

The Changing View of Input in the Treatment of Children with Deficits in Morphosyntax

Laurence B. Leonard

Purdue University

Principal Collaborators and Acknowledgments

- **Patricia Deevy, Marc Fey, Shelley Bredin-Oja, Sofía Souto**
- **Thanks to NIDCD, NIH (R01 DC 00458, R01 DC 004544, R01 DC 009574, R21 DC13334)**



Children with Developmental Language Disorder (DLD)/Specific Language Impairment (SLI)

- **Significant deficit in language ability**
- **Normal hearing**
- **Absence of neurological damage or disease**
- **Language deficit cannot be attributed to other weaknesses that may also be present**
- **The use of tense and agreement morphology is especially problematic in particular languages (e.g., English, Swedish, German)**

Tense/Agreement Inconsistency in English

- *Molly sings every day, Molly sing every day*
- *Chris played the guitar yesterday, Chris play the guitar yesterday*
- *Tanya's running, Tanya running*

Three-Group Design

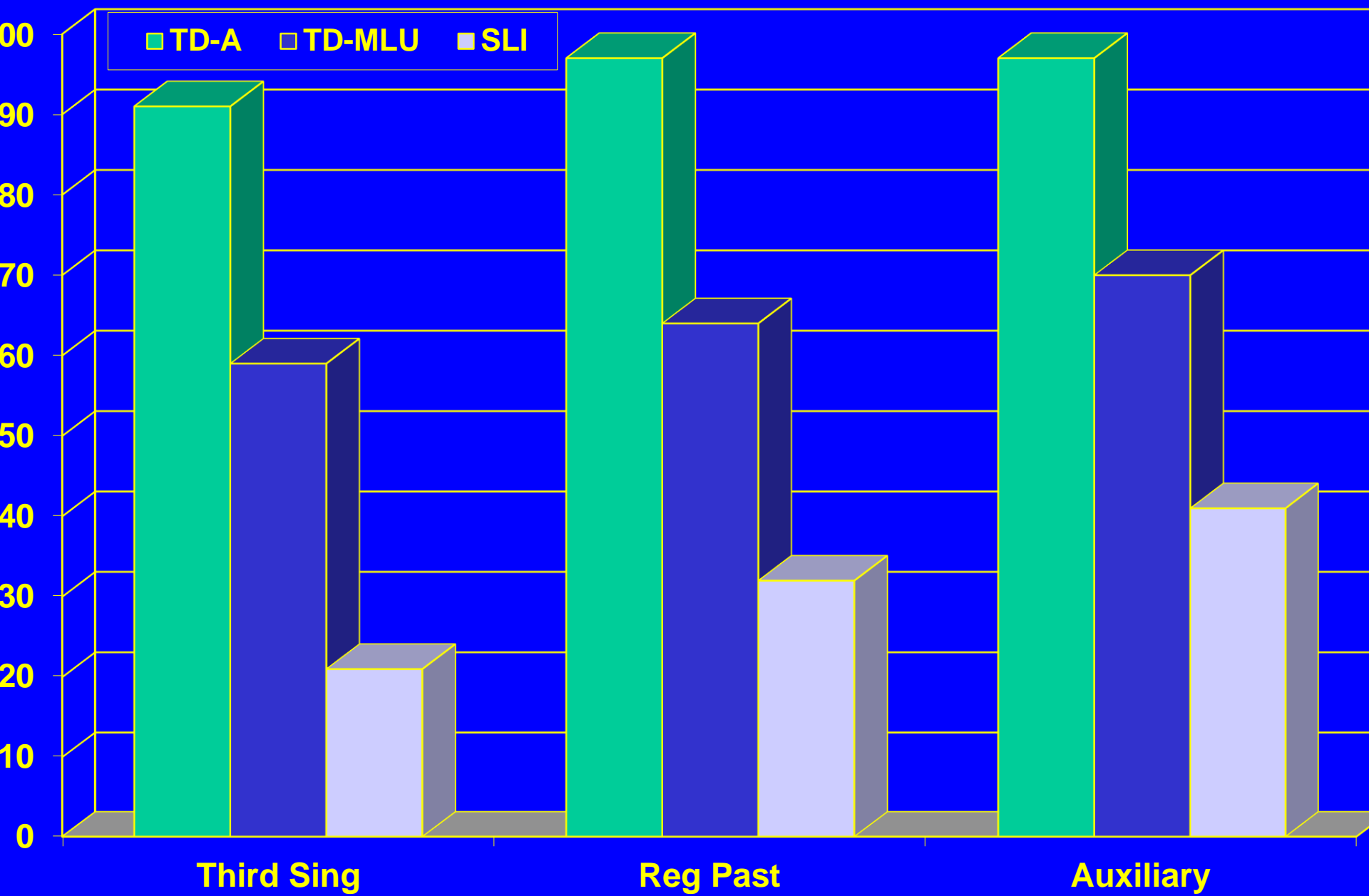
	DLD	TD-A	TD-MLU
English			
Age	5;0	5;0	3;0
MLU	3.62		3.68

Three-Group Design

	DLD	TD-A	TD-MLU
English			
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Three-Group Design

	DLD	TD-A	TD-MLU
English			
Age	5;0	5;0	3;0
MLU	3.62		3.68



Could input play an important role in FACILITATING these children's development of tense/agreement morphology?

Conversely, could input sometimes play a role in SLOWING UP these children's development of tense/agreement morphology?.

There are currently three input-based approaches that are applicable to DLD/SLI and have empirical support:

- **“Input Informativeness” (Hadley et al., 2011)**
- **“High Variability” (Plante et al., 2014)**
- **“Competing Sources of Input” (Leonard, Deevy and Colleagues)**

There are currently three input-based approaches that are applicable to DLD/SLI and have empirical support:

- These approaches do not assume that input causes the language impairment. But choice of input can facilitate or slow development.**
- All three approaches go beyond looking at token frequency, by considering relative frequency and type frequency.**
- Current evidence based mostly on English but their assumptions seem applicable to other languages.**

There are currently three input-based approaches that are applicable to DLD/SLI and have empirical support:

- **“Input Informativeness” (Hadley et al., 2011)**

Input Informativeness: Emphasis is on OVERT Tense/Agreement Forms in the Input

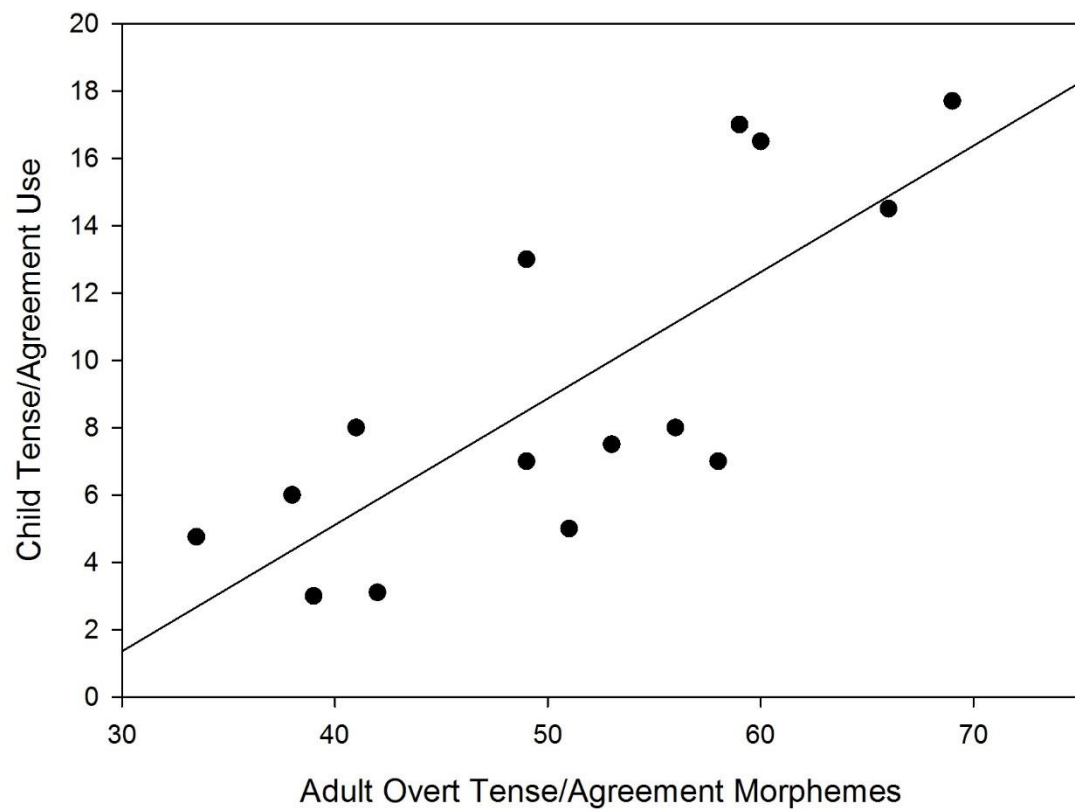
- *Molly sings every day*
- *Chris played the guitar yesterday*
- *Tanya's running*
- *The cars are yellow*

Input Informativeness: Rationale

- Based on the Legate & Yang (2007) finding that, across languages, the proportion of overt and unambiguous tense/agreement forms in the input predicted how early children would become consistent in their use of tense/agreement forms.
- In some languages, children hear many bare stems and nonfinite forms and as a result may be slow to learn contexts for tense/agreement use.
- Relative frequency is important: proportion of overt forms

Input Informativeness: Evidence 1

- Within English, Hadley et al. (2011) found that the degree to which parents' speech to their 21-month-old children contained OVERT tense/agreement forms predicted the rate at which their children used tense/agreement at 30 months.
- *Oh, the horse wants to go in the barn; The cow chased the pig; That car is yellow.*



Input Informativeness: Evidence 2

- Using a treatment design, Hadley et al. (2017) found that a larger proportion of nouns in subject position and uncontracted tense/agreement morphemes in declarative sentences in the parents' speech was predictive of greater growth of tense/agreement morphemes in their children's speech.
- *The big horse wants to go in the barn; The brown cow chased the pig; That car is yellow.*

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- *The big horse wants to go in the barn; The brown cow chased the pig; That car **is** yellow.*

Input Informativeness: Toy Talk 1

- Input should emphasize OVERT tense/agreement forms that cannot be misinterpreted as nonfinite forms.
- This was operationalized in Toy Talk by teaching parents to: (1) talk about the toys the child is playing with; and (2) give the object its name (e.g., *The tower's tall* instead of *It's tall*).

Input Informativeness: Toy Talk 2

- Note: in English, “zero-marked” tense/agreement forms (e.g., *I like ice cream; You need a bath*) are identical phonetically to infinitives, and their tense/agreement status is potentially ambiguous.
- Therefore, parent utterances referring to themselves (= first person, as in *I like*) or to the child (= second person, as in *You need*) should be kept to a minimum during Toy Talk activities.

Input Informativeness: Toy Talk 3

- Input that uses a noun in subject position is preferred over a pronoun in subject position.
- Forms such as *it's*, *that's*, *he's*, *she's* are sometimes memorized wholes and not recognized as containing a tense/agreement morpheme.
- Nouns combine with tense/agreement morphemes less often. Therefore, *'s* in *The boy's tall* and *The girl's happy* should be more easily identified.

Toy Talk Examples:

Child: Me getting the horse out.

Adult: That horse wants a drink

Child: And maybe some hay.

Adult: The hay is in the barn

Adult: Look, the dogs are running after the horse

Child: Where the cat?

Adult: The cat is sleeping in the house.

Adult: The dogs played with the cat and now the cat is
really tired.

Child: I like cats.

Adult: And this cat likes you!

There are currently three input-based approaches that are applicable to DLD/SLI and have empirical support:

- **“Input Informativeness” (Hadley et al., 2011)**
- **“High Variability” (Plante et al., 2014)**

High Variability: Emphasis is on Input with a Large Number of Unique Verbs Used with the Target Form

- *runs, jumps, plays, sings, sees, eats, drinks, kicks, etc.*
- Type frequency is very important: the number of unique verbs should be large.

High Variability: Rationale

- Children and adults learn a grammatical form faster when it is the unchanging element in a changing context.
- In artificial grammar studies, the number of different exemplars representing the changing context is crucial.
- When 24 different exemplars are used for X, the rules aX , Xb , and aXb are learned more readily than when fewer exemplars are used for X.

Artificial Language Example (*aXb*):

pel wadim rud
pel kicey rud
pel puser rud
pel fengle rud
pel coomo rud
pel loga rud
pel gople rud
pel taspu rud
pel hiftam rud
pel deecha rud
pel vamey rud
pel skiger rud

pel benez rud
pel gensim rud
pel feenam rud
pel laeljeen rud
pel chila rud
pel roosa rud
pel plizet rud
pel balip rud
pel malsig rud
pel suleb rud
pel nilbo rud
pel wiffle rud

Artificial Language Example (*aXb*):

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pel gensim rud

pel feenam rud

pel laeljeen rud

pel chila rud

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pel balip rud

pel malsig rud

pel suleb rud

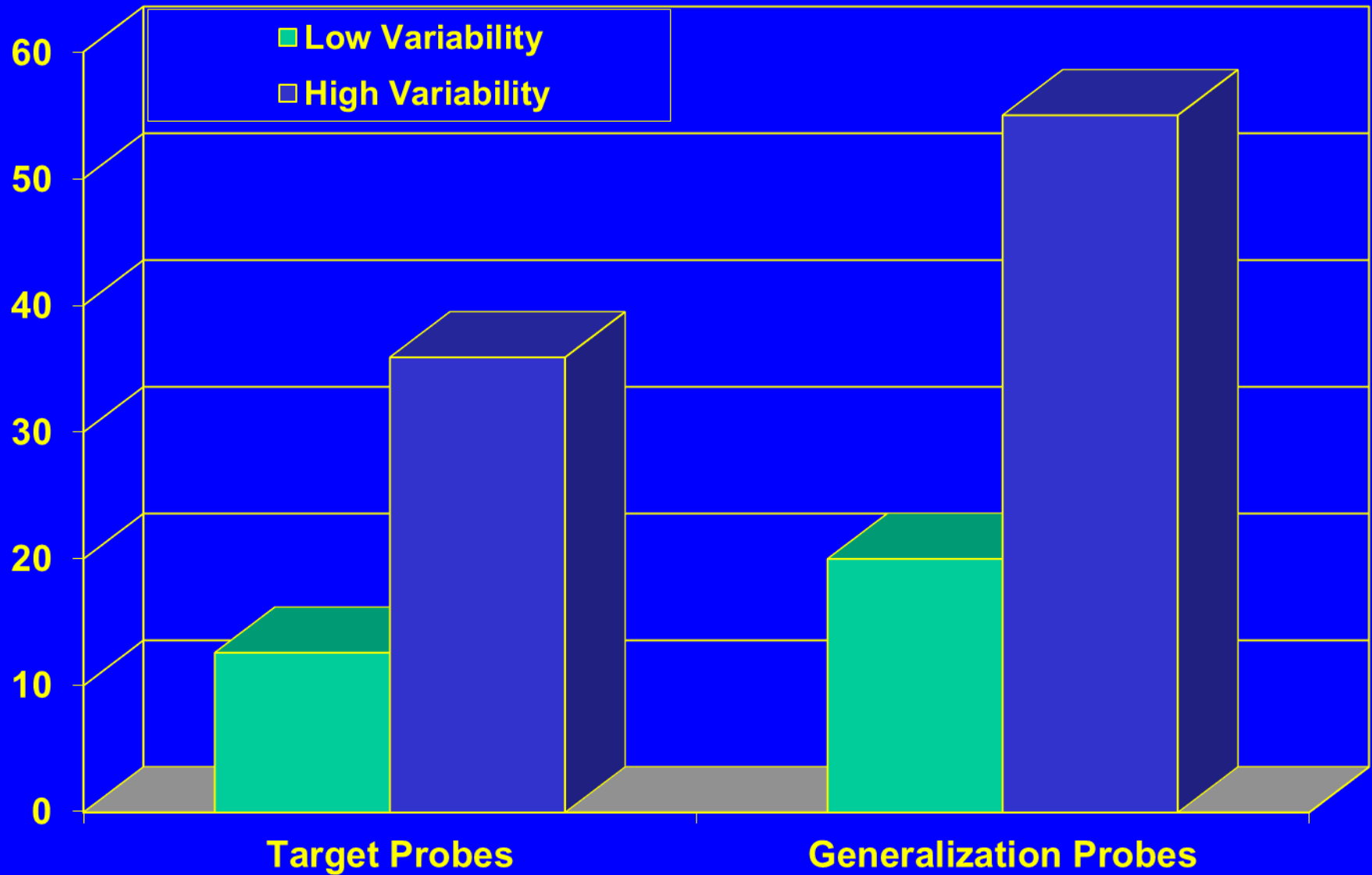
pel nilbo rud

pel wiffle rud

High Variability: Evidence

- Plante et al. (2014):
- 18 DLD/SLI, age 5 years
- Six weeks of treatment (recasting)
- $Xb = \text{Verb} + s$ (or $\text{Verb} + ed$)
- $aXb = is \text{Verb} + ing$
- High Variability Condition: $X = 24$ unique verbs
- Low Variability Condition: $X = 12$ unique verbs
- The total number of verb tokens was equal in the two conditions.
- Learning in terms of both accuracy and generalization was better when 24 different exemplars were used.

Percentage Use of Auxiliary *is* in Obligatory Contexts



High Variability: Application 1

- When teaching verb inflections or function words associated with verbs, use a larger number of unique verbs. For example, for English third person singular, 24 unique verbs can be used, as in:

throws

plays

hears

hops

hides

wears

blows

stops

runs

sees

reads

sleeps

listens

slides

knocks

makes

jumps

likes

drinks

opens

cleans

hugs

writes

walks

throws

plays

hears

hops

hides

wears

blows

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walks

High Variability: Application

- When teaching verb inflections or function words associated with verbs, use a larger number of unique verbs. For example, for English third person singular, 24 unique verbs can be used, as in:
- The greater diversity can easily be incorporated into stories, and, with proper planning, even procedures such as recasting can be used.

This is a story about a girl who liked dogs. Every day she walked to the park to see the dogs there. She watched as the dogs played with each other, and sometimes they barked when they saw a squirrel. The girl really loved one dog – a collie. She called her Lassie, because the dog looked a lot like the famous dog in the movies. One day, Lassie followed the girl home! The girl tried to get Lassie to go back to the park, but.....

(1) Liked
(2) Walked
(3) Watched
(4) Played

(5) Barked
(6) Loved
(7) Called
(8) Looked

(9) Followed
(10) Tried
:
(24) Opened

Child: Horse go in the barn.

Adult: The horse **is going** in the barn? Good!

Child: Put him in there with the dog.

Adult: The dog **is watching** the horse eat the hay.

Child: Where the guy go? The farmer?

Adult: The farmer **is cleaning** the barn inside.

Child: It dirty inside?

Adult: Yes, the pig **is eating** his dinner in the barn and
he **is making** a mess!

(1) is going

(5) is making

(2) is watching

:

(3) is cleaning

(24) is riding

(4) is eating

There are currently three input-based approaches that are applicable to DLD/SLI and have empirical support:

- **“Input Informativeness” (Hadley et al., 2011)**
- **“High Variability” (Plante et al., 2014)**
- **“Competing Sources of Input” (Leonard, Deevy and Colleagues)**

Competing Sources of Input: Emphasis is on a Combination of: (1) Input with Tense/Agreement Forms; and (2) Avoiding Potentially Confusing Sentence Structures

- Use: *The girl likes ice cream; She's running; Dad washed the car*
- Avoid: *Does the girl like ice cream? We saw her running. Help Dad wash the car*
- Relative frequency is important: Easily interpretable forms relative to potentially confusing forms

Competing Sources of Input: Rationale

- Hearing overt tense/agreement morphemes in the input is desirable. However, children also hear nonfinite verbs in contexts that they might misinterpret.
- Children hear sequences such as *the girl like ice cream* from input such as “Does [the girl like ice cream]?” and sequences such as *her running* from input such as “We saw [her running].”
- Could the children mistakenly extract such sequences and use them as a basis for generating new utterances?

Previous studies suggest that children might extract nonfinite sequences from larger structures in the input:

- **Computational modeling studies (e.g., Freudenthal et al., 2007)**
- **Studies of young typically developing children (e.g., Theakston et al., 2003)**
- **Studies of children with DLD/SLI using priming (e.g., Leonard et al., 2002) and novel verb learning (Leonard & Deevy, 2001; Leonard et al., 2015)**

The dog eating

Little girl happy

He eat ice cream

She at home

She go

My coffee hot

The dog eating

Is [the dog eating]?

Little girl happy

Is [the little girl happy]?

He eat ice cream

Did [he eat ice cream]?

She at home

Was [she at home]?

She go

Can [she go]?

My coffee hot

Is [my coffee hot]?

Me do the dishes

The dog eating

Him hop

My coffee hot

Her at home

Them fly away

Me do the dishes

Help [me do the dishes]

The dog running

I see [the dog running]

Him hop

Let's watch [him hop]

My coffee hot

I like [my coffee hot]

Her at home

I want [her at home]

Them fly away

Did you see [them fly away]?

Adult Swedish:

Kristina dricker kaffe

Common error:

Kristina dricka kaffe

Adult Swedish:

Kristina dricker kaffe

Common error:

Kristina dricka kaffe

Adult Swedish:

Kan [Kristina dricka kaffe]?

Adult Swedish:

Kristina dricker kaffe

Common error:

Kristina dricka kaffe

Adult Swedish:

Kan [Kristina dricka kaffe]?

Adult German:

Ich fahre einen Toyota

Common error:

Ich einen Toyota fahren

Adult Swedish:

Kristina dricker kaffe

Common error:

Kristina dricka kaffe

Adult Swedish:

Kan [Kristina dricka kaffe]?

Adult German:

Ich fahre einen Toyota

Common error:

Ich einen Toyota fahren

Adult German:

Kann [ich einen Toyota fahren]?

The dog eating

Is [the dog eating]?

Little girl happy

Is [the little girl happy]?

He eat ice cream

Did [he eat ice cream]?

She at home

Was [she at home]?

She go

Can [she go]?

My coffee hot

Is [my coffee hot]?

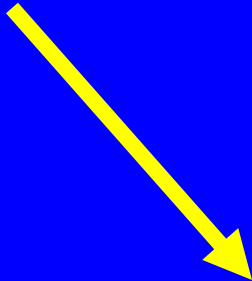
Input: *Look* [*the dog's eating*]

The dog's eating

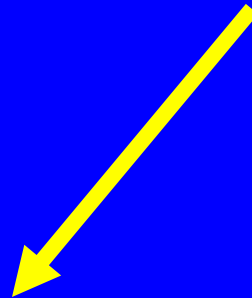
Input: *Is [the dog eating]?*

The dog eating

The dog's eating



The dog eating



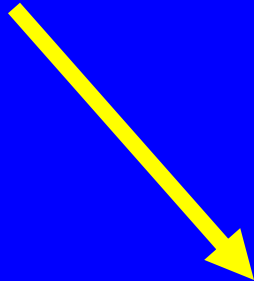
Typical Development

Is [the dog eating]?

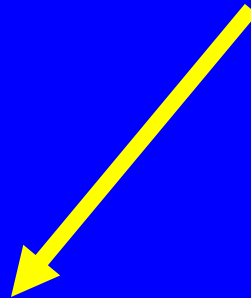
Typical Development

[Is the dog eating]?

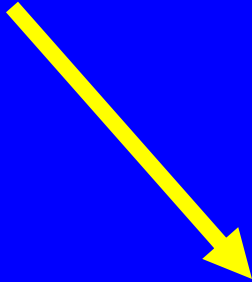
The dog's eating



The dog eating

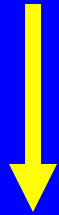


The dog's eating

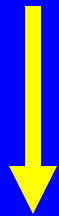


~~The dog eating~~

The dog's eating



The dog's eating



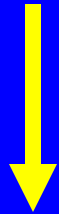
The cat's eating

The bird's eating

The dog was eating

The cat was eating

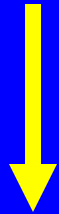
The dog's eating



The dog eating



The dog's eating



The cat's eating
The bird's eating
The dog was eating
The cat was eating

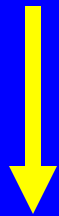
The dog eating



The cat eating
The bird eating

“Competing Sources of Input”

The dog's eating



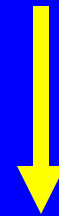
The cat's eating

The bird's eating

The dog was eating

The cat was eating

The dog eating



The cat eating

The bird eating

Is the inappropriate extraction and use of nonfinite subject-verb sequences related to comprehension difficulty with the larger structures?

Example:

Is the dog eating?

Deevy, Leonard, & Marchman (2014, 2017)

ECoder File Edit Controls Window Help

406C43

ME3 10/31/13
4063 7 s/auxorder2r
Pict Snd

00:00:56:01

Trial #	Trial Status	Response	Time Code
7	on	left	00:00:51.16
7	on	off	00:00:54.27
7	on	right	00:00:54.76
7	on	off	00:00:55.83
7	on	left	00:00:56.35
7	off	off	00:00:57.27
7	on	right	00:00:57.29
7	off	right	00:00:58.17
8	on	off	00:01:00.19
8	on	left	00:01:01.81
8	on	off	00:01:01.20
8	on	right	00:01:01.22
8	on	off	00:01:04.29
8	on	left	00:01:05.81
8	on	off	00:01:06.82
8	on	right	00:01:06.84
8	on	off	00:01:07.68
8	on	left	00:01:07.70
8	off	left	00:01:08.14
9	on	off	00:01:09.27
9	on	right	00:01:10.88
9	on	off	00:01:11.82
9	on	left	00:01:11.84
9	on	off	00:01:14.89
9	on	right	00:01:15.11
9	off	right	00:01:17.18
10	on	off	00:01:18.29
10	on	left	00:01:19.84
10	on	off	00:01:20.25
10	on	right	00:01:20.27
10	on	off	00:01:21.20
10	on	left	00:01:21.22
10	off	left	00:01:25.23
11	on	off	00:01:27.78
11	on	left	00:01:28.10
11	on	off	00:01:29.27
11	on	right	00:01:29.29
11	on	off	00:01:30.19
11	on	left	00:01:31.16
11	off	left	00:01:31.18

Pre-Screen Code

Trial: 7 Trial Status: On Response: Away Record Event

Subject Number: 4063 Order: S/Aux2r

Unused Trials: 1, 2, 3, 4, 5, 6, 15, 24, 33, 40 Prescreened out: 70/98
(whoops): ID: NOT Code:

Resynchronized: none

Notes:

Errors: none

Slide Frames: 1

Yes-No questions with auxiliary



See the nice little dogs running?

Are the nice little dogs running?

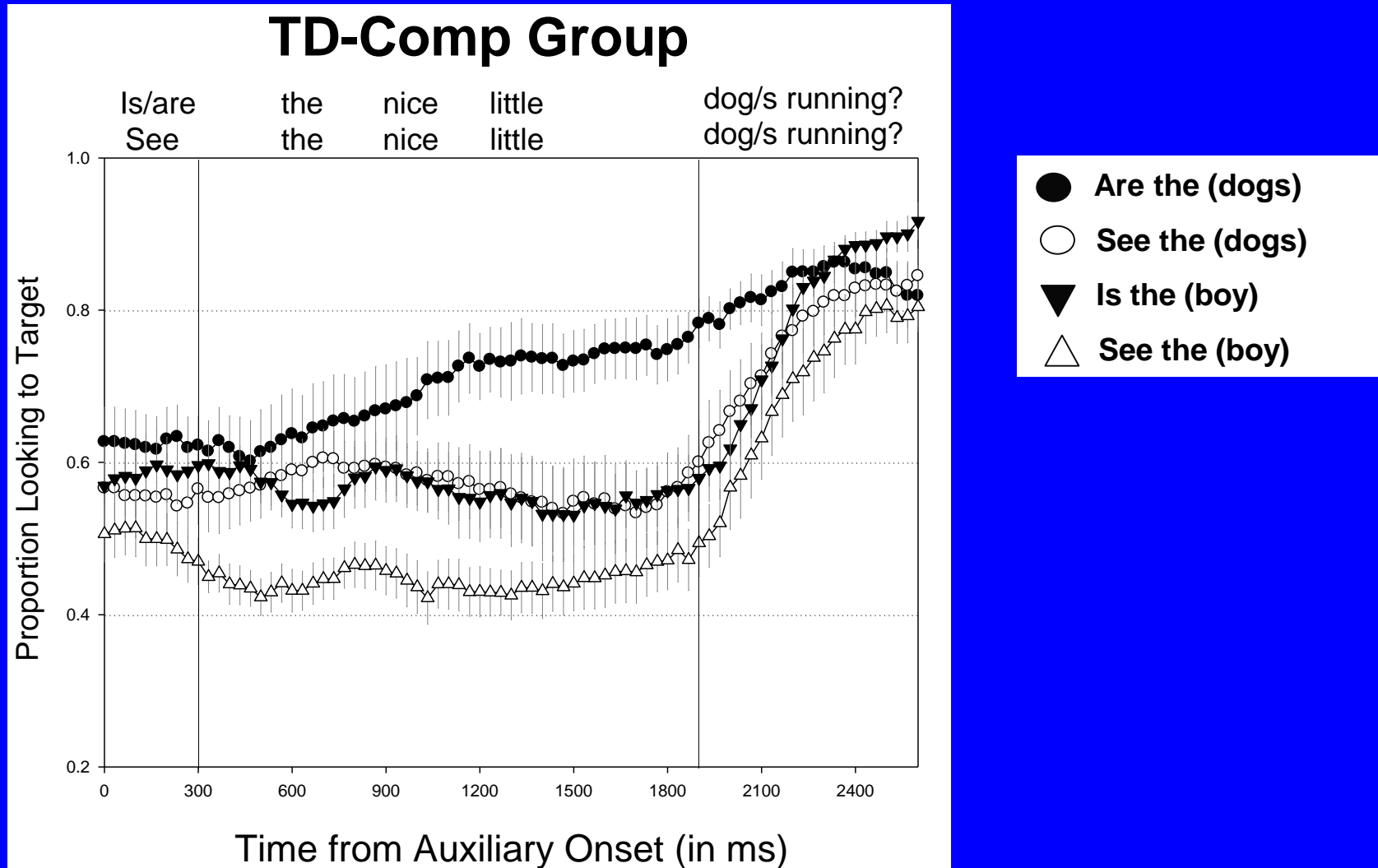
See the nice little boy running?

Is the nice little boy running?

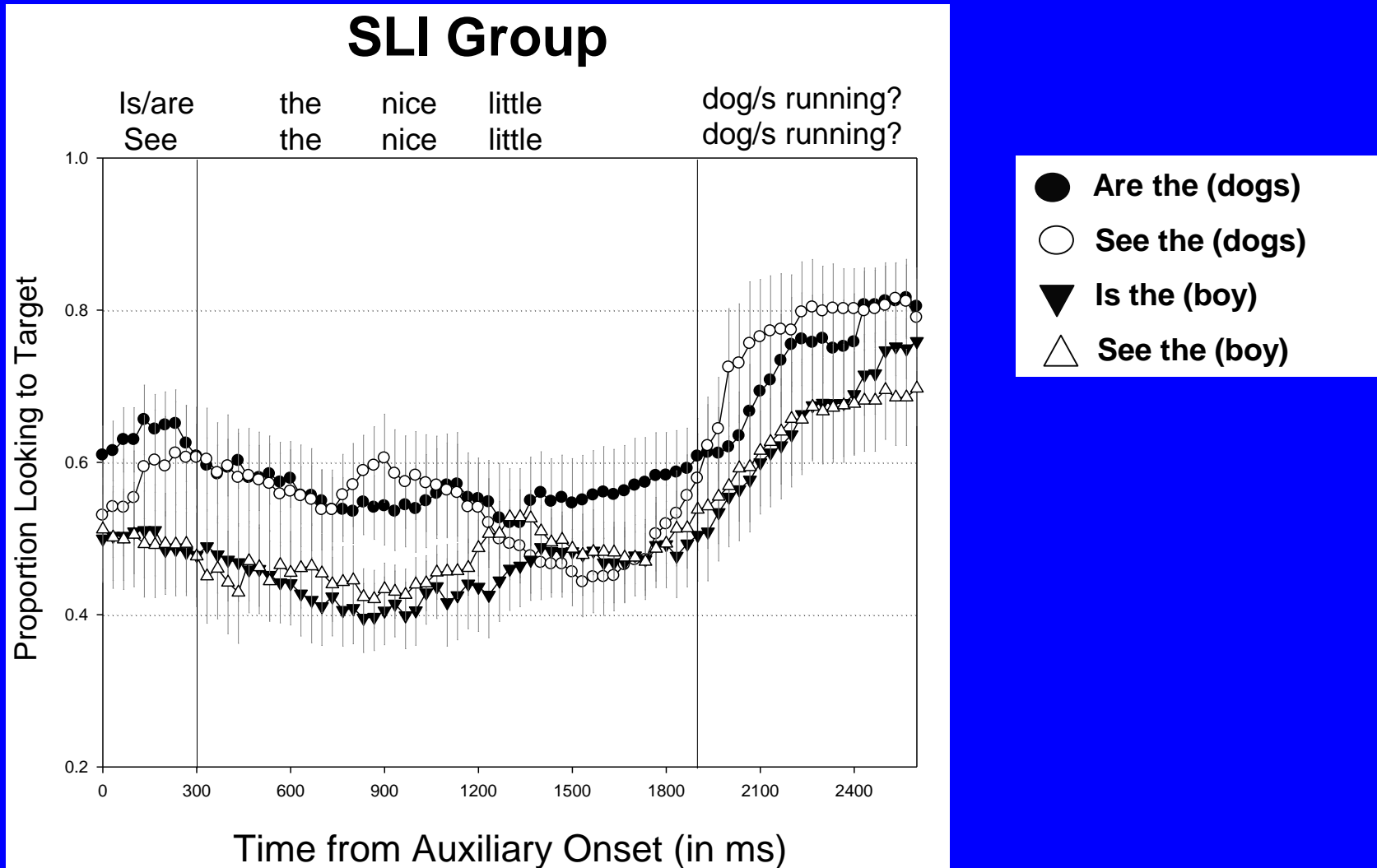
Participants

Group	Age	Celf-P2 Sentence Structure subtest (raw)	Aux IS production	Aux ARE production
SLI (11)	4;10	15.3	59%	61%
TD-Comp (11)	3;6	14.7	95%	98%
TD-Age (13)	4;11	18.4	99%	98%

Results



Results



If children learn that subject-verb sequences appearing later in a sentence are constrained by verbs appearing earlier in the sentence, will this facilitate their tense/agreement use?

The Treatment Study

Fey, Leonard, Bredin-Oja, & Deevy (2017)

N = 20 children with DLD/SLI randomly assigned to a “competing sources of input” (CSI) group or a “traditional” (Trad) group. Treatment = 16 weeks.

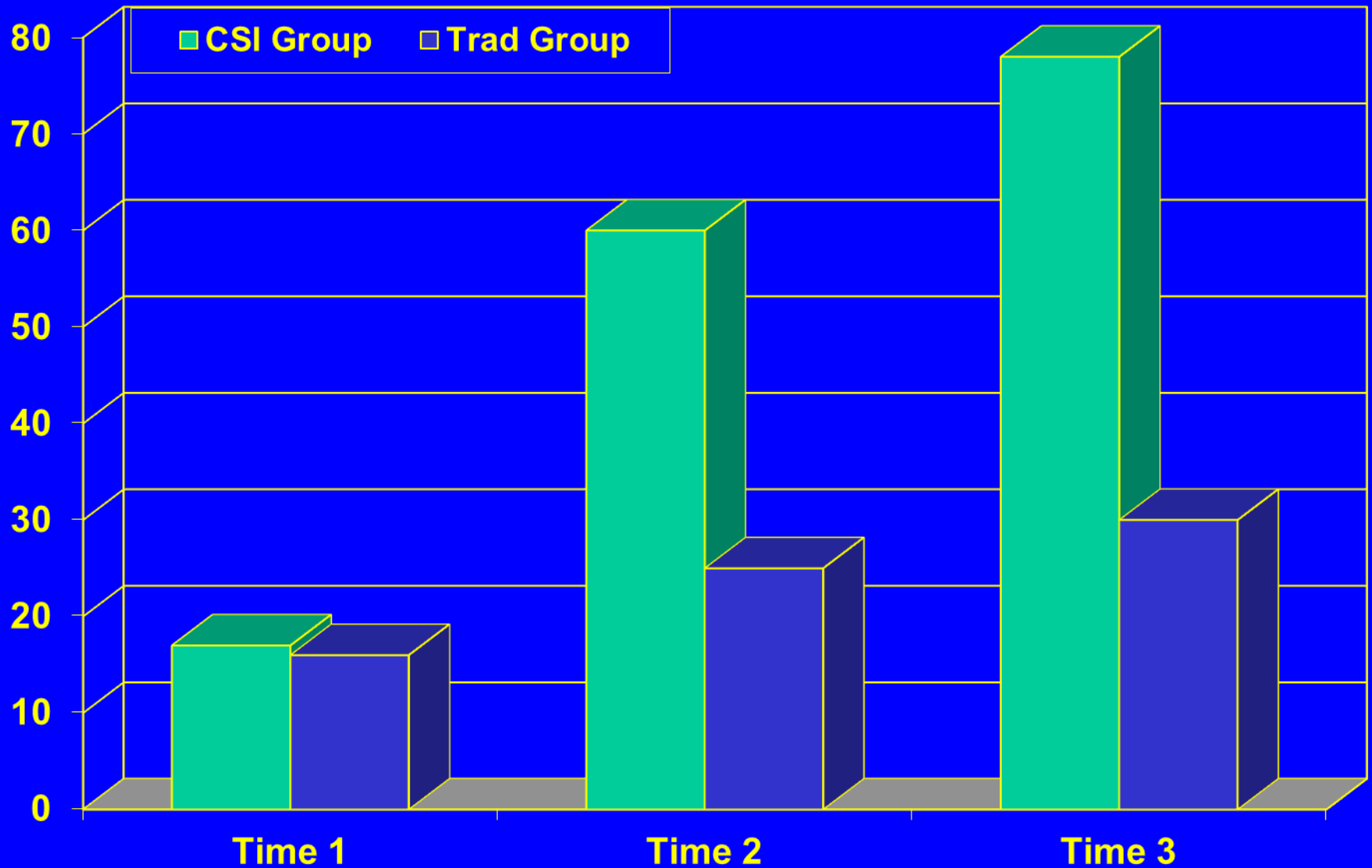
Age at Time 1: CSI = 46 months, Trad = 45 months

**Auxiliary *is* use at Time 1: CSI = 15%,
Trad = 15%**

CSI Versus Trad Sessions

- **Comprehension:** CSI: Is/Was the boy building a tower? Is/Was the girl climbing a ladder? Trad: Is the boy/girl building a tower? Was the boy/girl climbing a ladder?
- **Story:** CSI: 12 declaratives with auxiliary *is* Trad: 6 declaratives with auxiliary *is* and 6 yes-no questions with auxiliary *is*
- **Recasts:** CSI: 12 declaratives with auxiliary *is* Trad: 6 declaratives with auxiliary *is* and 6 yes-no questions with auxiliary *is*

Percentage Use of Auxiliary *is* in Obligatory Contexts



Summary: Can the Three Approaches be Integrated?

YES

- “Competing Sources of Input” = Tense/agreement in simple declarative sentences; avoid subject-nonfinite verb sequences in questions and complex sentences. Taught separately: Structural ties between forms appearing early in the sentence (e.g., *Is*) and those appearing later (e.g., *the girl climbing a ladder?*)
- “Input Informativeness” = Overt tense/agreement forms; declarative sentences preferred; nouns in subject position; subject-nonfinite verb sequences (e.g., “*We heard the boy sing*”) avoided because no overt tense/agreement
- “High Variability” = Many unique verbs (e.g., 24) used for each tense/agreement morpheme

THANK YOU

Key References

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Applications to Dutch?

- Overt tense: second person singular present tense (-*t*)
- Overt tense: third person singular present tense (-*t*)
- Overt tense: past tense (-*de/-te*, -*den/-ten*)
- Context dependent: plural forms in present tense (-*en*) vs. infinitive (-*en*)
- Input Informativeness: Both “*The girls run*” and “*We see the girls run*” are avoided
- Competing Sources of Input: “*The boy sings*” and “*We hear the boy sing*” are competitors (therefore, the latter is avoided)

Applications to Dutch? (continued)

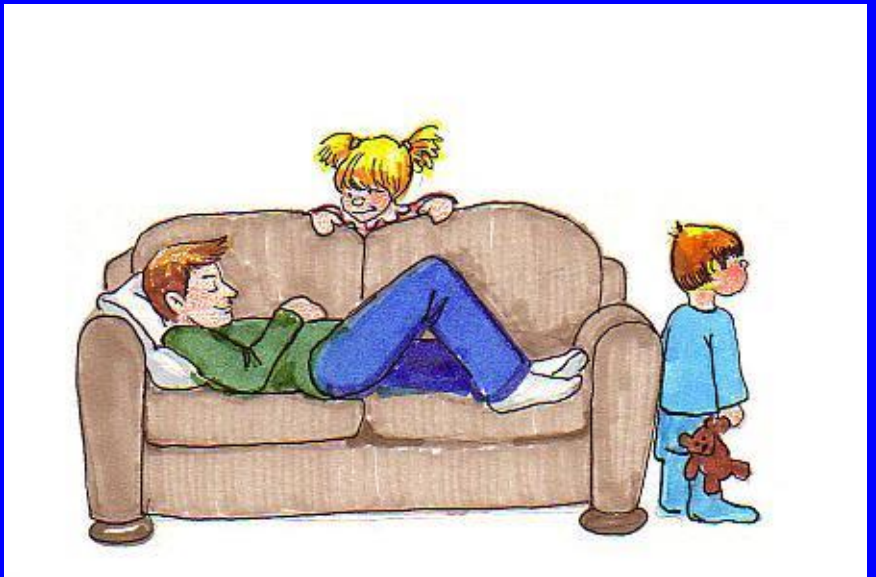
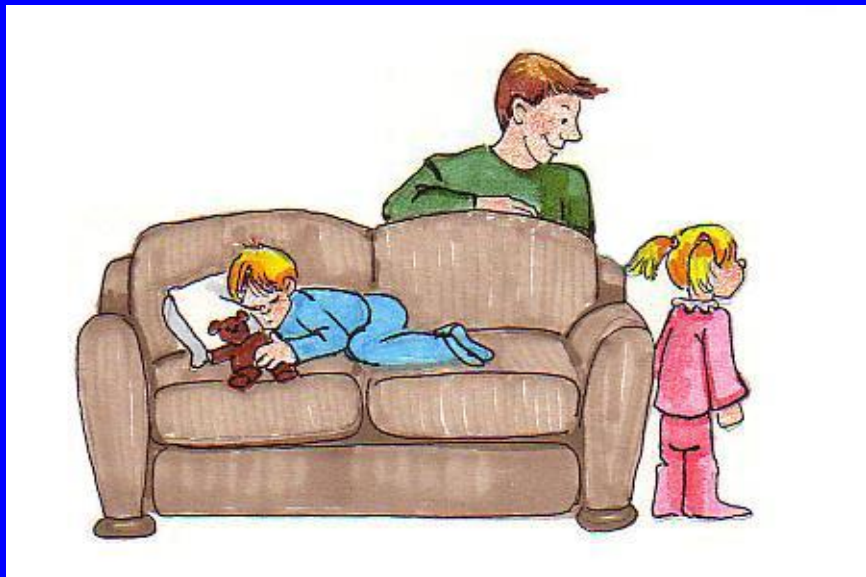
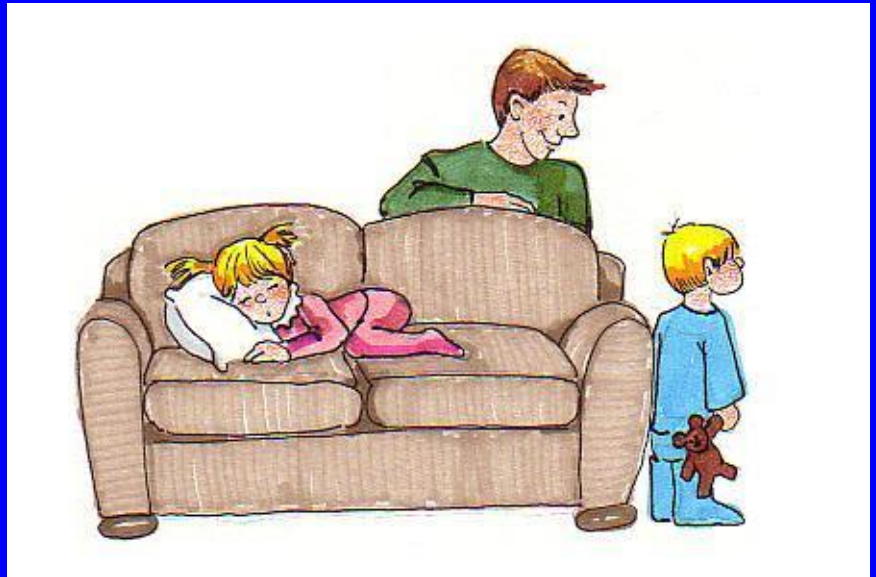
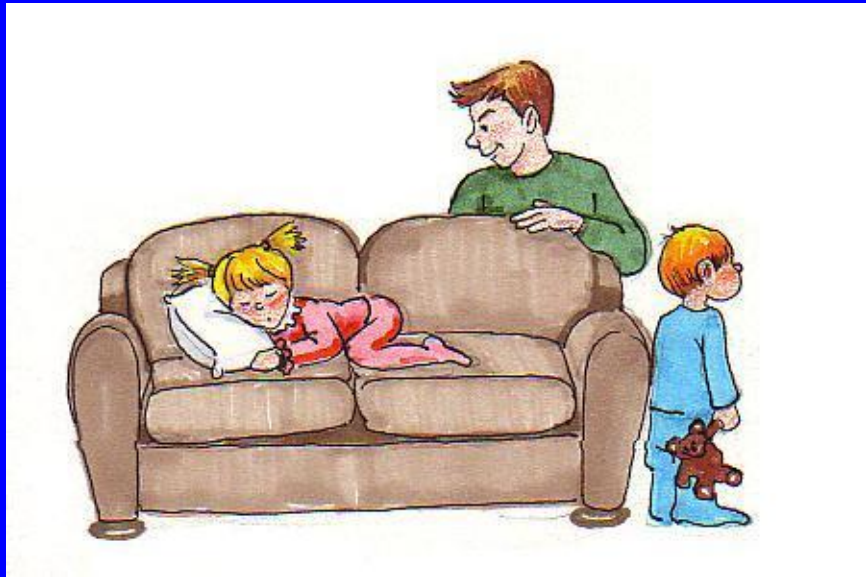
- In Dutch, could first person singular be the source of children's bare stems in second and third person contexts?
- Input Informativeness: “zero-marked” forms (e.g., *I like*, *I need*) are avoided because they decrease the proportion of overt tense/agreement forms in the input
- In Dutch, could the (bare-stem) form of second person in Verb + Subject contexts be a source of bare-stem errors in other contexts?
- Competing Sources of Input: Children may not appreciate sentence context differences (e.g., “*Did the boy run*” → “*The boy run*”)

Is the inappropriate extraction and use of nonfinite subject-verb sequences related to comprehension difficulty with the larger structures?

Example:

The dad sees the girl sleeping

(Leonard & Deevy, 2011; Souto et al., 2016)



Comprehension Study 1

(Leonard & Deevy, 2011)

DLD/SLI group (age 5;0, % use *is* = 30%)

TD-Comp group (age 3;7, % use *is* = 81%)

(matched according to general sentence comprehension test score)

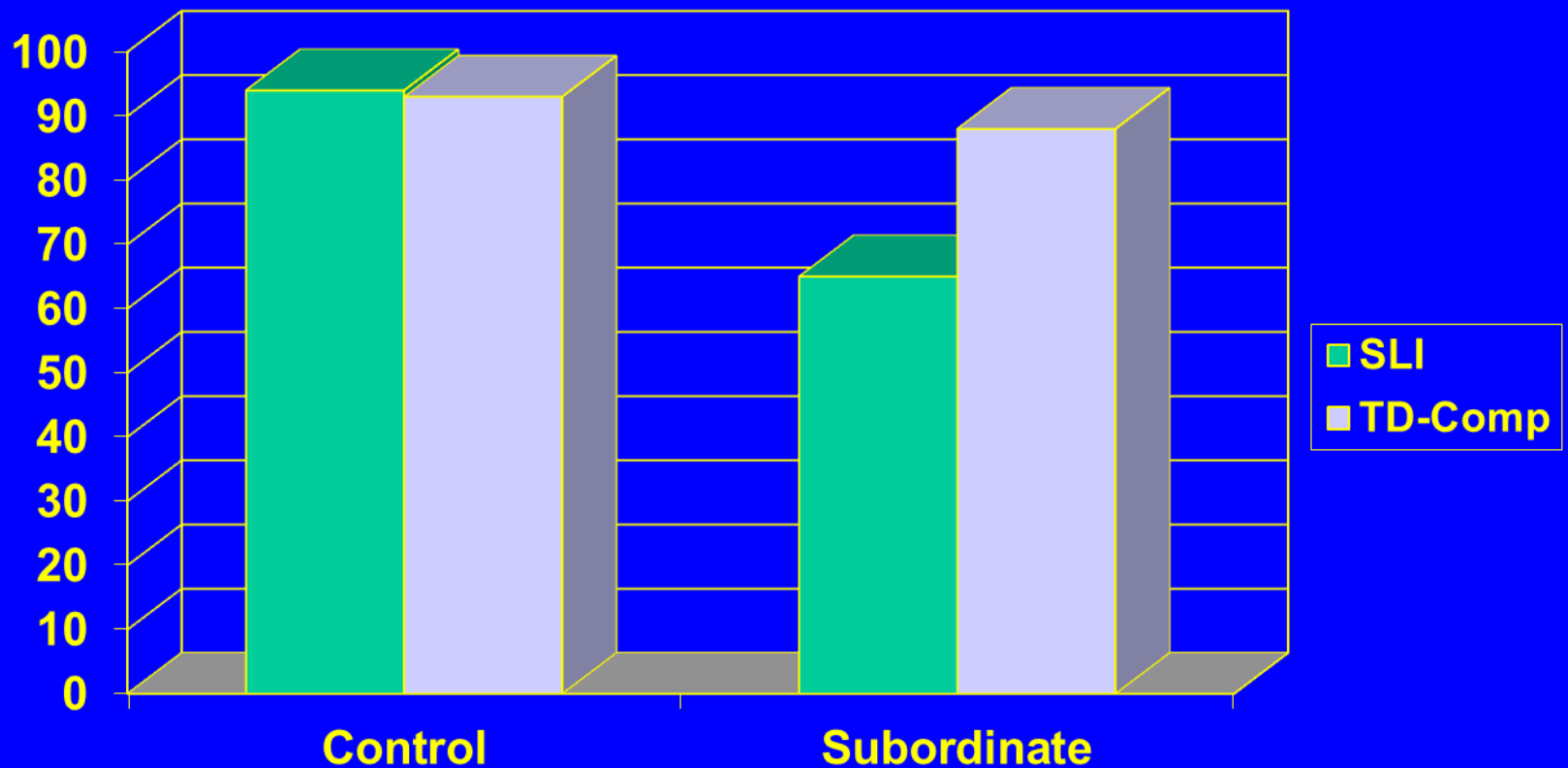
Example of Target Sentence:

The dad sees the girl sleeping

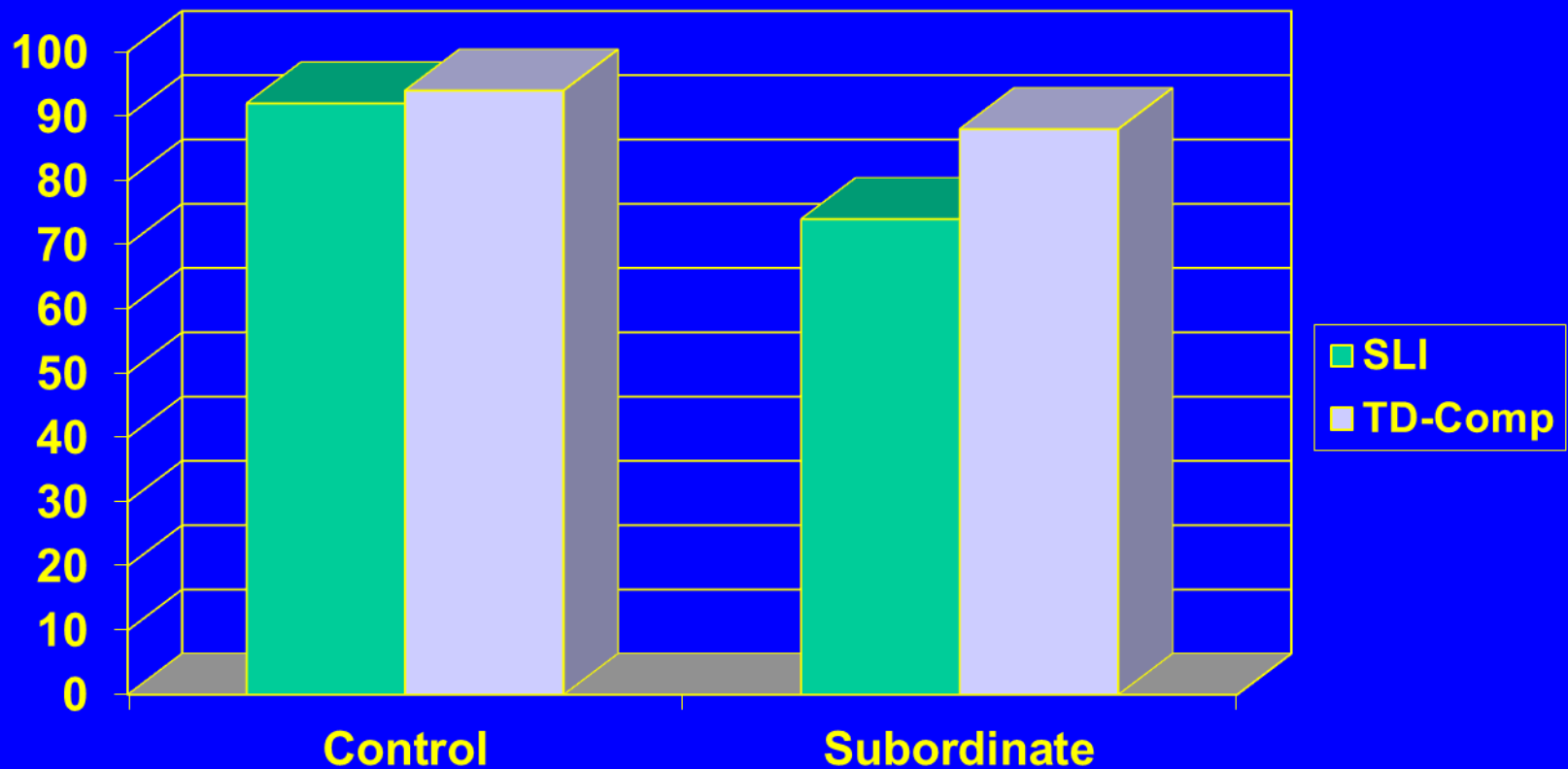
Example of Control Sentences:

The girl is sleeping; The dad sees the girl

Percentage Correct on Control and Subordinate Clause Comprehension Items (Leonard & Deevy, 2011)



Percentage Correct on Control and Subordinate Clause Comprehension Items (Souto, Leonard, Deevy, Fey, & Bredin-Oja, 2016)



The dad sees the girl sleeping

The dad sees the girl sleeping

The dad sees her sleeping

The dad sees the girl sleeping

The dad sees her sleeping



Her sleeping

The dad sees the girl sleeping

The dad sees her sleeping



Her sleeping

She sleeping

Her sleeping

Is she sleeping?



She sleeping

Will children with DLD/SLI produce novel verbs in nonfinite form or with tense/agreement depending on how these verbs appear in the input?

Novel Verb Learning Study 1:

From Leonard & Deevy (2011):

DLD/SLI group (age 5;1, % use of *is* = 54%)

TD-A group (age 5;1, % use of *is* = 95%)

5 novel verbs were presented
exclusively in nonfinite form, as in:

We saw the dog pagging

And 5 novel verbs were presented
exclusively with auxiliary *was*, as
in:

Just now the bird was channing

Following the presentations of each novel verb, probe items were presented that obligated use of auxiliary *is* (i.e., “What’s happening here?”). For example:

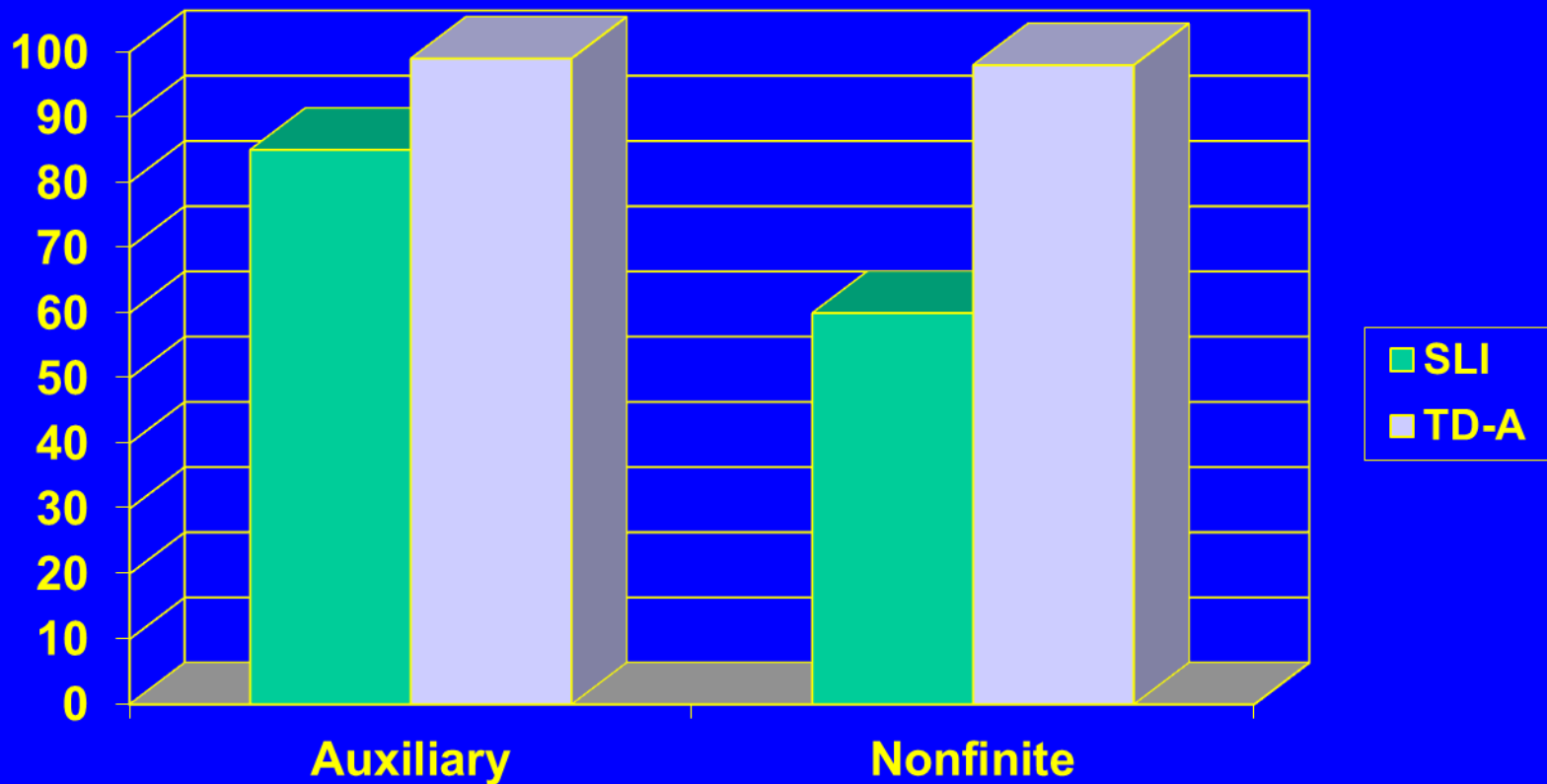
Presented: *The bird was channing*

Probes: *The cat is channing*

Presented: *We saw the dog pagging*

Probes: *The cow is pagging*

Effect of Input Condition: Percentage Use of *is* in Probes



Input Informativeness: Toy Talk 4

- In English, it is better to avoid questions in second person, because they are often shortened.
- *Are you going to open it → You going to open it?*
- *Do you like milk? → You like milk?*
- When questions are shortened in this way, they contain no overt tense/agreement forms
- Questions in third person are rarely shortened in English and are permissible though not ideal.

High Variability: Application 2

- Even with a diverse set of verbs, care should be taken to use a wide range of sentence subjects:
- *The girl runs, She plays, The monkey sees, The horse jumps, etc.*
- Consider the alternative:
- *She runs, She jumps, She plays, She sees, etc.*
- In this case, the child might learn instead the rule *she* + Verb + *s*, and therefore use Verb + *s* only with *she*.

From Redmond & Rice (2001):
Most judgments of grammaticality
by children with SLI were in
keeping with predictions.
However, sentences such as *He
made the robot fell into the pool*
were often accepted, contrary to
expectations. Note the sequence
[the robot fell into the pool]

From Fey & Loeb (2002):
Treatment using recasting was uncharacteristically ineffective when teaching auxiliary *is* through questions, as in *Is Daddy driving the truck?* Note that sequences such as [*Daddy driving the truck*] are those proposed to be a source of nonfinite utterances

Adult Italian:

“Can [Cristina drink coffee]?”

Può [Cristina bere caffè]?

AND

Può bere caffè Cristina?

Cristina può bere caffè?

Adult Italian:

“I make [Cristina drink coffee]”

Faccio bere caffè a Cristina

(I make drink coffee to Cristina)

“I make [her drink coffee]”

Le faccio bere caffè

(To her I make drink coffee”)

The Modal Hypothesis: Why is the evidence from English weaker than the evidence from other Germanic languages?

English:

Can [Kristina drink coffee]?

Does [Kristina drink coffee]?

Swedish:

Kan [Kristina dricka kaffe]?

There is extensive evidence of working memory limitations in SLI. Although the proposal does not hinge on an assumption of working memory limitations, any such limitations are surely likely to render sentence interpretation more difficult.

Who is [the happy brown dog washing x]?



From Deevy & Leonard (2004): If children with SLI must hold the wh-phrase in memory for a longer sequence of words before the syntactic position to which it is related can be identified, comprehension is much poorer than in younger typically developing children.

“The man drinks beer”

Dutch error:

De man bier drinken

= The man beer drink

Correct: De man drinkt bier

Adult Dutch:

Kan [de man bier drinken]?

Can [the man beer drink]?

*Is the boy playing basketball?
The boy is playing basketball.*

*Does the boy play basketball?
The boy plays basketball*

It appears that a different structure is needed to facilitate use of third person singular –s (see Next Steps!)

Next Steps

- Treatment design with other contrasts as targets, as in *We hear the boy play his guitar versus We think the boy plays his guitar*
- Treatment designs using interrogative plus emphatic utterances, as in *Does the girl like ice cream? Yes, she does like ice cream; she likes ice cream*
- Determine whether similar input effects relate to word order errors in Germanic languages

