Mechanistic Support language in Colombian Spanish-speakers

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Abstract. Beyond basic spatial relations (e.g., teddy on table), we know little about how children learn to talk about Mechanical Support events (e.g., objects attached/hung from a surface via tape) and map them onto linguistic structures. Moreso, the majority of the research that has been done focuses on children learning English—a language that has several verbs that lexicalize support via a specific mechanism (Levin 1993; e.g., glue, tape, clip, etc.). The current study seeks to deepen our understanding of spatial language acquisition by diversifying the populations that have been studied. Specifically, 4-to-6 year-old monolingual Spanish-speaking children and adults in Colombia viewed Mechanical Support events (e.g., girl puts paper on door via tape) and were then asked, 'Can you tell me what my sister did with my toy?'. Both children and adults used Non-Mechanism (e.g., *poner* = 'put', *colgar* = 'hang') and Mechanism Verbs (e.g., *pegar* = 'stick'); the use of Mechanism Verbs increased from 4-to-6 years of age. In addition, whether the mechanism was visible in the event influenced how it was mapped to language; when the mechanism was visible (vs. when it was hidden), children and adults were more likely to encode the mechanism in a prepositional phrase (e.g., *lo colgó con un gancho* = 'she hung it with a clip'). These findings shed light on the development of Mechanical Support language in Spanish-speaking children, the influence of context—specifically, visibility of mechanism—on language, as well as the lexicalization patterns for encoding physical support in Spanish more generally.

Keywords. support relations; mechanical support; cognition; Spanish language; language development; force dynamics

1. Introduction. Children's acquisition of spatial language begins at an early age (Johnston & Slobin 1979) and has been shown to play a role in children's later academic success, especially STEM-related disciplines, such as science and math (Zimmerman et al. 2018). Yet we still know relatively little about how children acquire spatial language, and how acquisition may differ based on the language being learned. To explore this, we focus on the spatial domain of physical support. Physical support can be understood as the causal-force dynamic relations between objects in which one object prevents another object from falling (Coventry et al. 1994, Herskovits 1986, Landau 2020, Vandeloise 1991). The types of causal-force dynamic relations comprising physical support events are quite broad: all support relations involve some knowledge of gravity, some support relations require knowledge that solid objects can't pass through each other (e.g., teddy on top of

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table), while others require mechanism-specific knowledge (e.g., hooks, tape, and velcro all have different properties that prevent objects from falling). In addition, the cause of the support can be visible or hidden (e.g., picture taped to a wall where the viewer can see the tape, or it is hidden behind the figure object; see Figure 1).

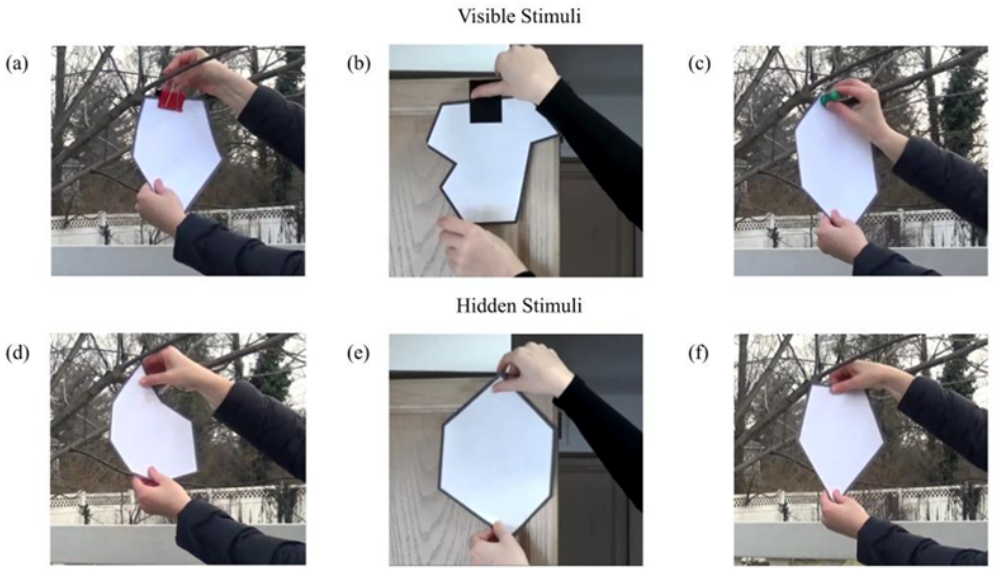

Figure 1: Examples of stimuli

1.1. ENCODING PHYSICAL SUPPORT IN LANGUAGE. The way in which language maps to physical support relations is complex—with language differentiating the semantic space of support into, at least, two distinct types—Support-From-Below (SFB) and Mechanical Support. Levinson and Wilkins (2006) report that for many languages, there is a Basic Locative Construction (BLC) that maps canonically to SFB. In Spanish, the BLC is *estar en* ('to be on') which encodes static support configurations as in (1). The BLC describes the state of a support event (i.e., once the object is already attached to the other) and does not explain how the causal change of state between the two objects occurred (i.e., from not having contact to being attached to the other).

(1) El oso est-á en la mesa
DEF.M bear be.3SG.PST on DEF.F table
'The bear is on the table.'

For dynamic events of support, the verb *poner* ('put') acts semantically similarly to the BLC for static events—it is semantically empty in that it does not encode details about the support, such as the mechanism that was used (picture on the wall via a nail) or the result orientation of the figure object (picture hanging on a wall, which means it is oriented downward). *Poner* differs from *estar* in that it encodes the action which results in the static configuration as in (2).

(2) Ella pus-o la foto en la pared
She put.3SG.PST DEF.F picture on DEF.F wall
'She put the picture on the wall.'

In contrast to the BLC that maps to SFB (Levinson & Wilkins 2006), there is no single linguistic construction that has been proposed to map canonically to Mechanical Support. Rather, there are a variety of linguistic constructions.

1.2. THE LANGUAGE OF MECHANICAL SUPPORT. Mechanical Support may be encoded with the BLC or a simple verb as in (3) below:

(3) a. estar en
be.INF on
'be on'

b. La foto est-á en la pared
DEF.F picture be.3SG.PST on DEF.F wall
'The picture is on the wall.'

c. Ella la pus-o en la pared
She it.F put. .3SG.PST on DEF.F wall
'She put it on the wall.'

Mechanical Support can also be encoded by a variety of different lexical verbs in Spanish. Importantly, lexical verbs vary as to what component of the Mechanical Support is encoded. In (4a) *colgar* ('hang') encodes the orientation, but not the specific mechanism of attachment (i.e., the paper is oriented downward from the tree); in (4b) *pegar* ('stick') encodes a characteristic/property of the mechanism (i.e., sticky); and in (4c) the specific mechanism of support (fastener) is encoded (i.e., *clavar* = 'nail'). Of note, in English, lexical verbs that encode the mechanism (often denominals) are common in Mechanical Support language (e.g., tape, pin, clip) yet less is known about whether they are used in Spanish.

(4) a. La niña colg-ó el papel del árbol
DEF.F girl hang.3SG.PST DEF.M paper of+DEF.M tree
'The girl hung the paper on the tree.'

b. La niña peg-ó el papel al árbol
DEF.F girl stick.3SG.PST DEF.M paper to+DEF.M tree
'The girl stuck the paper to the tree.'

c. La niña clav-ó el papel al árbol
DEF.F girl nail. .3SG.PST DEF.M paper to+DEF.M tree
'The girl nailed the paper to the tree.'

Since verbs such as (3c) *poner* and (4a) *colgar* do not encode the mechanism, we refer to these types of verbs as Non-Mechanism Verbs. In contrast, since verbs such as (4b) *pegar* and (4c) *clavar* encode the mechanism (a property or the actual fastener), we refer to these types of verbs as Mechanism Verbs. This classification was motivated by Levin's (1993) English classification of verbs, which characterizes verb classes according to their semantics.

Linguistic structures other than verbs can be used to encode the mechanism, such as prepositional phrases, (5a) (*con una cinta* = 'with a tape'). Speakers have a variety of options in how they combine phrases. For example, speakers may combine a simple verb (5a) (*poner en* = 'put on') or another lexical verb (5b, 5c) with a prepositional phrase. These events can also be described by combining two separate clauses (5d).

(5) a. Ella lo pus-o en el tablero con una cinta
She it.M put.3SG.PST on DEF.M board with INDF.F tape
'She put it on the board with a piece of tape.'

b. Ella lo colg-ó con un gancho
She it.M hang.3SGPST with INDF.M clip
'She hung it with a clip.'

c. Ella lo colg-ó de un gancho
She it.M hang.3SGPST from INDF.M clip
'She hung it from a clip.'

d. Ella le pus-o cinta y lo pus-o en la puerta
She 3SG.IO put.3SG.PST tape and it.M put.3SG.PST on DEF.F door
'She put tape on it and put it on the door.'

We know from studies of other domains (e.g., Manner of Motion, Causation) that languages vary in their lexicalization patterns (see Talmy 2000). Given this, in addition to the range of linguistic constructions that are offered to map to Mechanical Support, in the current study we ask 1) How do monolingual Spanish speakers encode dynamic Mechanical Support events? And 2) How may these descriptions change over development in monolingual Spanish speakers? In addition, since the mechanism of support can be visible to the viewer or hidden in Mechanical Support events (see Figure 1), we vary this feature in the current study. Research suggests that children reason about the visible and hidden properties that explain how objects behave and interact (Schulz 2012); thus, in the current study we ask how the visibility of the mechanism may affect how language maps to Mechanical Support events.

2. Participants. Since preschool-aged Spanish-speaking children in the U.S. are exposed to English in various contexts outside of the home (e.g., preschool settings, extracurricular activities; Welsh & Hoff 2021) recruiting in the U.S. might result in cross-linguistic transference among participant responses. To control for this, the present study examined how Mechanical Support events were encoded in monolingual Spanish-speaking children (4-to-6 year-old) and adults from a midsize urban Latin-American city in Colombia, where the national language is Spanish. Manizales is the capital of the Department of Caldas, and the population was around 450,000 people at the time of testing. The city is nestled between rural agricultural coffee-cultivating land and an urban environment with several renowned universities, contributing to the diversity in ways of life among its citizens.

Thirty-eight 4-to-6 year-old children (M_{age} = 5 yrs, 9 mos.; Range = 4 yrs, 0 mos. - 6 yrs, 11 mos.; 16 females) were recruited from private preschool centers or elementary schools by sending home study flyers and consent forms. Children were tested and recorded during school hours in a separate classroom or the school library (n = 36) or via Zoom (n = 2). Primary caregivers (n = 35; three caregivers did not report this information) self-reported education level based on a 6-point scale representative of standard educational trajectories in Colombia at the time of testing (0 = N/A, 1 = Preescolar [Preschool], 2 = Primaria [Elementary], 3 = Secundaria [High School], 4 = Media [Tech/Trade School], 5 = Universitaria [College-level], 6 = Posgrado [Graduate level]). Most caregivers reported a post high-school equivalent level of education or higher (n = 27).

Thirty-two adults were recruited and tended to be caregivers of participating children, preschool or elementary school staff, or referred to by other participating adults. Adults were tested in person (n = 10) or via Zoom (n = 22) after school hours, and all responses were video recorded.

Ten additional participants were tested, but their data were excluded due to not understanding the task/not completing the experiment (n = 6 children), suspected language delay (teacher-reported; n = 2 children), and video/connection error (n = 1 child, 1 adult).

3. Procedure. Participants were video recorded as they completed an elicited production task with a Spanish-speaking and Manizales-born research assistant in one-on-one sessions. The experiment began with a practice trial designed to familiarize participants with the procedure. During the practice, participants watched a motion event (a person rolling) and were asked to describe 'what happened?'. All participants were shown sixteen videos (12 test trials, 4 filler trials) of dynamic support events. The videos were 7 to 9 seconds long and displayed a female agent acting out different dynamic configurations with cutout paper shapes (see Figure 1). In the test trials, a figure object (paper) was attached to another object (tree or door) with a mechanism (clip, tape, or pin). All the configurations were designed such that they could be described with any of the verb types included in Table 1. Out of the test trials, half of the events showed the mechanism of attachment (i.e., visible) and the other 6 events concealed the mechanism of support (i.e., hidden). Filler trials consisted of the female agent placing the paper cutout underneath an object (e.g., chair) or into another object (e.g., pot). After watching each trial, the researcher asked, 'Can you tell me what my sister did with my toy?' in Spanish. Videos were replayed if requested by the participant.

4. Coding. A trained research assistant transcribed and coded participant utterances (N = 816) for the verb type and subclass (see Table 1). In addition, three other categories included Other (verbs that did not fall into one of the four verb subclasses), No verb (utterances in which a verb was omitted), and Does not encode support (utterances in which Mechanical Support was not described). We also coded for how the mechanism was encoded (see Table 2). A second trained research assistant coded 14% of the transcriptions in terms of the verb type and subclass and how the mechanism was encoded. The inter-rater reliability was 93% and 97%, respectively. Any disagreements between raters regarding coding were resolved by the final author.

Verb Type	Verb subclass	Example in Spanish
Non-Mechanism	Simple Verbs (BLC events)	poner = 'put'
	Orientation Verbs	colgar = 'hang'
Mechanism	General Verbs of Attaching	pegar = 'stick'
	Specific Verbs of Attaching	enganchar = 'hook'

Table 1: Verb classes relevant for encoding Mechanical Support (based on Levin 1993)

Encoding of Mechanism Type	Example in Spanish
Main Verb	lo pegó a la puerta = 'she stuck it to the door'
Prepositional Phrase	lo colgó con un gancho = 'she hung it with a clip'

Separate Phrase	le puso un clip y lo pusó ahí = 'she put a clip on it and put it there'
Main Verb + Prepositional Phrase	lo pegó con una cinta en una puerta = 'she stuck it with tape on the door'
Main Verb + Separate Phrase	le puso cinta negra y lo pegó en el armario = 'she put black tape on it and stuck it on a dresser'
Other (the mechanism was mentioned but not in terms of Mechanical Support between the figure and ground object)	le puso un gancho = 'she put a clip on it'

Table 2: Categories for encoding of mechanism

5. Results. Descriptive statistics for all verbs are reported in Table 3. Mechanism and Non-Mechanism Verbs accounted for the majority of utterances (96.3%). Other verb categories were less than 5%, so, the analyses excluded these categories. As shown in Table 3, children used primarily Simple Verbs (e.g., *poner* = 'put'), Orientation Verbs (*colgar* = 'hang'), and General Verbs of Attaching (e.g., *pegar* = 'stick'), whereas adults used primarily the latter two verb types (Orientation Verbs and General Verbs of Attaching).

		Children		Adults	
		Visible	Hidden	Visible	Hidden
Non-Mechanism	Simple Verbs	.28 *(.03)*	.24 *(.03)*	.09 *(.02)*	.12 *(.02)*
	Orientation Verbs	.24 *(.03)*	.16 *(.02)*	.41 *(.04)*	.27 *(.03)*
Mechanism	General Verbs of Attaching	.44 *(.03)*	.57 *(.03)*	.40 *(.04)*	.59 *(.04)*
	Specific Verbs of Attaching	.01 *(.01)*	-	.03 *(.01)*	-
Other	Other	-	-	.04 *(.01)*	.006 *(.01)*
	No Verb	.004 *(.004)*	.004 *(.004)*	-	-
	Does not encode support	.022 *(.01)*	.027 *(.01)*	.031 *(.01)*	.017 *(.01)*

Table 3: Mean proportions (with standard errors) of verbs for children and adults by visible and hidden stimuli

First, focusing on the children, we conducted a mixed-effects logistic regression to examine whether children's likelihood of using Mechanism Verbs (0 = Non-Mechanism Verbs, 1 = Mechanism Verbs) increased with age between four and six years and whether mechanism visibility had an impact. Age (in days) was entered as a covariate and Mechanism Visibility (visible vs. hidden) was entered as a fixed effect. Random intercepts for Participants, a by-Participant random slope for Mechanism Visibility, and the correlation between the two were also entered. Age significantly predicted the likelihood of using Mechanism Verbs; the use of Mechanism Verbs

increased with age, (β = .7807, 95% confidence interval [CI] = 1.116 to 4.27, p = .023). However, Mechanism Visibility did not influence the likelihood of using Mechanism Verbs; children were equally likely to use Mechanism Verbs for events in which the mechanism was visible or hidden (β = .786, 95% CI = 0.663 to 7.26, p = .198).

Next, we explored the likelihood of using Mechanism Verbs (0 = Non-Mechanism Verbs, 1 = Mechanism Verbs) among both children and adults (see Figure 2). We conducted a mixed-effects logistic regression with Age (children vs. adults) and Mechanism Visibility (visible vs. hidden) as fixed effects, and random intercepts for Participants, a by-Participant random slope for Mechanism Visibility, and the correlation between the two. Age was not a significant predictor of verb type; children and adults did not differ in their use of Mechanism Verbs (β = .133, 95% CI = 0.525 to 2.487, p = .737). However, Mechanism Visibility significantly influenced the likelihood of using Mechanism Verbs; participants were more likely to use Mechanism Verbs when the mechanism was hidden compared to when it was visible (β = .808, 95% CI = 1.422 to 3.54, p < .001).

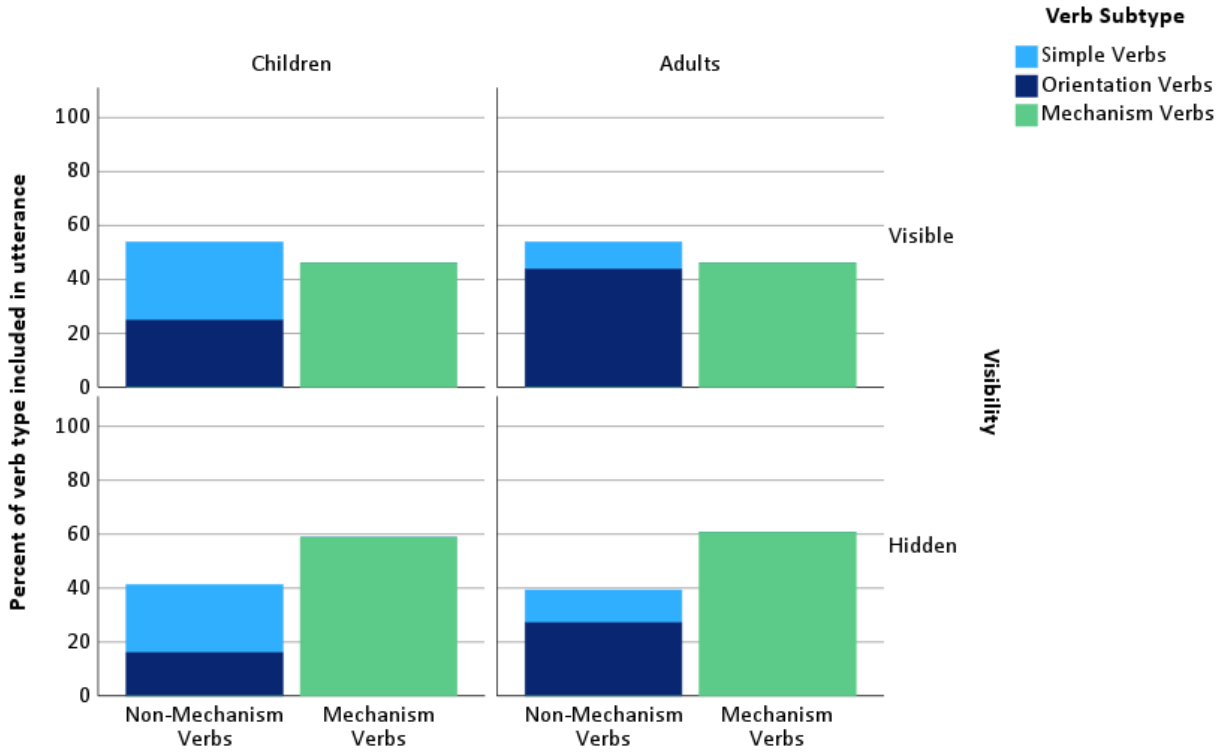

Figure 2: Percentage of verb type (and subtype) included in utterances

Additionally, when participants used Non-Mechanism Verbs (e.g., *poner*, *colgar*), we examined whether there were any differences in verb subclasses by age and visibility. Children used more Simple Verbs (e.g., *poner* = 'put'), whereas adults used more Orientation Verbs (e.g., *colgar* = 'hang'; β = 3.052, 95% CI = 3.131 to 142.82, p = .002). Mechanism Visibility did not influence whether participants would use Simple vs. Orientation Verbs, (β = .043, 95% CI = 0.328 to 3.329, p = .942).

We also examined whether participants encoded mechanisms other than in the verb. We found that 62% of all utterances encoded the mechanism in a variety of linguistic structures (see Table 2 and Figure 3). While participants mostly encoded the mechanism in the verb (e.g., *pegar* = 'stick'),

and more for hidden events (58.2%) vs. visible events (44.2%), they encoded the mechanism in prepositional phrases more frequently for visible events (24.7%) than for hidden events (8.9%).

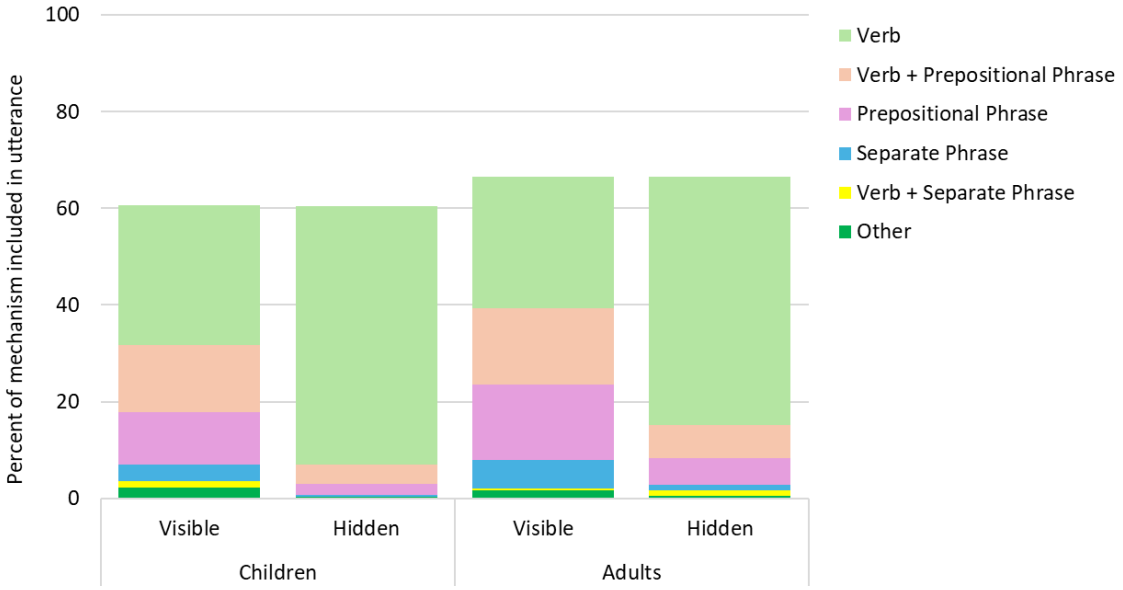

Figure 3: Percentage of trials that encoded the mechanism (and how it was encoded)

6. Discussion. Our findings suggest that when describing events of an agent attaching a figure object to a ground object (e.g., girl puts paper on a tree with tape), both child and adult monolingual Spanish speakers primarily use both Non-Mechanism and Mechanism Verbs; the use of Mechanism Verbs (e.g., *pegar* = 'stick') increases from 4 to 6 years of age, but then remains stable (i.e., there was no difference between children's and adult's use of Mechanism Verbs). In addition, Mechanism Verbs (e.g., *pegar* = 'stick') were more likely to be used when the mechanism was hidden vs. visible - a finding that can be explained by examining how the mechanism was encoded in linguistic structures in addition to the verb. When the mechanism was visible, children and adults were more likely to encode the mechanism in a prepositional phrase (e.g., *lo colgó con un gancho* = 'she hung it with a clip') for visible events vs. hidden events; for hidden events participants were more likely to encode the mechanism in a General Verb of Attaching only (*lo pegó a la puerta* = 'she stuck it to the door').

These findings shed light on the development of Mechanical Support language in Spanish-speaking children, the influence of context—specifically, visibility of mechanism—on language, as well as the lexicalization patterns for encoding physical support in Spanish more generally. We consider each of these in turn.

The increase in the use of Mechanical Support verbs (e.g., *pegar* = 'stick') in children 4 to 6 years of age reflects the development of these verbs in English speaking children. For example, when 2.5- to 4.5-year-olds describe Mechanical Support relations, they tend to use the BLC, BE *on* in English (e.g., the picture is on the wall), rather than lexical verbs that older children and adults use (e.g., the picture sticks/taped to the wall). It is not until about 6 years of age that English-speaking children felicitously use a variety of lexical verbs and prepositions to encode Mechanical Support. Johannes et al. (2016) propose that one reason for this protracted development is that BE *on* may block the use of lexical verbs for English-learning children. In fact, when children are presented with a forced-choice task between lexical verbs and BE *on,* they tend to choose the lexical verb, suggesting sensitivity to verb meanings (Lakusta et al. 2024). Similar studies should

be conducted with Spanish-speaking children to examine whether, when presented with *poner* ('put') vs. *pegar* ('stick'), children would select *pegar* ('stick'), further suggesting sensitivity to verb meaning. Other explanations, not mutually exclusive from the first, are that children (regardless of the language they speak) have to learn about how mechanisms work—they must learn about the different causal force dynamic relations between the different mechanisms and the objects that they support (e.g., tape, magnet, glue). Once this knowledge is acquired, children may use these types of verbs more felicitously in production. Adult input may also play a role; studies in our lab are examining how parent input may change as children get older.

The finding that mechanism visibility in the events affected how both children and adults describe Mechanical Support suggests that context plays a role in how event components get mapped to language. When the mechanism was visible (a picture attached to a tree with a clip), participants tended to encode it in a prepositional phrase (e.g., *lo colgó con un gancho* = 'she hung it with a clip'); when it was hidden, a lexical verb was used (e.g., General Verb of Attaching – *pegar* = 'stick'). This suggests that both children and adults 1) encode the mechanism when it is visible, and they do so in a prepositional phrase (see more on this below), and 2) make inferences about *how* the figure object is adhering to the ground object (e.g., by sticking) when the mechanism is hidden. These findings extend research reporting that children reason about mechanisms when they are engaged in exploratory play and try to find the causal structure of an object or system (e.g., how does this toy work? Why did this toy stop working?; Muentener & Bonawitz 2017, Schulz 2012). Future research should further explore in what other ways context may play a role in the linguistic encoding of Mechanical Support events, such as examining whether certain types of mechanisms may be easier for children to describe than others (e.g., tape vs. magnets) and whether the effectiveness of the mechanism may influence children's acquisition of the linguistic structures that encode it (e.g., if objects only sometimes stay up when using adhesive materials, this may influence children to pay attention to the mechanism and thus encode it more often in language).

Our findings also contribute information about how the Spanish language lexicalizes mechanisms in physical support events. Note that Spanish speakers—adults and children—rarely used Specific Verbs of Attaching (e.g., *enganchar* = 'hook'). Rather they used both General Verbs of Attaching (e.g., *pegar* = 'stick') and Orientation Verbs (e.g., *colgar* = 'hang'); children also used Simple Verbs (e.g., *poner* = 'put'). This pattern of verb use can likely be explained by the number of these verb types in Spanish—Spanish seems to have fewer Specific Verbs of Attaching compared to other languages, such as English (which has more than 50; Levin 1993), and thus it may not be surprising that Spanish speakers would rarely use Specific Verbs of Attaching to describe Mechanical Support. What seems notable, however, is that Spanish speakers encode physical support with both Orientation Verbs and General Verbs of Attaching, whereas recent findings—that used highly similar support events as the current study—suggest that English-speaking adults overwhelmingly use General and Specific Verbs of Attaching (*stick, tape*, etc.) rather than Orientation Verbs (*hang*). Although further research is needed that directly compares how English and Spanish speakers encode Mechanical Support, we speculate that the two languages may show different lexicalization patterns—reflecting patterns that have been shown for how English and Spanish encode Manner of Motion events (Talmy 1985). For Manner of Motion events (*the girl walked up the hill*), English and Spanish differ in how manner and path are lexicalized in the verb phrase (e.g., Talmy 1985) English—a satellite-framed language—tends to encode the manner and motion in the verb (e.g., *walk*), whereas Spanish—a path-framed language—tends to encode the path and motion in the verb (e.g., *subir* = 'go up'). We propose that

this lexicalization pattern may extend to the linguistic encoding of Mechanical Support events. Mechanisms are intuitively similar to manners; *how* something is supported (mechanism) is akin to *how* something moves (manner). In contrast, the orientation of the figure relative to the ground is a component of the path (Jackendoff 1992). Given that mechanisms of support are types of manner (and spatial orientations are a component of the path), we predict that, in a study directly comparing the two languages, the pattern of language-specific lexicalization patterns observed for Manner of Motion events may extend to Mechanical Support events. If so, adult English speakers should lexicalize mechanical manner (i.e., mechanisms) in the verb phrase (over the orientation)—that is, they should primarily use Mechanism Verbs to encode Mechanical Support—whereas adult Spanish speakers should do the opposite—they should use Non-Mechanism Verbs to encode Mechanical Support and encode the mechanism in another clause. Current research in our lab is testing this prediction.

In sum, the current study sheds light on how children learn to talk about Mechanical Support events, and it does so by testing children and adults in Colombia who are monolingual Spanish speakers—thus diversifying the populations that are studied. The findings revealed that although both children and adults used Non-Mechanism (e.g., *poner* = 'put', *colgar* = 'hang') and Mechanism Verbs (e.g., *pegar* = 'stick') to describe events of a person attaching cutout paper shapes to another object, the use of Mechanism Verbs increased from 4 to 6 years of age. In addition, the visibility of the mechanism influenced how it was mapped to language; when the mechanism was visible (vs. when it was hidden), children and adults were more likely to encode the mechanism in a prepositional phrase (e.g., *lo colgó con un gancho* = 'she hung it with a clip'). Future research should explore the factors that explain the developmental progression that we observed in children and investigate other event features that may influence how language is mapped to Mechanical Support. Additionally, it is important to examine how the encoding of Mechanical Support in Spanish may compare to other languages, such as English, where adults primarily use Mechanism Verbs to encode the support (Hauss et al. under revision). These findings shed light on the development of Mechanical Support language in Spanish-speaking children, the influence of context—specifically, visibility of mechanism—on language, as well as the lexicalization patterns for encoding physical support in Spanish more generally.

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