije Chatino Sign Language (Hou 2018). Moreover, in line with the findings in ASL, NSL, and Nicaraguan homesign systems (Goldin-Meadow et al. 2015), CTSL signers have been shown to favor object-based strategies in non-agentive contexts and action-based strategies in agentive contexts (Ergin and Brentari 2017). In summation, CTSL typologically fit with the way other sign languages favor their use of iconic strategies in certain semantic categories and event structures.

When potential biases are removed, the available data in this study suggest that there is not a strong preference in CTSL for either action-based or object-based iconic forms for referring to everyday objects, as study 1 presented evidence in favor of action-based strategies and study 2 presented evidence for object-based strategies. Action-based iconic representations have been claimed to be the building blocks of an emerging lexicon in the manual modality (e.g., Ortega et al. 2014 and Ortega and Özyürek 2020). In particular, Ortega and Özyürek (2020)[9] presented evidence for the overwhelming use of *acting* in gestures across a variety of concepts[10]. While study 1 presented evidence in line with this finding (i.e., action is the primary mode of iconic representation, closely followed by object-based strategies), study 2 portrayed another possibility where object representations dominate the cumulative results. In other words, there is no suggestive evidence from the present data for action-based iconic representations to be the main precursor of an emerging lexicon in the manual modality. Mental images capturing the physical form (i.e., size and shape) of the target items or the simultaneous selection of an image representing the physical form of an object and an action associated with that object seem to be equally likely to be selected for iconic representations.

4.2. Is There a Difference across Cohorts of Signers in the Use of Iconic Strategies?

Previous research on emerging sign languages presented evidence for developmental differences across cohorts of signers (e.g., Senghas et al. 2004 and Padden et al. 2013). For instance, Ergin and Brentari (2017) showed that CTSL in its first generation favored action-based iconic forms over object-based iconic forms and evolved into systems favoring the opposite patterns as of the second generation. NSL in its first generation favored object-based strategies and evolved into a system favoring action-based iconic forms over time (Goldin-Meadow et al. 2015). Along these lines, previous research on CTSL also presented evidence for generational differences in various linguistic domains, such as systematic opposition in word order preferences across event types, the use of distinct morphological devices in differentiating various verb classes, and in modification strategies (Ergin et al. 2018, 2020; and Ergin et al. 2021, respectively). For example, in response to transitive constructions, CTSL-1 frequently produces object-verb (OV) sequences without the subject (S) and irrespective of the semantic structure of the construed event, whereas CTSL-2 produces more complete responsenses involving all three arguments, with a systematic opposition of SOV and OSV word orders in those events involving an inanimate patient acted upon by a human agent and those involving a human patient acted upon by a human agent, respectively (Ergin et al. 2018). Similarly, CTSL-1 signers produce significantly shorter responses and make use of simple or complex modification structures significantly less often than CTSL-2 signers in reliably differentiating between the modifier and the modified (Ergin et al. 2021). This study reveals a similar developmental pattern across generations of signers: the CTSL-1 signers produced single-sign responses significantly more often than the CTSL-2 signers, and their responses in object descriptions were significantly shorter

both in study 1 and study 2. In other words, the CTSL-2 signers relied on more combinatorial sequences of signs, probably to mark the target objects more precisely. Regarding the preference for compositionality between CTSL-1 and CTSL-2, the findings of the current study can be considered evidence of a systematization of the lexicon, being more precise semantically and more complex morphologically.

For the implementation of iconic strategies, these data show that there were no differences across generations of signers. Many of the iconic forms were already present as of CTSL-1, and they did not wait until CTSL-2 to emerge. Similarly, Ergin et al. (2020) reported that *mirroring*, an *iconically motivated morphological device* that makes use of both hands in a mirror configuration to express symmetry and plays a differentiating role between events involving symmetry and asymmetry, is present both in CTSL-1 and CTSL-2 with no significant difference. Other devices that do not iconically represent a mental image, such as *temporal sequencing* of events (e.g., WOMAN PUSH and GIRL FALL for "Woman pushes girl"), follow a developmental path that requires them to be invented over time, as they are almost completely absent in CTSL-1 and start to emerge in CTSL-2. Although many linguistic devices may require a developmental trajectory across generations, iconic representations may not be one of them. This may be a reason for not observing differences between CTSL-1 and CTSL-2 in the implementation of iconic strategies in the lexicon.

4.3. Is There a Difference in the Use of İconic Strategies and Their Combinations When the Target Objects Are Presented in İsolation vs. Context?

The available data in this study present evidence for significant differences in CTSL responses when objects are presented in isolation and in context. First, both cohorts produced significantly shorter responses in context. Second, there was no significant difference in the lengths of the responses between CTSL-1 and CTSL-2 in context. However, they significantly differed from each other in their responses when the objects were presented in isolation, and CTSL-2 still used more combinatorial forms in context, suggesting that CTSL-2 may be more reliably marking the target's real-world referents by narrowing the number of possibilities for the intended meaning.

Another key finding here is the differences in the implementation of iconic strategies in response to objects presented in isolation and in context. Both cohorts were inclined to use significantly fewer action-based iconic strategies in context and significantly more object-based or simultaneous object- and action-based strategies. When presented in isolation, in order to identify the target items more precisely, signers may tend to put them in context and produce iconic combinations involving actions associated with the target objects along with the object-based iconic forms. Alternatively, they may tend to incorporate the object-based forms into the associated actions and simultaneously produce both in order to reliably convey the intended message (e.g., see Section 3.2 for PLASTIC BAG and BALL being incorporated into the main action PUT INSIDE). However, when items are presented in context, this may not be considered a necessary condition, as there are already sufficient contextual clues contributing to the accurate interpretation of the event structure.

4.4. Final Remarks and Future Directions

In summation, this study adds to the body of research investigating how object-based and action-based iconic representations and their combinations are used for referring to everyday objects in the emerging lexicon of CTSL, which has emerged in the absence of a conventionalized linguistic system. It also expands the previous research on the similarities and differences across CTSL generations and items produced in isolation vs. in context. In order to talk about the CTSL lexicon as a whole and to generalize these results to natural discourse in CTSL, further evidence from the conversational data should be analyzed for future work.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/languages7020118/s1. Supplementary S1: the family tree. Supplementary S2: the pictures of the stimuli items. Supplementary S3: the images of the objects. Supplementary S4: a sample trial in the task.

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Notes

1 Ergin and Brentari (2017) cautiously drew this conclusion as there was only one signer tested for handshape preferences in the first generation.

2 See also Kimmelman et al. (2018) for unsystematic variation of object vs. handling strategies across European sign languages.

3 Note that not every two-sign string is a systematic compound in CTSL (see Ergin et al. 2021).

4 The age range of the participants was reported as they were tested in 2013.

5 The data in Study 1 and Study 2 were collected in August 2013 and August 2014, respectively. All data were coded by the corresponding author.

6 These signs are typically referred to as size and shape classifiers in the literature (i.e., SASS; see Supalla 1982). In this study, they are referred to as object-based strategies, as they depict the physical form or an aspect of it, which is in line with the main research question of the current study, aiming to address whether it is the object-based or the action-based strategies that form the building blocks of an emerging lexicon.

7 Note that the movement involved in tracing forms is not in any way related to the manipulation of an object but describes the properties of size or shape.

8 The sign strings referring to the target objects are stated in square brackets. "^" is used for combining the signs in each string.

9 In their coding scheme, Ortega and Özyürek (2020) divided object-based iconic forms into further categories such as *representing* and *drawing*, which may have resulted in amplifying the count of action-based iconic forms.

10 Note that although sign languages are not improvised gestural systems, and there is ample evidence showing complex linguistic organization in sign languages, there is also growing evidence showing that gesturers and signers consistently draw from the same set of iconic strategies to mark the differences across semantic categories when they are asked to express entities in the manual modality (e.g., Hwang et al. 2017; and Ortega et al. 2017).

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