How are categories of intransitive verbs formed? The interaction between meaning and grammar based on evidence from children's acquisition

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Abstract

In the domain of Linguistics, the categories of intransitive verbs, namely the unaccusativity, is a long-debated topic. Unaccusativity suggests that intransitive verbs can be divided into unergative and unaccusative verbs, based on their subjects' similarity to the subjects of transitive verbs or the objects of transitive verbs. Previous research has discussed how the meaning of verbs can decide the unaccusativity of intransitive verbs, but the meanings of verbs alone still cannot predict the unaccusativity of intransitive verbs cross-linguistically. Moreover, while the sentential environment can have an impact on the categories of intransitive verbs, previous studies did not investigate how the environment plays a role in the categories. This paper examines this issue from child language acquisition. I select a few sentential environments in the children's corpus of Mandarin and conduct a qualitative analysis that suggests that these sentence environments indeed possess the properties of either category. In a child acquisition experiment, I show that when the category of verbal meanings and sentential environments align, the categorization of verbs is the most obvious and efficient. I introduce the concept of 'compatibility' to describe this relationship between verb meaning and the sentential environment. These results suggest that speakers can infer the unaccusativity of verbs from a variety of sentence environments in language that may not be directly linked to the concept of unaccusativity, and the concept of 'compatibility' in language environment is a crucial factor in the categories/categorization of unaccusativity.

Keywords: intransitive verbs, meaning, grammar, unaccusativity, interaction

Introduction

The field of Linguistics has long discussed the division of intransitive verbs into two categories. This division, known as *split intransitivity*, or *unaccusativity* when formalized by Perlmutter (1978), is based on either grammatical and semantic similarities between the subject of an intransitive verb and either the subject (in the case of unergative verbs) or the object (in the case of unaccusative verbs) of a transitive verb. A 'diagnostic' sentence as exemplified in (1), is used for this division.

(1) (Auxiliary selection, Burzio, 1986, p.20)
a. (unergative)
Giovanni ha telefonato.
Name have.3sg telephone.pp
'Giovanni has telephoned.'
b. (unaccusative)
Giovanni è arrivato.
Name be.3sg arrive.pp
'Giovanni has arrived.'

In sentence (1), the unergative verb 'telephone' selects for the auxiliary verb 'have', which is similar to the auxiliary 'have' used with the subject of a transitive verb in Italian. In contrast, the unaccusative verb 'arrive' selects for 'be', similar to the object of a transitive verb when promoted to a subject position. To explicate the determinant factors of this division, Projectional approaches (Chomsky, 1981; Pinker, 1989; Hale & Keyser, 1993; Levin & Rappaport-Hovav, 1995) argue that the meanings of verbs play a crucial role in determining unaccusativity. For instance, 'telephone' denotes an ongoing event (atelic), while 'arrive' implies a change with a specific endpoint (telic). On the other hand, constructional approaches (Hoekstra, 1992; Borer, 1994; Goldberg, 1995; van Hout, 1996; Ritter & Rosen, 1996) argue that a verb's category is established when it occurs in a sentence rather than being inherent to the verb itself. According to Borer (2000), the verb 'move' in (2) can be either unergative or unaccusative depending on whether the timespan following the verb suggests an endpoint.

(2) (Borer, 2000, p.326)
a. The piano moved (in two hours) (unaccusative, telic)
b. The piano moved (for two hours) (unergative, atelic)

The subsequent consensus among scholars (Rappaport-Hovav & Levin, 1998; Sorace, 2000) suggests that the meaning of a verb largely determines whether a verb's category can be altered in different sentences, thereby maintaining the inherent category of unaccusativity of verbs. If a definitive category is still required for a verb, constructional consideration involves understanding how various sentences (including diagnostic and non-diagnostic sentences) in a language can decide the unaccusativity of verbs and how various sentences exert sentential effects on verb categories. These previous studies have not yet examined how language input can be an active factor and examining this aspect can provide new insights to this issue.

In a recent study, Lin and Washington (2023) employ computational modeling to quantify the unaccusativity effects from 11 different sentence environments. This child language acquisition study highlights the importance of verb frequency in specific sentence environments on the unaccusativity of verbs. It is found that when new verbs occur

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in certain unergative/unaccusative constructions more frequently, their categorization into respective categories becomes more obvious. Expanding on this study, this study aims to unveil more constructional factors in language input. I convert this linguistic inquiry into a child language acquisition problem because children can provide more efficient and observable learning outcomes than adults. A few sentence environments are identified in the CHILDES Taiwanese Mandarin corpora (MacWhinney, 2000), where the occurrence of unaccusative and unergative verbs exhibits notable differences. I examine their grammatical properties and assign them to unergative or unaccusative environments. Subsequently, I conduct a behavioral experiment, which yields evidence confirming the influence of these identified sentence environments. These results indicate that when a verb appears in sentence environments (grammar) that align with its inherent meaning, the categorization of unaccusativity becomes more obvious. I propose the term 'compatibility' to describe this constructional factor in language input. Overall, this study offers insights into the relationship between verb meanings and the grammatical environment regarding unaccusativity.

Corpus study

In this corpus study, our objective is to identify sentence environments that exhibit a higher frequency of occurrences with either unergative or unaccusative verbs. Building upon the findings presented in Lin and Washington (2023), where the co-occurrence of verbs and sentence environments is a factor in unaccusativity, I adopt this methodology.

I initiated our study by selecting a set of unergative and unaccusative verbs used by Lin and Deen (2021). These verbs were chosen based on these experiments that have confirmed the ability of children in the same age range to distinguish between these two categories. The unergative verbs in our selection included *pao3* ('run'), *tiao4* ('jump'), *fei1* ('fly'), *wei2-xiao4* ('smile'), *ku1* ('cry'), *sheng1-qi4* ('be angry'), while the unaccusative verbs were *liu2* ('flow'), *diao4* ('drop'), *si3* ('die'), *bu2-jian4* ('disappear'), *rong2* ('melt') and *lai2* ('come').

To analyze the usage patterns of these verbs, I conducted a count of their occurrences within the CHILDES corpus (MacWhinney, 2000). It is important to note that our investigation only focused on Taiwanese Mandarin corpora, including Chang1, Chang2, ChangPN, ChangPlay, TCCM, and TCCM-reading, as our study specifically recruited children from Taiwan. It is worth mentioning that 'to melt' and 'to smile' were excluded from our analysis due to their absence (0 occurrences) in the corpora.

Table 1 shows the counts of unaccusative and unergative, and the statistical difference of the count between unergative and unaccusative verbs in the corpora. The p-values in the last column are calculated based on the normalized count of unergative and unaccusative verbs (See the Reference for the normalized count).

Table 1, raw occurrence counts of unaccusative and unergative verbs in sentence environments

Sentence environment	Unaccusative verb	Unergative verb	Statistical difference (p-value)
Total occurrence	12,391	3,283	0.3138 (raw count)
V+perf[1]	2,225 (18%)	173 (5%)	0.073
V+dur	0	5 (0.15%)	0.09
S+V (preverbal)	5,040 (40.7%)	2,428 (74%)	0.23
V+perf+ subject (postverbal-subject)	8 (0.06%)	0	0.03*
V+N	165 (1.3%)	320 (9.7%)	0.482
V1+V (resultative)	2,268 (18.3%)	9 (0.3%)	0.02*
Progressive *zai*+ V	4 (0.03%)	95 (2.9%)	0.04*
Want+V	140 (1.3%)	108 (3.29%)	0.033*
V+ complement	520 (4.2%)	634 (19.3%)	0.362
Modal verb *hui* + V	354 (2.85%)	171 (5.21%)	0.376

As we see in Table 1, the percentage occurrence of unergative and unaccusative verbs show drastic differences in V+perf, S+V, V+N, V1+V, V+complement, Want+V. Unaccusative verbs show numerically much higher percentages in V+perf, V1+V, while unergative verbs show numerically higher percentages in S+V, V+N, V+complement. However, the differences between unaccusative and unergative verbs only achieve statistically significant differences in normalized counts of V+perf+subject (Student t-test, $t(8)=2.342$, $p=.03<.05$*), V1+V (resultative, $t(8)=-2.74$, $p=.02<.05$*), Progressive *zai*+V ($t(8)=-2.19$, $p=.04<.05$*), Want+V ($t(8)=2.42$, $p=.033<.05$*). Postverbal-subject sentences[2] have only 8 occurrences with unaccusative verbs, so I suppose their influence on categorization can be trivial. Based on these simple statistical findings and previous findings in Lin and Washington (2023) that higher occurrences of verbs within sentence environments can lead to more obvious categorization, I select these three sentence environments,

[1] Perf=perfective marker *-le* and dur=durative marker, *-zhe*, complement means the second predicate that follows the first predicate.

[2] Also, the postverbal-subject sentence is the diagnostic I used for the following experiment. Using this very sentence as a stimulus for judgment of the same sentence may not be appropriate.

namely V1+V, want+V, and the Progressive *zai*+V for the next experiment. Before doing this, I conduct a thorough examination of these sentence environments to explore their grammatical properties.

The grammatical properties of the sentence environments

Up to this point, by examining the co-occurrence patterns of verbs and sentence environments, I have identified three sentence environments that may bear significance in categorizing intransitive verbs. Our subsequent objective is to provide additional qualitative evidence from the literature to affirm the grammatical properties of these sentence environments. It is important to know that our goal is to classify these sentence environments into (more likely to be) unergative or unaccusative based on the grammatical properties in these sentence environments and the positions verbs occur. To this end, I apply a broad grammatical criterion, without examining the detailed structures of these sentence environments.

Progressive aspect marker *zai* (unerg)

The progressive aspect marker *zai* has been a topic of discussion in studies such as Li and Thompson (1981) and Li and Bowerman (1998). These studies have highlighted that *zai* tends to appear with activity verbs, which are characterized by their lack of an inherent endpoint, making them atelic. Yang (1995) and Liu (2012) have also contributed to this discussion by suggesting that *zai* does not commonly co-occur with achievement verbs for its telic nature, as exemplified below:

(3)

?Laowang	zai	**si**
Name	prog	die

'Laowang is dying.'

The grammatical properties associated with *zai*, including atelicity, and its preference for activity verbs, all align with the typical characteristics of unergative verbs rather than unaccusative verbs. Based on these observations, it is reasonable to see *zai* as a sentence environment more compatible with unergative verbs.

Want+V (unerg)

In Mandarin Chinese, the want+V involving the verb *yao* ('to want') is associated with a volitional modal verb emphasizing the desires of an agent (Tsang, 1981). It is synonymous with *xiang-yao* ('to want') according to Lü (1999), with a specific emphasis on a volitional agent who intends to perform an action. This common requirement of volitionality within 'want+V' aligns with the definition of unergative verbs proposed by Perlmutter (1978).

Consequently, it is reasonable to suggest that the notion of volitionality makes 'want+V' more compatible with unergative verbs rather than unaccusative ones. This interpretation gains further support from the fact that certain unaccusative verbs, such as *diao*, sound less natural when used within the *xiang-yao* sentence:

(4)

???Ta	xiang-yao	**diao**
He	want	drop

'He wants (himself) to drop'

Resultatives (V1+V, unacc)

In Mandarin, it is observed that unaccusative verbs are more commonly used as the second predicate rather than the first predicate in resultative sentences (Wang, 2010; Liu, 2019). Li (2007) also addressed that the second predicate in a resultative implies a meaning of change-of-location and change-of-state, that frequently correspond to the telic readings of unaccusative verbs. Below are two examples of resultative (second predicates are **bold)**.

(5)

a. Zhang-san	da-**si**	le	yi-ge	ren
Name	beat-die	perf	one.cl	person

'Zhangsan beat a person to death

b. Zhang-san	jiao-**lai**	le	yi-ge	ren
Name	call-come	perf	one.cl	person

'Zhangsan called one person to come'

Only a few unergative verbs can be used as the second predicate of the resultative, but it triggers a result reading, as entailed by a resultative.

(6)

Zhang-san	ma-**ku**	le	yi-ge	ren
Name	scold-cry	perf	one.cl	person

'Zhangsan scolded one person until he/she cried'

Therefore, the finding that the second predicate position in a resultative sentence triggers result-oriented meanings suggested its higher compatibility with unaccusative verbs.

Locative inversion (LVS, unacc)

In addition to the three sentence environments, previous studies have cast attention on LVS sentences, as shown below.

(7)

Fang-zi-li	**si**-le	yi-ge	ren
Home-in	die-perf	one.cl	person

'One person died at home'

As discussed in Liu (2007), locative inversion (LVS) in Mandarin involves the initial position occupied by a locative phrase, followed by a verb, an aspect marker (such as the perfective marker *-le*), and finally, the subject. The research by Liu (2007) and Laws and Yuan (2010) has demonstrated that when the perfective marker *-le* is used in LVS, the verbs predominantly in this sentence are unaccusative. Based on the previous study, LVS is therefore a sentence environment that

is more compatible with unaccusative verbs than unergative verbs.

In the preceding section, I examined the grammatical properties associated with four selected sentence environments. I hypothesize that these specific sentence environments might exert significant influence on the categorization of intransitive verbs into either unergative or unaccusative verbs. In the following section, I design a child language experiment to examine how the categorization occurs and the results may provide insights into their interactions.

Child Acquisition Experiment

Participants

Ninety-five Mandarin-speaking children in a kindergarten in Taipei city, aged 4;9 to 6;4 (mean=5;6), participated in acceptability judgement tasks. Children were randomly assigned to three groups: N=31 in meaning-only, N=33, in incompatible, and N=31 in compatible groups.

Materials and Design

I conducted an acceptability judgment task involving three groups of children to assess how they categorized nonce verbs in Mandarin. These children watched an animated video that depicted the meaning of a nonce verb, with a dog as the central character learning Mandarin. The dog produced diagnostic sentences using the nonce verb, and the children's task was to determine whether the dog used the nonce verb correctly using 'o' (circle) and 'x' (cross).

There exist three groups in this experiment. The 'Meaning-only Group' watched an animated video that illustrated the intended meaning of a nonce verb. After viewing an animation, these children were presented with a diagnostic sentence in which the dog believed the nonce verb could be used. The children were then asked to rate how acceptable the diagnostic sentence sounded to them. In essence, the categorization by the Meaning-only group should be solely based on the meaning of nonce verbs. They did not receive any additional information about the sentence environment.

It is important to note that, although the diagnostics were not intended to directly describe the animation, they were intentionally designed to closely match the scenarios depicted in the animation that the children had watched. For instance, in sentence Figure 1, the subject of postverbal-subject diagnostics remained 'an arrow,' and only a temporal adverbial 'yesterday' was added to maintain the naturalness of the diagnostic sentence.

In the 'incompatible group' and 'compatible group', children also watched animations that illustrated the meaning of a nonce verb in each trial. This animation was played with either an 'incompatible' or a 'compatible' sentence environment, so children received both the meaning and sentential context of new verbs (See Table 2 for the 'compatible' and 'incompatible' sentence environments). Following the completion of the animation and the sentential environment, children were asked to rate a diagnostic sentence. The sentential environments were progressive, want+V, and resultatives and LVS we selected in the corpus study.

Table 2, critical items in the experiment

verb	Meaning	Group		
		Meaning-only	Incompatible group	Compatible group
a	Atelic (unerg)	N/A	Resultatives (unacc)	Progressive (unerg)
b	Atelic (unerg)	N/A	LVS (unacc)	Want+V (unerg)
c	Telic (unacc)	N/A	Progressive (unerg)	Resultative (unacc)
d	Telic (unacc)	N/A	Want+V (unerg)	LVS (unacc)
e	Telic (unacc)	N/A	Progressive (unerg)	Resultative (unacc)
f	Telic (unacc)	N/A	Want+V (unerg)	LVS (unacc)

The sounds of the verbs, animations depicting the meanings of nonce verbs, and the association between existing verbs and nonce verbs were subjected to norming tests involving 5 native Mandarin-speaking adult participants. In the norming test of sounds, 12 one-syllable sounds were created to represent the sounds of the nonce verbs. The adult participants were then asked to select an existing verb that best matched the sounds of each verb from a set of three options. In the end, the six sounds were selected, because none of the existing verbs associated with these six sounds were selected more than two times during the norming trials.

As for the animations, a total of 12 animations were created, including four unergative-targeted animations and eight unaccusative-targeted animations. For each animation, norming participants were given a set of three existing verbs to choose from. 5 native Mandarin-speaking adult participants were asked to select as many existing verbs as they felt best matched each animation. Six animations were chosen based on the criterion that none of the associated existing verbs were selected more than two times by the participants.

After the 6 animations and 6 sounds were selected, adult speakers were asked to describe the action depicted in the animations. All the speakers unanimously described the animation using aspect markers *-le* (perfective) and *-zhe* (durative marker), accurately reflecting the telicity in the animation. Also, their descriptions matched the intended verbal meaning depicted in the animations, i.e., telic, and atelic events. This norming test affirmed that the chosen animations effectively convey the intended meanings of the nonce verbs.

The following six nonce verbs were used:

a. 'si2' (unergative-targeted): a sun rotates and shines (atelic event)

b. ‘lai1’ (unergative-targeted): a boy moves fast around the circle (atelic event)

c. ‘ni1’(unaccusative-targeted): an arrow moves fast and hits the wall, and stops on the wall (telic)

d. ‘ta2’ (unaccusative-targeted): a person vanishes and shows up on the top of a tree (telic)

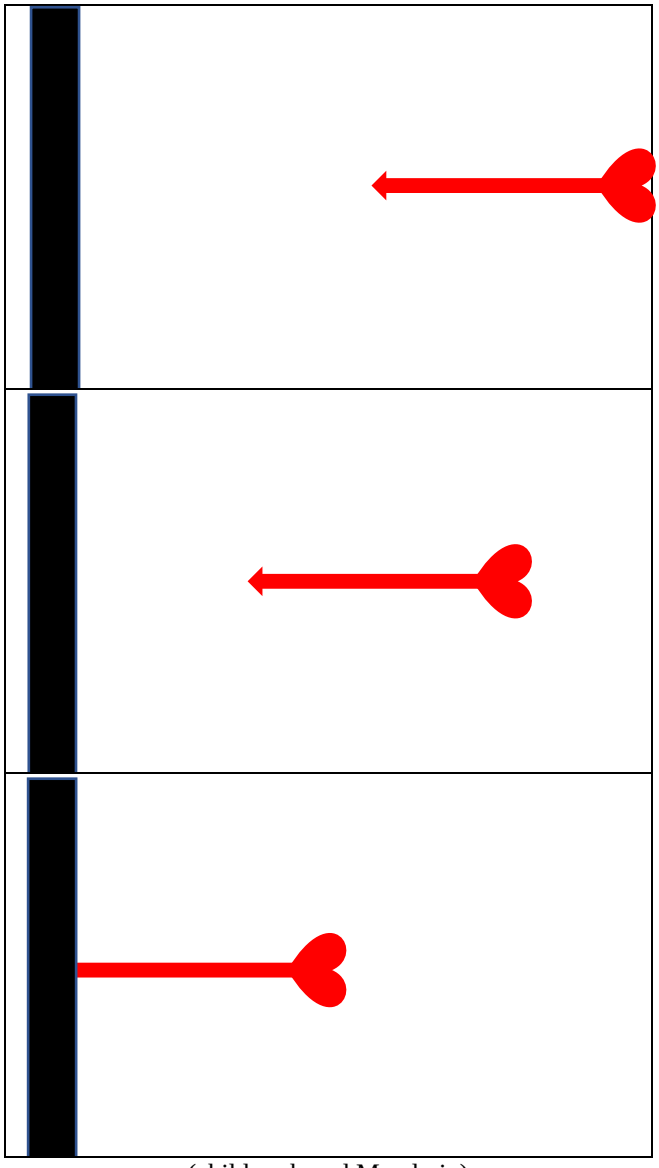
e. ‘qun1’ (unaccusative-targeted): a ball gets poured by the rain and becomes big (telic)

f. ‘dai2’ (unaccusative-targeted): a caterpillar disappears and shows up with its color changed (telic)

Figure 1, an example of ‘ni1’ in the compatible group

a. (first slide, children watched an animation depicting the meaning of the verb ‘ni1’)

(children watched)

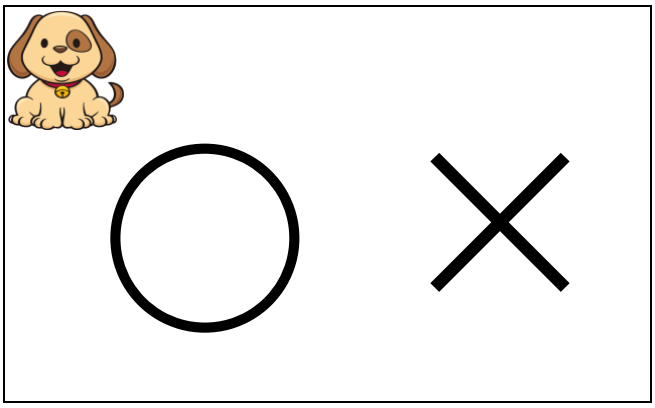


(children heard Mandarin)

‘This new verb is called ‘ni1’. We can say: ‘yesterday, one person shoot-ni1-perf one arrow. (resultative)

b. (second slide, a dog used the nonce verb ‘ni1’ within a diagnostic and children had to rate the acceptability of the diagnostic)

(children watched)



(children heard Mandarin)

zuo-tian	ni1-le	yi-zhi	jian
yesterday	ni1-perf	one.cl	arrow

‘One arrow ni1-ed yesterday’ (postverbal-subject diagnostic)

These six critical items in Table 2 were crossed with the two diagnostics (durative sentence and postverbal-subject). The experiment had 12 critical items and 5 fillers yielding a total of 17 critical items in each group.

Diagnostics

Diagnostic sentences are the only metric for obtaining the result of categorization. I used the two most frequently discussed diagnostic sentences in Mandarin, postverbal-subject diagnostic (Huang, 1987) and the aspect selection test (Liu, 2007), to assess the learning outcome of unaccusativity.

Procedures

The entire procedure was modeled on the acceptability judgement task in Ambridge (2011) with modifications. Child participants and the investigator sat together on one side of the table and watched the PowerPoint slides together. Participants were informed that they were going to help a dog learn Mandarin, and that they were asked to judge the acceptability of diagnostics to assist in the dog's learning. They were instructed to use their intuition even if they were unfamiliar with a verb. Participants listened to a description of a nonce verb, including its meaning and, in the incompatible and compatible group, its sentential environment. A slide with a circle (‘o’) and a cross (‘x’) then appeared, representing ‘good’ and ‘bad’ respectively. Participants heard a diagnostic sentence using the nonce verb and were asked to indicate its acceptability by placing stickers on a sheet with a circle and a cross. Before the official experiment, training trials were conducted with existing Mandarin verbs and nonce verbs using the procedure in Ambridge (2011). During the training session, children were instructed on how to rate a sentence with a binary scale, a

metric different from Ambridge's (2011) five-point scale. The entire experiment lasted about 15-20 minutes, with separate sessions for the meaning-only, incompatible and compatible groups during a week.

Results

The results were converted to the 'accuracy': when children's ratings on diagnostic sentences were the same as the category that the meaning indicated, they were 'accurate' and otherwise were seen as 'inaccurate'. In Figure 2 below, we see that the compatible group scores numerically 60%, higher than the meaning-only group (46%), and the incompatible group (47%). In Figure 3, all the sentences in the compatible groups show numerically higher than the other two groups.

The results were then fitted into the logistic regression models (Python statsmodels, Seabold & Perktold, 2010). The independent variable was 'group' (meaning-only, incompatible, compatible), while the dependent variable was 'accuracy'. Both verb and participant were treated as random variables. Consistent with our earlier findings, the compatible group variable was a statistically significant predictor ($z=4.1$, $p<.001$***), but not the incompatible group ($z=0.348$, $p=.728$). This confirms a robust reinforcement effect of sentence environments in the compatible group.

I then fitted the data into another logistical regression model with 'accuracy' being the dependent variable and each sentence environment being the independent variable. The results show that LVS, resultatives, and want+V were statistically significant predictors ($z=3.539$, $p<.001$***, $z=2.782$, $p=.005$**, $z=2.213$, $p=.027$*), while progressive was not statistically significant predictor ($z=1.291$, $p=.197$). However, the reinforcement effect is still valid as we observed the accuracy improved from 39% to 54% with the progressive sentence. Figure 3 demonstrates a consistent trend wherein items in the compatible group were rated closer to the expected ratings compared to those in the meaning-only and incompatible groups. This finding further supports the notion that the sentential environment can reinforce the categorization when verbal meanings align in the same categories. It also confirms that the 'compatibility' between verbal meanings and sentential environments is crucial, and not all sentence environments, such as those in the incompatible group, can reinforce the categorization.

Discussion and conclusion

To conclude, this paper included a corpus study and a child language experiment. I first used frequency to select a few sentence environments that differ significantly in their distribution of unergative and unaccusative verbs. I confirmed the grammatical properties of these sentence environments and tested how those sentence environments can reinforce the categorization of verbs. The results show that when the category of verbal meaning and that of sentence environment align, the categorization is the most successful and efficient. Hence, in addition to the previously discussed 'frequency' factor related to the co-occurrence of verbs and sentence environments, I introduce the notion of 'compatibility' between verb meanings and the grammatical environment as a crucial factor in the categorization/categories of unaccusativity. It is important that these constructional factors in language input be considered and explored in future research on unaccusativity.

Figure 2, mean accuracy across three groups (error bars indicate standard deviations)

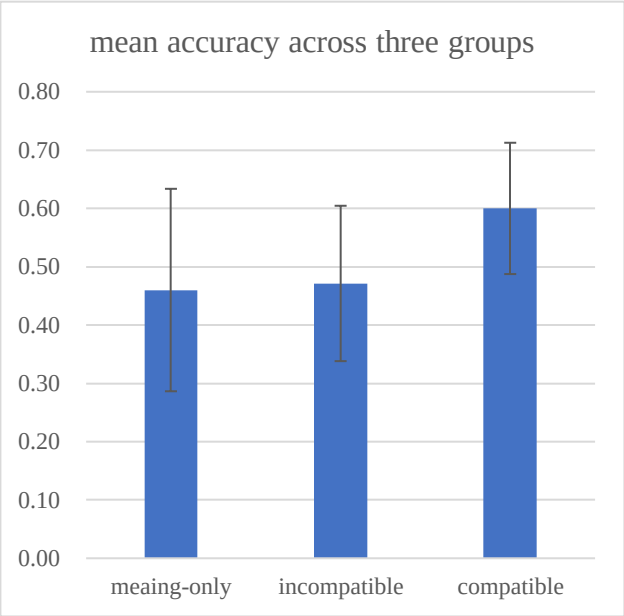


Figure 3, mean accuracy specified with the sentence environments (error bars indicate standard deviations)

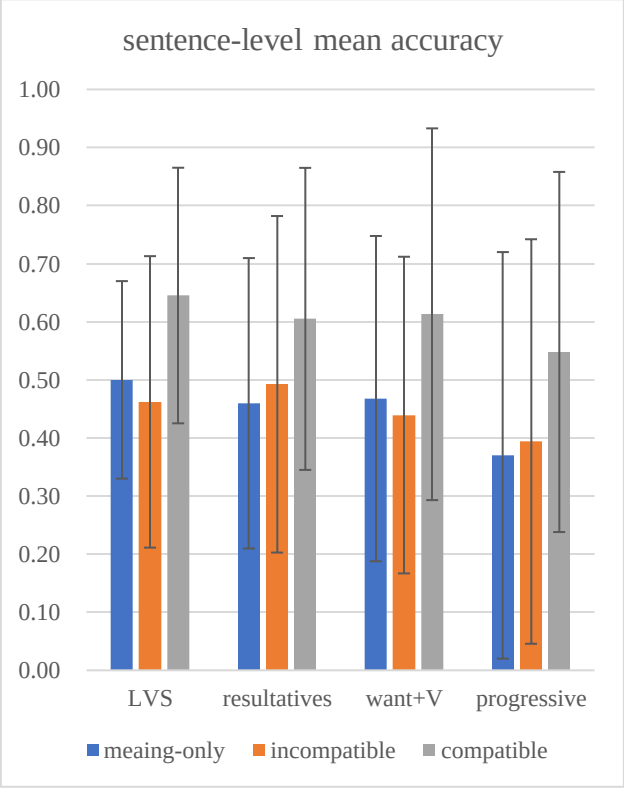


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Table 3, 4, normalized counts for unergative verbs and unaccusative verbs. The normalized count is obtained by dividing the raw counts of the verb in each construction by the total occurrences of the verb.

	jump	fly	run	cry	angry
Total occurrence	668	817	1111	524	177
V+perf	0.0045	0.022	0.014	0.2042	0.1695
V+dur	0.0045	0	0	0.0038	0
S+V (preverbal)	0.3652	0.2986	0.2196	0.4656	0.3785
V+perf+ subject (postverbal)	0	0	0	0	0
V+N	0	0.3917	0	0	0
V1+V (resultatives)	0	0	0.0072	0.0019	0
Progressive (*zai*)	0.0314	0.0355	0.0054	0.08206	0.0113
Want+V	0.015	0.0245	0.027	0.0782	0.0395
V+complement	0.1362	0.1567	0.3645	0.0191	0
Modal verb *hui* + V	0.0053	0.10796	0.16585	0.2132	0.02068

	come	drop	flow	die	disappear
Total occurrence	9068	2223	209	605	290
V+perf	0.1142	0.355	0.005	0.327	0.6897
V+dur	0	0	0	0	0
S+V (preverbal)	0.3992	0.3765	0.3827	0.4017	0.8965
V+perf+subject (postverbal)	0.0004	0.0017	0.0191	0.0066	0.0137
V+N	0	0.3917	0	0	0
V1+V (resultatives)	0	0	0.0072	0.0019	0
Progressive (*zai*)	0.0314	0.0355	0.0054	0.0821	0.0113
Want+V	0.0150	0.0245	0.0270	0.0782	0.0395
V+complement	0.1362	0.1567	0.3645	0.0191	0
Modal verb *hui* + V	0.0180	0.0612	0.0495	0.0687	0.1017