

# How to Set the Compounding Parameter

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## 1. Overview

A central question in generative linguistics is how children set the parameters of grammatical variation. Here I will begin by reviewing some relevant evidence from the time course of language acquisition, and by considering several approaches to parameter setting that are compatible with this evidence. Next I will turn to the specific case of the Compounding Parameter (TCP), where I will review what we know about children's method of setting TCP in English and Japanese. After briefly discussing some broader implications of what we know at present, I will describe two new research strategies that I hope will lead to future advances.

## 2. Parameter setting in children

The time course of child language acquisition can be a rich source of evidence about what the child is acquiring, and how it is acquired. Existing findings in this domain have a number of important implications. Arguably the most important is that, at least in certain cases, what the child acquires can be described as the setting of an abstract parameter. In these cases we see relatively abrupt, coordinated changes affecting multiple, distinct grammatical structures.

For example, in a multi-child (N=12) study of English dative constructions, Snyder & Stromswold (1997) estimated the age of acquisition of a given structure by finding the age of 'first clear use, followed soon after by regular use' in a longitudinal corpus of spontaneous-speech samples from each child. The absolute ages varied substantially across children, but the pattern did not: in every child examined, double object datives (e.g. *I sent Mom a picture*) were acquired at approximately the same age as *make*-causatives (*I'll make him eat it*), perceptual reports (*I saw him leave*), *put*-locatives (*He put it on the table*), and V-DP-Particle combinations (*I threw the apple away*).

Moreover, the double object datives reliably appeared at an age *less than or equal to* the age for prepositional *to*-datives (*I sent a picture to Mom*); and the V-DP-Particle combinations reliably appeared at an age *less than or equal to* the age for V-Particle-DP combinations (*I threw away the apple*). Acquisition of *to*-datives was relatively independent of acquiring *to* as a directional preposition (where it can be paraphrased by *towards*), but was tightly correlated with acquiring *to* as a marker of dative case (e.g. *That one belongs to me / What happened to him?*). In all cases, the children passed rapidly from never using a given structure, to using it regularly and with a minimum of errors. Where errors did occur, they were almost always errors of omission, rather than commission.

These patterns were not well explained by frequencies of use, in either the child's speech or the parents'. Yet, they did make sense in terms of a child selecting values for grammatical parameters, especially the parameters (whatever their precise nature might be) that determine the availability of accusative case and dative case in English. The observed sequence of acquisition for the various

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surface structures could then be explained in terms of "parametric prerequisites" (i.e. the non-default parameter settings that are necessary for each of the structures).<sup>1</sup>

Turning to acquisitional mechanisms, an important finding is that children are clearly not engaged in simple trial-and-error learning: if they were, they would necessarily make many types of commission errors that almost never occur (e.g. Maratsos 1998, Snyder 2007).<sup>2</sup> The evidence from spontaneous speech instead indicates that children are largely "deterministic" learners (cf. Berwick 1985): they seldom (if ever) adopt an incorrect grammatical choice, and then backtrack from it. Instead they work "underground" (to borrow a term from Maratsos), and wait until they understand the relevant points of the target grammar, before they begin to make productive use of a new grammatical structure.

During a period when the child is still working underground, and does not yet have the grammatical means to express a given idea efficiently, several things can happen in the child's spontaneous speech. In some cases the child will use a circumlocution. Other times the child will express the intended meaning using an utterance that simply omits key portions of the target structure (i.e. the portions about which the child is still undecided). Yet, it can also happen that a specific meaning is simply "ineffable" for a time. For example, Sugisaki & Snyder (2006) examined longitudinal corpora from ten children acquiring English, and found that six of them had a dramatic gap between the onset of direct-object questions and the onset of prepositional questions ('P-questions', e.g. 'What did you put the box on \_\_\_?'). For a period ranging from 2.2 months to 9.0 months (mean 4.9), these six children were routinely producing direct-object questions, and also the declarative counterparts to P-questions (i.e. sentences in which the main verb took a PP complement), but were never producing P-questions. Moreover, when P-questions finally did begin to appear, they were used almost as frequently as direct-object questions, and they were consistently adult-like from the outset.

The finding that a child can experience a protracted period of ineffability, followed almost immediately by the onset of adult-like production, has major implications for the theory of grammar. A proposed grammatical formalism is automatically ruled out, unless it somehow permits the child to add new structures incrementally; and unless it permits the child to be confident (at some point) that a particular grammatical choice is the correct one, even though other grammatical choices remain undecided.

Hence, broadly speaking, the acquisitional evidence summarized in this section indicates three major characteristics that are required in a successful model of grammar acquisition: (i) a change in the grammar can be incrementally additive, in the sense of monotonically enlarging the set of permitted structures; (ii) a change can be parametric, in the sense of adding multiple structures in a single step; and (iii) most (if not all) changes are deterministic, in the sense that children show little if any evidence of backtracking.

### 3. Compatible formats and mechanisms

Strictly speaking, characteristics (i) and (ii) concern the format in which a grammar is specified, while characteristic (iii) is a property of the algorithm used to select a grammar. This distinction is an important one, although in practice the format and the algorithm may be interdependent. Note that a grammatical format satisfying both (i) and (ii) will (more or less by definition) be a system of 'subset parameters', in the sense of Wexler & Manzini (1987). Note too that a non-subset parameter can often be converted fairly readily into a pair of subset parameters, with similar but non-identical empirical

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<sup>1</sup> This approach is an updated version of Brown & Hanlon's (1970) notion of 'cumulative complexity': If the (late-acquired) prerequisites for two surface structures are the same, we should expect concurrent acquisition; and if the (late-acquired) prerequisites stand in a subset-superset relation, we should expect an ordered ('less than or equal to') pattern of acquisition. The qualifier "late-acquired" is necessary because the parametric basis for two distinct structures (e.g. *put*-locatives, V-DP-Particle) is seldom identical, but it can easily happen that most of the parameter settings relevant to either structure are acquired fairly early, and that the final prerequisite (i.e. the 'limiting factor') for the two structures is the same.

<sup>2</sup> This is not to say that children never make commission errors, but rather that the few types of commission errors they make routinely (e.g. optional infinitives, inflectional overregularization) belong to a tiny subset of the logical possibilities.

coverage. For example, the Head Parameter, understood as a syntactic parameter that specifies a general left-right order for a head relative to its complement, is a non-subset parameter, because the set of surface forms allowed by a head-initial grammar is neither a subset nor a superset of the forms allowed by a head-final grammar. Yet, one can readily convert the Head Parameter into a pair of subset parameters, one that (dis)allows head-initial structures, and another that (dis)allows head-final structures. This yields a grammar that allows all the situations permitted under the Head Parameter, plus two more: one where both orders of head and complement are allowed, and another where neither order is allowed.

As discussed in Snyder (2007:181), one might try to account for the one-word ("holophrastic") stage in toddlers by saying that at that point, the child still has both these parameters set to 'off', and that multiword utterances are therefore excluded. Whether there are any languages (or acquisitional stages) in which both parameters are set to 'on', thereby allowing both head-initial and head-final orders as base-generated options, is unclear to me. If not, one might consider the possibility that UG simply excludes some of the logically possible combinations of parameter settings, and that this is one of them.

An interesting implementation of subset parameters can be found in Fodor (1998) and Lightfoot (1999). Fodor expresses the idea in terms of 'treelets', where a treelet is a contiguous subgraph of the tree diagram for a well-formed sentence, as it would appear at the point of spell-out. The idea is that syntactic variation can in principle be expressed in terms of the (un)availability of each option within a UG-supplied set of potential treelets.<sup>3</sup> Moreover, treelets can be used directly as the "building blocks" of structural representations during language comprehension and production. By distinguishing between structurally ambiguous versus unambiguous parses during comprehension, the parser can provide highly reliable information that a given treelet must be allowed in the target language: this will be true whenever the treelet was part of an unambiguous parse.

Fodor calls this approach to parameter-setting the Structural Triggers Learner (STL) algorithm. In computer simulations that Fodor has conducted in collaboration with William Sakas, STL reportedly often requires something additional (e.g. Sakas & Fodor's 2012 'conditioned triggers') in order to reach a point where unambiguous parses begin to occur with any frequency. Nonetheless, to the extent that STL can be made to work, the combination of a 'treelet' format for expressing syntactic variation, and the STL procedure for identifying the target grammar in terms of this format, offers an approach that is both incrementally additive and deterministic.<sup>4</sup>

A concern, however, is whether treelets in themselves provide sufficient expressive power to handle more abstract points of parametric variation. For example it seems *prima facie* that the Snyder-Stromswold findings will call for a treelet that is present only in selected languages, and that is a necessary component of English *put*-locatives, V-DP-Particle combinations, *make-causatives*, perceptual reports, double object datives, V-Particle-DP combinations, and *to*-datives, but that is probably unnecessary in other types of VP. Whether the existence of such a treelet is plausible is difficult for me to judge, but the fact that there is not to my knowledge any single (overt) word of English that can occur in all of, and only, these structures suggests to me that even constructing a "candidate" treelet will be difficult.

A variant of Fodor's model could fare better on abstract parameters of the sort that seem to be needed here, but at a cost. The idea would be to posit both treelets and abstract parameters, and to link treelets to specific parameter-settings. This could easily give rise to principled, implicational relationships among structurally distinct treelets, of a type that could possibly relate the various structures in the Snyder-Stromswold findings, for example. The trouble is that the form of any given treelet would probably end up varying quite a bit, as a function of multiple, independent parameter-settings. The result could be that a treelet involved in an unambiguous parse of a double object dative, for example, would implicate a treelet involved in a *make-causative*, but the learner

<sup>3</sup> Lightfoot (1999) makes a very similar point about "cues," which he takes to be quite similar to treelets.

<sup>4</sup> Here I am assuming that the learner produces an utterance by building a (potentially incomplete) structure, using only those treelets that have been confirmed in an unambiguous parse. If so, the learner's structural repertoire will grow incrementally and deterministically until it reaches the adult state.

would not know which version of the causative treelet should be adopted unless she already knew the settings of many additional parameters.

A very different approach, based on the idea of an innately specified 'learning path', can be found in Dresher (1998) (a follow-up to Dresher & Kaye 1990).<sup>5</sup> The key motivation for this approach is the fact that interdependencies between parameter settings can lead to enormous learnability problems. The problems are greatly reduced if the learner knows which parameter to set first. In fact, the problems can be eliminated altogether if the learner knows exactly what to look for, at each possible point in the path; and depending on the result, knows exactly where to go next.

Dresher focuses on how a learner could possibly identify the correct settings for a set of (12) major parameters of metrical phonology. His solution is to tell the learner which parameter to set first, and to provide a procedure that the learner can follow to identify the correct value of that parameter. The procedure might involve collecting a sample of some minimum number of words with a particular set of properties, for example, and provide instructions on, say, how to test the sample for quantity sensitivity. Depending on the answer, the learner will be directed to another parameter to tackle next, and once again will be supplied with a procedure to follow.

The learning path is effectively a decision tree, and in principle every decision can take into account the results of every previous decision, because the decision tree can be set up in such a way that one's location in the tree is always uniquely associated with a single path through the tree up to that point. In practice, however, this would rapidly lead to a combinatorial explosion:  $2^n$  distinct loci in the tree, where  $n$  is the number of binary decisions up to the present moment. The potential for this type of explosion can be eliminated by breaking the learning path into a number of independent paths, each of which is reasonably short. Then a learner could even work through a number of separate paths in parallel.<sup>6</sup>

Dresher's model guarantees deterministic learning, and is fully compatible with parametric learning, but does nothing to guarantee incremental additivity. Yet the general mechanism of a learning path is compatible with a vast array of representational formats for grammatical knowledge, and a suitable choice will ensure incremental additivity. For example, one could associate arriving at a particular point in the learning path with adding a specific treelet to one's inventory. Alternatively, one could choose a format that directly accommodates parameters of a more abstract nature. For example, any version of "constructive parameters," in the sense of Snyder (2011), should work: that is, any system in which setting a parameter to a marked value corresponds to adding a new structure-building operation to the learner's repertoire. This could mean an operation that adds a treelet-like block of structure, but it could also mean an operation that provides a new rule for semantic composition, and thereby increases the set of grammatically well-formed <sentence, meaning> pairs. Or it could mean the addition of a new element like Harley's (2002)  $P_{HAVE}$  to the set of "abstract words" that are allowed to occur in a syntactic numeration. On Harley's assumptions, a language will not permit any surface structure in which a 'possessor' DP c-commands a 'possession' DP (e.g. a double object dative construction), unless  $P_{HAVE}$  is available.

An interesting difference between learning paths and STL (at least if we stick to the basic version of STL, with nothing to add extrinsic implications between treelets) is that whenever STL adds a treelet to the learner's repertoire, it means that a particular substructure was instantiated in the input, and that that same substructure is now available for the learner to use in production. The learning-path

<sup>5</sup> I believe the term 'learning path' originated in Lightfoot (1989). Lightfoot (2006) discusses the fact that it would be entirely possible (and useful) to combine proposals from Dresher (1998) and Fodor (1998) with proposals from his own work. This seems correct, given that all three authors are developing approaches that are (to varying degrees) incremental, parametric, and deterministic. Also, note that the idea of innately specified learning paths is taken up and developed, along slightly different lines, in Baker (2001).

<sup>6</sup> Note that different versions of the learning path idea make distinct, testable predictions. For example, if the child follows a single "master path," rather than a set of shorter "mini-paths," then we should find that children who are all acquiring the same target language will all set their parameters in exactly the same order - even when there is no apparent reason for it (such as an intrinsic dependency of one decision on the other). This prediction would not be a necessary consequence of the mini-path version, although it is still logically possible that a mini-path too would impose some otherwise unnecessary ordering of decisions, and if so, the effect should be detectable.

approach requires nothing of the sort. Not only can a substructure that was instantiated in the input fail to appear in the learner's productive repertoire (as can also happen in STL), but a substructure that has never occurred in the input can readily become part of the learner's repertoire. All it takes is a statement at a certain point in the learning path that tells the learner to add it.

#### 4. Case study: The Compounding Parameter (TCP)

In this section I will briefly review TCP (Snyder 1995 et seq.), which provides an especially clear case study of parameter setting during child language acquisition. For present purposes, the essential information is the following. TCP is an abstract grammatical parameter, probably linked to the syntax-semantics interface (Snyder 2012). Its positive setting, [+TCP], is a necessary condition (or 'prerequisite') for creative, endocentric nominal compounding (NNCs). By "creative" I mean that the language allows new compounds, e.g. *faculty lab space committee*, to be created freely when they are needed, and to be interpreted flexibly, in a way that fits the discourse context.

The [+TCP] setting is also a prerequisite for adjectival resultatives ('A-resultatives', e.g. *sand the wood smooth*, *wipe the table clean*), and for separable directional particles (e.g. *rip the lid off*). To date, all languages identified as [+TCP] on the basis of NNCs have also allowed adjectival resultatives, but only a proper subset of these languages have allowed separable particles. (See Table 1.) All languages allowing A-resultatives and/or separable particles have allowed NNCs.

<b>(Family) Language</b>	<b>Separable particles?</b>	<b>Adjectival resultatives?</b>	<b>Creative N-N compounding?</b>
<i>(Austroasiatic)</i> Khmer	Yes	Yes	Yes
<i>(Finno-Ugric)</i> Estonian	Yes	Yes	Yes
<i>(Germanic)</i> Dutch	Yes	Yes	Yes
<i>(Sino-Tibetan)</i> Mandarin	Yes	Yes	Yes
<i>(Tai-Kadai)</i> Thai	Yes	Yes	Yes
<i>(Japonic)</i> <b>Japanese</b>	<b>No</b>	Yes	<b>Yes</b>
<i>(LSF Family)</i> ASL	No	Yes	Yes
<i>(Language Isolate)</i> Basque	No	No	No
<i>(Afroasiatic)</i> Egyptian Arabic	No	No	No
<i>(Austronesian)</i> Javanese	No	No	No
<i>(Romance)</i> Spanish	No	No	No
<i>(Slavic)</i> Serbo-Croatian	No	No	No

Table 1. Summary of cross-linguistic survey (as reported in Snyder 2012).

With respect to parameter setting, the following information will be relevant. First, in languages like English, separable directional particles are used with high frequency. They are also highly distinctive, in the sense that [-TCP] languages often have difficulty constructing anything directly comparable. Hence, particles look like they would provide a highly effective trigger for children acquiring a [+TCP] language. Other potential triggers exist, but occur less frequently.

In contrast to English, Japanese lacks anything like separable directional particles (e.g. Snyder 2012). Candidate triggers for [+TCP] in Japanese appear to be limited to A-resultatives and one other possibility, recursive N-N compounds.<sup>7</sup> Both A-resultatives and recursive NNCs appear to be somewhat infrequent in child-directed Japanese.

Regarding the relationship between a given parameter-setting and the "triggering" evidence that leads a child to adopt that setting, one of the logical possibilities is that there is always a single surface form that is the designated trigger. In the case of TCP, however, there are two findings that make this possibility appear unlikely.

First, in children acquiring English, there is evidence suggesting that separable directional particles are the primary trigger – even though they are unavailable in Japanese. If the English-learning child were relying on one of the potential triggers that is also available in Japanese (namely A-resultatives or recursive NNCs), we might expect to see some of them going through a clear-cut "Japanese" stage, in which novel compounding is present for a noticeable period of time when V-NP-Particle structures are still absent. (This stage would be expected to end at the point when the child finally acquired whatever additional properties enable English to have particles.) Yet, this is not what we find. If we examine longitudinal corpora of spontaneous speech, and estimate the age of acquisition of a structure by finding the age of 'first clear use, followed soon after by regular use' (FRU), we find that the age of FRU for novel compounding is tightly correlated with age of FRU for V-NP-Particle. In fact, the best-fit line is very nearly an identity function (Figure 1).

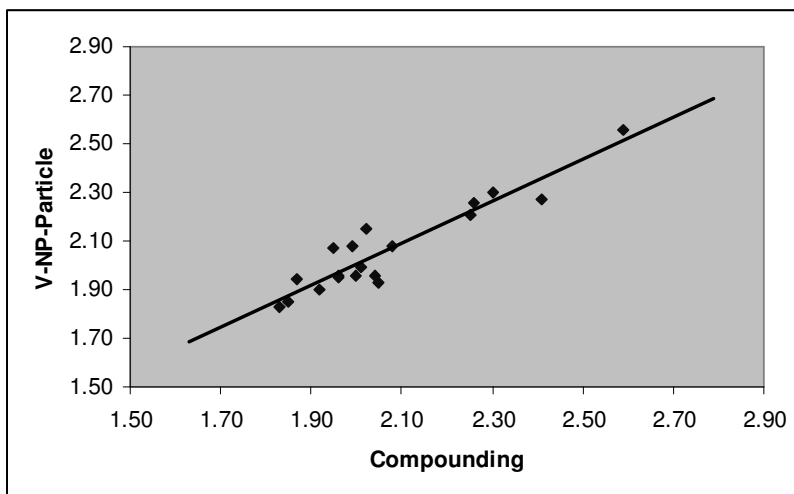


Figure 1. Ages (in years) of FRUs,  $N=19$  ( $r = .937$ ,  $t(17)=11.1$ ,  $p<.001$ ; cf. Snyder 2007)

<sup>7</sup> An example of a recursive NNC in English would be the following:

- (i) [N [N [N peanut] [N butter] ] [N sandwich] ]

As first noted by Namiki (1994), the generalization (at least to a very good approximation) is that a language has creative nominal compounding if and only if it has recursive nominal compounds. (For a proposal that children rely on evidence of recursion much more broadly, as a way to identify the genuinely grammar-based processes in their target language, see Roeper & Snyder 2004.)

Second, if children had a single, designated trigger for [+TCP], then even allowing for some modest variation in the trigger's input frequency, we might expect the distribution of ages for the FRU to be broadly similar across languages. Yet, this is not what we find. As illustrated in Figure 1, all of the 19 English-learning children examined in Snyder (2007) were making regular use of novel compounding well before age three, and many were doing so before age two. In contrast, when Sugisaki & Isobe (2000) used elicited production to test a sample of 20 children acquiring Japanese, they found children as old as 4;11 who were not yet fully adult-like on novel compounding. Their sample ranged in age from 3;04 to 4;11 (median: 4:02), and fully 8 of the 20 were judged to be non-adult-like. These 8 spanned the full age-range from 3;04 to 4;11, with a median age of 3;10. Hence, even allowing for effects of the differences in methodology, the distribution of ages for the onset of novel compounding in Japanese appears to be "shifted" at least a year later than it is in English.

If this is correct, it means that at least one parameter of UG, namely TCP, has a specific setting ('+') that is acquired on the basis of entirely different triggers in different languages. In terms of the learning-path approach, this result indicates that we need to allow for the existence of two entirely different paths through the decision tree that arrive at exactly the same parametric choice: perhaps a path invoking a test for discontinuous V-(DP)-Particle combinations (which is traversed by children acquiring English), and another path that combines syntactic and semantic evidence to identify A-resultatives (traversed by children acquiring Japanese).

In terms of a treelet-based approach, the result indicates that it will probably be insufficient to adopt what might be considered the simplest version of the model, where the parameters are merely the availability, or not, of a particular treelet, and where each treelet contains a large enough segment of tree structure that it can only occur in a limited range of possible sentence-types (and hence, can readily be part of an unambiguous parse). The difficulty once again is finding something abstract enough to link compounds, particles and A-resultatives. As discussed earlier, one way to accomplish this would be to postulate extrinsic, implicational relationships between different treelets, perhaps in terms of links to an abstract parameter, but this would have to overcome the problem noted earlier, namely that the precise form of the treelets getting linked would often need to vary as a function of multiple, interacting parameters.

Another possibility would be to liberalize our notion of what a treelet can be, and adjust the STL model accordingly. Recall that under STL, treelets are adopted by the learner on the basis of a successful, structurally unambiguous parse. Yet, at least as I understand it, the success of a parse is determined purely by its ability to account for the incoming sequence of constituents, regardless of whether it yields a compositional interpretation that is compatible with the context. If this understanding is correct, and if TCP is correctly taken as a parameter of the syntax-semantics interface, then a treelet that (somehow) expresses the positive setting of TCP might have no direct effect on the syntactic structure, and then might never be part of an unambiguous parse.

On the other hand, if we count a parse as successful only when it allows a compositional interpretation that is compatible with the discourse context, then it will become possible for a treelet expressing [+TCP] to be learnable by STL. This is because sentences from a [+TCP] language will sometimes receive a suitable interpretation only if the [+TCP] treelet is included in the parse. Under this scenario, we will obtain the right result from "STL proper": The triggering experience will be a successful, unambiguous parse of a sentence that includes the TCP treelet (whether the sentence uses this treelet in a recursive compound, particle, or resultative structure); and the result of this triggering experience will be to add that same TCP treelet to the inventory of available treelets.

## 5. Two novel research strategies

Strictly speaking, the findings discussed in the previous section should be considered preliminary, because there exist alternative interpretations that are currently difficult to rule out. First, as suggested above, the concurrent acquisition of particles and compounds in English might indicate that successful analysis of the English verb-particle is what tells the child that English is [+TCP], but another possibility also needs to be considered: it might instead be that all the prerequisites for English

particles, aside from [+TCP], are acquired very early (perhaps because particles are so frequent in the input). In that case [+TCP] would become the limiting factor for both particles and novel compounding, and the eventual trigger for [+TCP] might be whatever it is (A-resultatives, recursive NNCs) that triggers [+TCP] in Japanese.

Second, while the input frequencies for recursive NNCs and A-resultatives are low in English, it is conceivable that they are lower still in Japanese, and that this difference is sufficient to explain the difference in the typical ages of acquisition. A frequency difference of this kind could perhaps result from the fact that Japanese provides a competitor to recursive NNCs in the form of recursive, genitive-marked modifiers; and/or from the fact that A-resultatives are possible in a more limited set of cases in Japanese than in English. (Washio 1997 reports that direct counterparts to English "strong" resultatives, like "hammer the metal flat" and "dance your shoes threadbare," are rejected by a majority of the Japanese-speakers with whom he has consulted.)

Two new studies (on which I am collaborating with Letitia Naigles and Diane Lillo-Martin) represent new research strategies, and have the potential to address the concerns just mentioned. First, we are using the Intermodal Preferential Looking (IPL) paradigm to measure children's comprehension of novel compounds (e.g. "a hand chair," for a chair in the shape of a hand), and the same children's comprehension of directional particles (e.g. "She's kicking it in/out"). We expect to find that most children will either succeed on both or fail on both. Yet, if we can catch some children who are right at the point of going from non-adultlike to adultlike, we may see a third pattern. Specifically, if we are correct in thinking that children gradually work out the syntax of English particle constructions, and then suddenly get [+TCP] as a free by-product when they decide on the correct analysis, we might expect to find reasonably good comprehension of the particles in children who are "on the cusp" of acquiring them, but have not yet done so. These children should generally fail to understand novel compounds, however, because prior to actually adopting [+TCP], the compounds will presumably have to be treated as lexicalized forms (just as they are in [-TCP] languages like French and Spanish). If so, the child will have no way of using the grammar to derive an interpretation that fits the context. In sum, we are hoping that IPL might provide us with an especially fine-grained picture of acquisition, at a point when it is still in progress.

Second, when we are confident of our IPL materials, we will progress to a teaching study. The idea is to take a sample of English-acquiring children at the age of about 24 months, when relatively few children are using verb-particle combinations or novel compounds. Half of these children will receive enriched input relevant to particles, and the other half will receive matched input relevant to a different area of English grammar. On a post-test we hope to find a greater increase in comprehension of particles in the 'particle' group than the control group. If so, we also expect to find a greater increase in comprehension of novel compounds in the particle group than the control group - even though no training on compounds will be provided. Admittedly there are many technical challenges we still need to overcome, but if successful, the training methodology should be an excellent source of information about precisely what input the child uses to set TCP (or indeed any other parameter), and the cascade of grammatical consequences that follow.

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