

Children's acquisition of *but*

Learning dimensions of meaning: Children's acquisition of *but*

Barbora Skarabela, Nora Cuthbert, Alice Rees, Hannah Rohde and Hugh Rabagliati

School of Philosophy, Psychology and Language Sciences, University of Edinburgh

Correspondence should be addressed to:

Barbora Skarabela, School of Philosophy, Psychology & Language Sciences, University of
Edinburgh, Edinburgh, EH8 9AD, United Kingdom

Email: b.skarabela@ed.ac.uk

Abstract

Connectives such as *but* are critical for building coherent discourse. They also express meanings that do not fit neatly into the standard distinction between semantics and implicated pragmatics. How do children acquire them? Corpus analyses indicate that children use these words in a sophisticated way by the early pre-school years, but a small number of experimental studies also suggest that children do not understand that *but* has a contrastive meaning until they reach school age. In a series of eight experiments we tested children's understanding of contrastive *but* compared to the causal connective *so*, by using a word learning paradigm (e.g., *It was a warm day but/so Katy put on a pagle*). When the connective *so* was used, we found that even 2-year-olds inferred a novel word meaning that was associated with the sentence context (a t-shirt). However, for the connective *but*, children did not infer a non-associated contrastive meaning (a winter coat) until age 7. Before that, even 5-year-old children reliably inferred an associated referent, indicating that they failed to correctly assign *but* a contrastive meaning. Five control experiments ruled out explanations for this pattern based on basic task demands, sentence processing skills or difficulty making adult-like inferences. A sixth experiment reports one particular context in which five-year-olds do interpret *but* contrastively. However, that same context also leads children to interpret *so* contrastively. We conclude that children's sophisticated production of connectives like *but* and *so* masks a major difficulty learning their meanings. We suggest that discourse connectives incorporate a class of words whose usage is easy to mimic, but whose meanings are difficult to acquire from everyday conversations, with implications for theories of word learning and discourse processing.

Keywords: child language; connectives; comprehension; discourse relations; contrast; *but*

1. Introduction

To construct coherent discourse, we rely critically on connectives: words such as *but*, *so* and *because*. Connectives cue how phrases are contingent on one another, and contribute importantly to the overall interpretations of their utterances, as illustrated in the following three examples:

1a. Samuel teased Andrew *so* John scolded him.

1b. Samuel teased Andrew *because* John scolded him.

1c. Samuel teased Andrew *but* John scolded him.

Here, the same two clauses relate to each other in different ways, with the different connectives cueing different discourse coherence relations between them (Asher & Lascarides, 2003; Hobbs, 1979; Kehler, 2002; Mann & Thompson, 1988; Prasad, Dinesh, Lee, Miltsakaki, Robaldo, Joshi, & Webber, 2008; Sanders, Spooren, & Noordman, 1992; Wolf & Gibson, 2005). In (1a), *so* highlights the role of the second clause as a causal consequence of the first clause, in (1b) *because* highlights the first clause as a consequence of the second, and in (1c) *but* is used to contrast the meanings of the clauses. Importantly, these coherence relations can have verifiable impacts on how adults interpret the sentences: intuitions about whether the pronoun *him* refers to the subject (Samuel) or the object (Andrew) of the first clause typically vary based on the discourse relation that the connective indicates (Kehler, Kertz, Rohde, & Elman, 2008; Koornneef & Sanders, 2013; Winograd, 1972). In (1a) and (1c), for example, English-speaking adults tend to infer that the pronoun refers to the subject, while in (1b) they are more likely to infer that the pronoun refers to the object.

Children's acquisition of *but*

How do children acquire connectives and the coherence relations that they express? The evidence on this is surprisingly contradictory. On the one hand, corpus analyses of children's spontaneous production suggest that markers of coherence relations are acquired by the preschool years (e.g., Bloom, Lahey, Hood, Lifter, & Fiess, 1980; French, 1981; Braunwald, 1985; Gallivan, 1986), but on the other hand experimental studies of children's comprehension suggest that their understanding of these relations may be fragmentary even at school age (e.g., Clark, 1971; Kail & Weissenborn, 1984; Pyykkönen & Järvikivi, 2012; Blything, Davies, & Cain, 2015; de Ruiter, Lieven, Brandt, & Theakston, 2020; Spenader, 2018; Volodina & Weinert, 2020).

To explore this in more depth, we turn to an example of a coherence relation whose production and comprehension behaviour appear particularly asymmetrical and contradictory: contrast, the adversative relation that is typically marked in English by the connective *but*. As reviewed below, children appear to produce *but* in an adult-like way by age 3, suggesting that it is acquired quickly and easily. However, another body of comprehension work suggests that children do not actually understand the meaning of *but* until perhaps five years later. We then present a series of experiments designed to resolve this mismatch, by accounting for theories of children's sentence processing and analyses of the meaning of *but*. To foreshadow our results, we find that, indeed, children do not reliably interpret *but* to convey a contrastive discourse relation until they reach school age. This difficulty is not explained by basic methodological considerations, by children's language processing skills, nor by their ability to generate pragmatic inferences. Instead, we suggest that discourse connectives represent a class of words whose usage is easy to mimic, but whose meanings are extremely difficult to acquire, with implications for theories of word learning and discourse processing.

1.1. The acquisition of *but*

A contrast between two discourse arguments is achieved when there is a conflict or contradiction between the propositions of the first and second segment. For example, in sentence (2) below, the first clause introduces a situation (hot weather) for which a typical association (wearing light clothes) is in conflict with the true circumstances (wearing a winter coat).

2. [It was a hot day] UTTERANCE 1 but [Katy was wearing a winter coat] UTTERANCE 2.

To achieve a contrastive reading between two discourse arguments, English speakers rely on a range of explicit linguistic expressions (e.g., *however*, *even though*, *yet*) of which the connective *but* is the most basic (Fraser, 1988). Often, the precise way in which two utterances contrast is underdetermined, and must be inferred by the listener, but the presence of a word like *but* highlights that the interpretation of the second clause must be understood to contrast in some important way with the interpretation of the first, even if the precise sense of contrast is not clear. By contrast, if *but* were replaced with *so* in (2), then the two clauses would cohere such that the second clause describes the (anomalous) consequence of the first, while if *because* were used then the second clause would be (nonsensically) explaining the first clause.

From observation of their spontaneous production, it would appear that children acquire the ability to signal contrastive discourse relations with the word *but* by about the age of three. Corpus studies suggest that when children begin to combine utterances, around two years of age, they initially only mark discourse relations with the connective *and* (e.g., Bloom et al., 1980; Braunwald, 1985), and only use it to express additive relations in which the meaning of the

Children's acquisition of *but*

conjoined sentences is a simple combination of the meanings of the individual sentences (e.g., *They're taking a vacuum cleaner to wipe and puppy dog's running*, Bloom et al., 1980, p. 244). Soon, however, *and* becomes ubiquitous and children use it to express a range of different meanings, which come in a fixed order, first temporal relations (e.g., *Jocelyn's going home and take her sweater off*), then causal relations (e.g., *She put a bandaid on her shoe and it made it feel better*) and finally adversative relations expressing contrast between two events (*It can't... and this can go here*) (Bloom et al., 1980). Then, by age 3, children begin to use multiple other connectives, including explanatory *so*, followed by contrastive *but*, which is also used in additive and causal contexts (Bloom et al., 1980; Braunwald, 1985). While children continue using both connectives *but* and *and* to mark adversative relations, the consensus from observation of spontaneous production is that they appear to use *but* accurately well before they enter school, in contexts that allow one statement to modify or contrast with a previous statement (French, 1981; Gallivan, 1986; French & Nelson, 2012).

In stark contrast to this, those studies that have examined children's comprehension of *but* indicate that even school-age children struggle to understand its contrastive meaning. For instance, Kail and Weissenborn (1984) tested French- and German-speaking children on their knowledge of the contrastive *but* (French *mais*/German *aber*) and found that, in both languages, children did not master the connective before age 9. Even older 7-year-olds, the study shows, often interpreted *but* as *and*: in a sentence completion task, they typically produced supportive rather than contrastive continuations after hearing a prompt that finished with *but*. Similarly, in a study looking at children's reading, Cain and Nash (2011) found that 8-year-olds had particular difficulty in judging whether adversative connectives like *but* and *although* were being used appropriately or inappropriately. And finally, using spoken language and a pronoun-resolution

task, Spenader (2018) found that younger Dutch-speaking school children did not interpret *but* (Dutch *maar*) contrastively. When asked for the referent of *he* in the example *Big Bird asked Ernie for money but he didn't have any money*, 7-year-olds were at chance, as compared to adults who assumed that the pronoun referred to the object of the first clause (Ernie), and also as compared to children's understanding of sentences with the causal connective *because* (Dutch *want*). Thus, these and other comprehension studies, using a range of methods and languages, have consistently found that children struggle to interpret *but* contrastively well into school age (Florit, Cain, & Levorato, 2017; Champaud & Bassano, 1994; Janssens, Drooghmans & Schaeken, 2015). Taken together with the results from children's spontaneous speech, there appears to be a striking asymmetry between children's accurate early production of contrastive discourse relations and their lasting difficulty understanding those same contrastive relations.

1.2. The *but* asymmetry

Why is there such an asymmetry between children's facility producing connectives like *but* and their apparent difficulty understanding those same words? One possibility is that the comprehension studies discussed above are actually underestimating children's competence, because the tasks provided are too complex or pragmatically infelicitous (*cf.* French, 1981; French & Nelson, 2012; Gallivan, 1986). For example, Kail and Weissenborn (1984) tested children's knowledge of the contrastive connective using sentence completions and acceptability judgments, which were themselves embedded in a complex context story that had a number of potentially confusing topics and alternative answers. Examining the materials, it is plausible that understanding those stories and distinguishing between acceptable and unacceptable sentences may have been challenging as it required a significant degree of real-world reasoning and

metalinguistic, not only linguistic, awareness. By contrast, while Spenader (2018)'s pronoun resolution method was far simpler, the interpretation of ambiguous pronouns is itself challenging, as indicated, for instance, by the weak performance of the 7-year-olds on a control condition of the task. Thus, it may be that children would show more adult-like comprehension of *but* – comprehension that matches their skill at production – when they are assessed with more naturalistic tasks or with materials that are syntactically simpler and more pragmatically felicitous.

However, there are also good reasons to think that children really may struggle to comprehend *but* until the school years, and that their apparent facility with production may not be the strongest indicator of their linguistic competence. Most pertinently, learning the meaning of *but* may be difficult because what that word conveys is both variable, with a high degree of context dependence (Seligman, 1985), and subtle, with no consensus description amongst semanticists (e.g., Bach, 1999; Potts, 2007; Lakoff, 1971).

The variability of *but*'s meanings can be seen in Seligman's (1985) analysis, which proposes that *but* is used in at least seven distinct yet related ways, including marking contrast between lexical items, such as *John is tall but Bill is short* (also known as semantic opposition), and contrast with an expected inference, such as *John is tall, but he is not good at basketball*, where the listener must infer that when someone is tall, they are expected to be good at basketball (see also Lakoff, 1971). That *but* has a variety of meanings can be seen in the fact that some of its senses are expressed by separate lexical items in other languages (e.g., where German uses *aber* to express most of the senses of English *but*, it uses *sondern* to express correction, as in *I don't want an apple but an orange*). Thus, given the variety of contexts in which *but* is used, it may be difficult for children to acquire it.

Children's acquisition of *but*

Another argument for children's difficulty acquiring *but* may be the subtlety of its semantic content. Semantic theories of *but* have assumed that while it is contrastive, that contrast may not be explicitly encoded in the truth-conditional contribution of the word. Frege (1956), for example, proposes that the meanings of *but* and *and* are almost identical, except that the former suggests that 'what follows is in contrast with what would be expected from what preceded it' (p.296). Grice (1975), following this, labelled the contrast carried by *but* as a *conventional implicature*, i.e., an implicature triggered by the meaning of the word, rather than by its context of use. The idea that the contrast indicated by *but* is a conventional implicature is now quite widespread. However, many current semantic theories (Bach, 1999; Potts, 2007; Wilson, 2016) favour an alternative approach in which the contrast expressed by *but* is instead semantic, although carried along a different dimension from the primary truth-conditional meaning of the word. For instance, Potts (2007), following Bach (1999), argues that the contrast in *but* cannot be a conventional implicature, because it appears to be part of the truth-conditional content of a sentence (e.g., if Sami tells you that *Bert is crazy but effective*, then it would be wrong to report *Sami said that Bert is crazy and effective* suggesting that the contrast is a part of the at-issue meaning of the sentence). Relatedly, in the Relevance Theoretic tradition, it has been suggested that *but*'s contrast is a type of so-called procedural meaning (e.g., Blakemore, 1989), a conventional meaning that does not express content, but that instead guides the comprehender in how they should draw inferences.

These theoretical perspectives differ, but from the standpoint of language learning they all provide the same basic insight: that the contrast expressed by *but* represents an additional dimension of meaning, beyond the primary meaning communicated by the speaker. And given that, it is reasonable to assume that *but*'s contrast will be difficult for children to master because

related phenomena, such as scalar implicatures over quantifiers like *some*, are also somewhat difficult for children to master (e.g., Noveck, 2001; Lidz & Musolino, 2002; Papafragou & Musolino, 2003; Horowitz, Schneider & Frank, 2018). If *but*'s meaning is indeed secondary, complex, and difficult to learn, then this would explain why comprehension experiments on children's understanding of *but* do not typically reveal adult-like knowledge until well into the school years.

However, this perspective would still leave unexplained why children seem to produce *but* with facility. If children do not actually understand its meaning, then surely we should expect their production to be different from adults'. One possibility, of course, is that prior work on children's production has somehow overestimated their facility with the term, perhaps because adult speakers – caregivers and researchers alike – may charitably recognise at least some level of contrast when *but* is used to juxtapose two clauses.

As such, studies to date have not satisfactorily clarified children's acquisition of *but*. Studies of production suggest adult-like competence, but it could be the case that this is an over-interpretation. Studies of comprehension suggest that *but* is acquired only later, but methodological issues in those studies may have underestimated children's capacity.

1.3. The present studies

In this paper, we provide a systematic experimental evaluation of children's ability to understand the contrastive discourse connective *but*, which we compare to their understanding of the causal connective *so*. We focus on the comparison of *but* with *so* because *so* (unlike *and*) generates unambiguous predictions about how to interpret discourse relations with expectations that are met, in contrast to *but* which is used for generating expectations that are violated or

contrasted. To provide this, we examine how, and at what age, children use these connectives to inform their interpretation of novel words. This methodological choice builds on recent demonstrations that even young children can successfully use discourse context for word learning (Sullivan & Barner, 2016; Sullivan, Boucher, Kiefer, Williams, & Barner, 2019). For example, when they hear *I'm very thirsty, but cold things hurt my teeth! Look at what I want! There's a gazz on the table*, even two-year-olds are able to reliably identify the correct referent of the unfamiliar word when offered a choice between a cup of coffee, an ice cream, and a cup of ice water (Sullivan & Barner, 2016). Moreover, 4- to 5-year-old children show a modest, but statistically significant, ability to use the connectives *and* and *because* to infer different referents for unfamiliar words, indicating that children's word learning builds upon their discourse comprehension (Sullivan et al., 2019). We thus reasoned that this word-learning method would be more sensitive than previous paradigms used to investigate children's comprehension of *but*, such as pronoun interpretation (Spencer, 2018) or meta-linguistic judgments (Cain & Nash, 2011). Moreover, our stimuli relied on simpler linguistic materials than the sentence-completion paradigm used by Kail and Weissenborn (1984).

In Study 1, participants engaged in a picture-selection task, in which they had to guess which of two pictures were referred to by a novel word, based on the context provided by a two-sentence description. These descriptions varied in the discourse relations and connectives that they contained. We compared children's interpretation of the novel words in three discourse contexts: one context without a connective (3a), one with the causal connective *so* (3b) and one with the contrastive connective *but* (3c):

3a. Mary brought a *ploam* on a winter day. [Control condition with no connective]

Children's acquisition of *but*

3b. It was a winter day *so* Mary brought a *ploom*. [Causal connective]

3c. It was a winter day *but* Mary brought a *ploom*. [Contrastive connective]

After hearing one of these descriptions, participants chose which of two pictures the novel word might refer to (see Figure 1A). In the example, *ploom* could refer to a depicted sledge or to a bicycle. In (3a), with no connective, we reasoned that participants would choose the sledge based on lexical associations. In (3b), the coherence relation *so* demands that the second clause provide a consequence of the first, and so participants should again choose the semantically associated picture (i.e., the sledge). Finally, the connective *but* in (3c) conveys that the meaning of the second clause contrasts with the first clause, and so participants should infer that *ploom* refers to the non-associated, contrastive picture (i.e., the bicycle).

Studies 1 and 2 assessed children's comprehension of these causal and contrastive coherence relations from 2 to 8 years of age. To foreshadow the results, we found that children struggled to interpret *but* as contrastive even at age 5. The subsequent studies (Studies 3-5) were designed to explore this difficulty, testing whether 5-year-olds, who are known to use the connective *but* in their conversations, might succeed under different conditions that could potentially facilitate comprehension of *but* and explain the source of children's difficulties. In Study 3, we consider whether particular aspects of the task and its design could limit children's performance, and show that modifications to the task do not relieve children's difficulty. In Study 4, we then consider whether limitations in children's sentence processing abilities can explain their difficulty with *but*, and show that they cannot. Finally, in Study 5, we consider whether children's difficulty with *but* reflects a lack of pragmatic support. We show that, under

some conditions, increased pragmatic support does allow children to interpret *but* contrastively – but only at the cost of their now failing to interpret the connective *so* as having a causal meaning.

2. Part 1: Do children struggle with contrastive relations?

2.1. Study 1

The aim of Study 1 was to assess how children in a wide age range (from 2 to 8 years) use discourse relations indicated by connectives. In a picture-selection task, participants were introduced to a novel word in one of three different contexts and had to choose which of two pictures the word referred to. The experimenter explained that they spoke a different language and would use unfamiliar words for some things. The participants were presented with novel words in three different contexts: (1) a control condition with no connective (e.g., *Mary brought a ploam on a summer day*), (2) a causal context indicated by the connective *so* (e.g., *It was a summer day so Mary brought a ploam*) and (3) a critical contrastive context indicated by the connective *but* (e.g., *It was a summer day but Mary brought a ploam*). We measured whether children chose a semantically associated picture (here, a bicycle) over a contrastive picture (a sledge).

Recall that prior work testing comprehension found that children did not treat *but* as contrastive until around 8 years. At issue was therefore the age in this sample at which children would start to select the contrastive picture for the *but* condition (e.g., a sledge in *It was a summer day but Mary brought a ploam*) at above-chance levels, a pattern of behaviour indicating that participants not only understood that the meaning of *but* was different from the meaning of *so*, but also understood that the meaning of *but* was specifically contrastive.

Children's acquisition of *but*

The study used a two-alternative forced choice picture selection task with a within-subjects design. Each participant received 24 sentences with eight items in each of the three conditions (i.e., no connective control, connective *so*, connective *but*) counter-balanced in a Latin square design.

2.1.1. Method

2.1.1.1. Participants. 18 adults (13 female) and 120 children between 2 years and 8 years old (61 female, 2 other/undisclosed). The age breakdown was 24 2-year-olds, 16 3-year-olds, 22 4-year-olds, 21 5-year-olds, 16 6-year-olds, 17 7-year-olds, and 2 8-year-olds who were combined into a group with the 7-year-olds. Participants were recruited in public places in Edinburgh, Scotland. All participants were primarily exposed to English in their homes. Ethical approval was obtained before recruitment. Participants or their caregivers provided consent before the study.

2.1.1.2. Materials. The study used three practice items and 24 test items. The first practice item tested the participants' understanding of a familiar word embedded in a simple discourse (i.e., *Here are two different things. One of these are glasses! Can you point to the glasses?*, with a picture of glasses and headphones). The second and third practice items tested their ability to choose a referent for an unfamiliar label from a foreign language (i.e., *Here are two different things. In my language we use a milgo when it's dark outside. Can you point to the milgo?*, with a picture choice between a glass of water and a torch). All materials can be accessed via [the OSF](#).

Sets of six test items were created as in (4a-f) below. Novel words were embedded in one of three types of context: a control single sentence context without a connective illustrated in (4a)

Children's acquisition of *but*

and (4d), a two clause context conjoined with the connective *so* in (4b) and (4e), and a two clause context conjoined with contrastive *but* in (4c) and (4f). For each set, two variants of each context were created with opposing meanings to control for complexity of inference, and to ensure that each picture was the intended referent half of the time.

4a. Mary brought a ploam on a summer day. (control)

4b. It was a summer day *so* Mary brought a ploam. (so)

4c. It was a summer day *but* Mary brought a ploam. (but)

4d. Mary brought a ploam on a winter day. (control)

4e. It was a winter day *so* Mary brought a ploam. (so)

4f. It was a winter day *but* Mary brought a ploam. (but)

Each practice and test item was presented with a pair of pictures (see Figure 1A, a complete set of stimuli and materials can be found via [the OSF](#)). Practice trials included three pairs of images with familiar objects (e.g., glasses and headphones, cup and torch, sunglasses and bread). All test trials showed a pair of images with opposed meanings (e.g., a bicycle and a sledge for item set 1 above), and each image was paired with an animal as the named character (e.g., a penguin for item set 1, see Figure 1A). One item, due to experimenter error, presented non-identical animal characters with each image.

The Latin Square design generated six lists of 24 test items, with eight items in each condition per list.

2.1.1.3. Procedure. The study was administered by approaching participants and their caregivers in public places (e.g., parks). Caregivers provided written consent on the child's behalf, and child participants gave their assent before proceeding with the study. Each participant was randomly assigned to one of six lists. Participants were instructed that in this game they should point to the picture that best matches the description they hear. The experimenter then presented a 'picture book' with one experimental item per page, starting with the three practice items and followed by 24 test items. The experimenter recorded the participant's response after each trial. The study took 10 minutes for most participants, and no longer than 20 minutes for the youngest participants. The participants were thanked and debriefed at the end of the study.

2.1.1.4. Analysis. We analysed these data in terms of the proportion of trials on which participants chose the picture that was semantically associated with the context (see Figure 1A for an example). We expected that adults would choose the semantically associated picture on *so* and *no connective* trials, but would choose the non-associated, contrastive picture on trials where *but* indicated contrast.

Our critical analysis examined when children showed the predicted adult-like patterns of choosing the associated pictures at above-chance levels on *so* and no-connective trials, and the non-associated pictures at above-chance levels on *but* trials. That pattern of behaviour would clearly indicate that children had learned that *but* is contrastive. In addition, we carried out direct comparisons between *so* and *but* trials in order to assess whether children treated the meaning of *but* as being different from the meaning of *so*. Note, however, that these direct comparisons do not establish whether participants understood *but* as contrastive: In a situation in which participants chose the associated picture on 90% of *so* trials but only 70% of *but* trials, then this

would show that the participants treated the connectives as different, but it would not indicate that they specifically treated *but* as having a contrastive meaning.

The data generated in this study, and our subsequent studies, typically followed extremely clear patterns, such that differences across conditions could be appreciated by the naked eye. Standard inferential statistical tests for clustered binomial data, like mixed effects logistic regression models, sometimes failed here because participants performed at ceiling in at least some conditions, which leads to separation in the data and poor, biased model fits. Therefore, in order to compare performance in individual conditions against chance, we relied on bootstrapped 95% confidence intervals (see e.g., the error bars in Figure 1B). We used mixed effects models only to compare across ages and conditions.

2.1.2. Results

Figure 1B shows that, with age, participants increasingly chose the associated picture in the *no-connective* control trials¹ (e.g., *Mary brought a ploam on a winter day*, Beta = .44(SE=.06), $z=6.6$, $p<.001$) and also in the *so* trials² (e.g., *It was a winter day so Mary brought a ploam*, Beta = .58(.07), $z=8.6$, $p<.001$), and this change was more-or-less monotonic. In both conditions, even two-year-olds were above chance at choosing the associated meaning (No Connective: \underline{M} = 0.66[95% CI = 0.60-0.73], So: \underline{M} =0.63[0.54-0.72]).

In contrast, performance on the *but* trials (e.g., *It was a winter day but Mary brought a ploam*) showed a different developmental pattern. Between 2 and 6 years, children were increasingly more likely to choose the semantically associated picture, even though *but* signifies

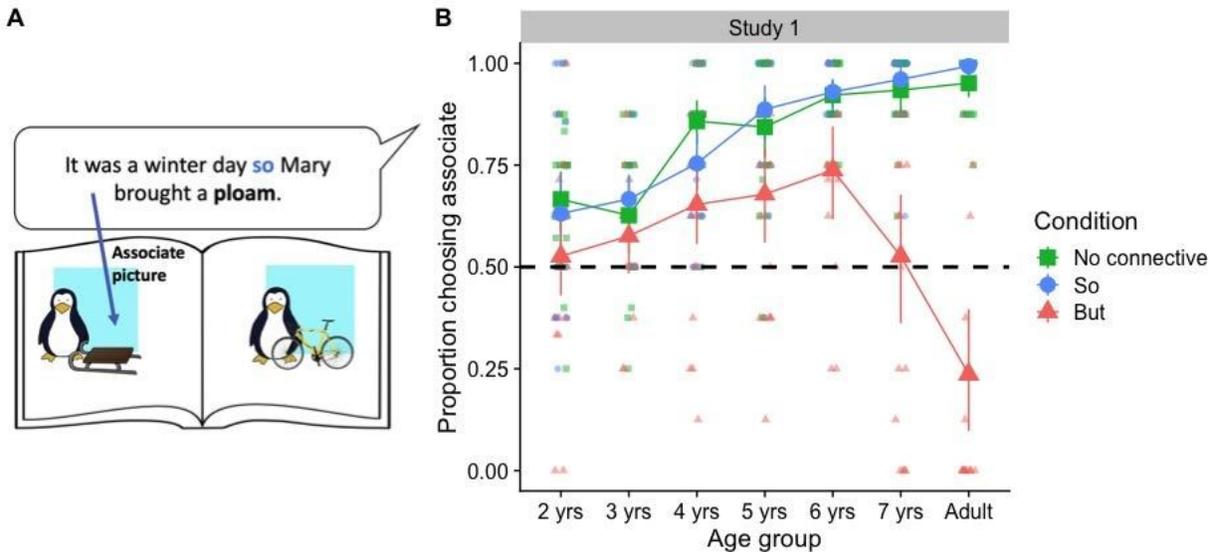
¹ For all regressions, we report model structure in footnotes using lme4 syntax. This model had structure `glmer(ChooseAssociate ~ scale(Age) + (1|Participant))`, applied to all children tested (and not adults)

² `glmer(ChooseAssociate ~ scale(Age) + (1|Participant))`, applied to all children tested (and not adults)

Children's acquisition of *but*

contrast³ (Beta=.24(.08), $z=302$, $p=.002$). It was not until around 7 years that this developmental pattern reversed, and even at 7 years performance was at chance ($\underline{M}=.52$ [95% CI=.38-.69]), with only adults choosing the contrastive picture more often than chance ($\underline{M}=.24$ [95% CI=.10-.40]). The pattern of development, therefore, was decidedly not monotonic.

Finally, we compared the proportion of trials on which participants selected the associated picture for the *so* and *but* conditions. Combining the child participants aged 2 through 6⁴, we found that they were significantly less likely to choose the associate in the *but* condition (Beta = -0.7(0.14), $z=5.1$, $p<.001$). However, this effect of connective was almost an order of magnitude smaller than the effect of connective for the participants aged 7 and older (Beta=-5.9(.056), $z=10.6$, $p<.001$).



³ glmer(ChooseAssociate ~ scale(Age) + (1|Participant)), applied to children under 7 years

⁴ glmer(ChooseAssociate ~ Connective + (1+Connective|Participant))

Figure 1. A. Example Stimuli for Study 1. **B.** Proportion of participants selecting the associated meaning by age and condition in Study 1. Large dots show group means, small dots show individual means. Error bars show bootstrapped 95% confidence intervals.

2.1.3. Discussion

Study 1 generated two key findings. The control condition and the connective *so* condition both show that even very young children will use discourse contexts to guess new associated word meanings, consistent with earlier studies of discourse bootstrapping (Sullivan & Barner, 2016; Sullivan et al., 2019). However, the second key finding highlights the limits of children's understanding of discourse: even at age 7, children were not reliably able to use the contrastive connective *but* to infer that a word may have a contrastive meaning. Indeed, children younger than 7 consistently chose the associated meaning in these contrastive contexts, at rates that were only a little bit lower than in the two non-contrastive conditions.

Since children's difficulty with *but* was so unexpected and the developmental trajectory so striking, we aimed to re-assess it with a slightly modified design and stimuli. First, in order to address the possibility that children were primed to select the associated picture in the *but* examples because this was the correct response in two of the three conditions, we removed the control ('no connective') condition, so that now participants would be expected to choose associated versus contrastive meanings on an equal number of trials. We also developed a new set of items in which the intended contrastive readings never risked violating real-world knowledge (i.e., some examples in Study 1 involved actions that were either very implausible or impossible, like a cat barking, e.g., 'Alex barks, but it is a toffee' with cat as the target, or sea travel by train, e.g., 'Max travelled across the ocean but he took the train' with train as the

target). We reasoned that this factor may have caused adults to only choose a relatively low proportion of non-associated choices in the contrastive condition, and we thus predicted that these modifications would facilitate contrastive inferences on *but* trials in both children and adults. Furthermore, we simplified the context of the stimuli presentation and removed the foreign language aspect of the study, simply introducing the picture-selection task as a guessing game that involved matching made-up words to one of the depicted single objects.

2.2. Study 2: Confirming children's difficulty with *but*

Study 2 provided a further test of whether children really do struggle with *but*, using a new set of stimuli and a new set of participants aged three-, five- and seven-years, each age group established as distinct in their interpretation of *but* by the previous study, as well as a control group of adults.

2.2.1. Method

2.2.1.1. Participants. 16 adults and 48 children, 16 (8 female) in each age group (3-, 5-, 7-years of age) were recruited via a lab database, local nurseries and lab Facebook page. All participants were native speakers of English. Ethics approval was obtained before recruiting participants.

Participants or their guardians provided consent before the study.

2.2.1.2. Materials. The study included three practice items and 20 new test items. The first practice item tested the participants' understanding of a familiar word embedded in a simple discourse (i.e., *Here are two different things. One of these is a football! Can you point to the football?*, with a picture of a football and a bicycle). The second and third practice items tested

Children's acquisition of *but*

their ability to choose a referent for an unfamiliar label (e.g., *Here are two different things. We use a milgo when it's dark outside. Can you point to the milgo?*, with a picture choice between a cup and a torch). Visual stimuli were coloured drawings of objects, without the paired animals used in Study 1. All materials can be accessed via [the OSF](#).

The sets of 4 test sentences followed a similar form to the *so* and *but* conditions of Study 1, as in sentences (5a-d), presented with a pair of images. For sentences (5a-d), the images were of a winter coat and a t-shirt.

- 5a. It was a cold day *so* Katy put on a pagle.
- 5b. It was a cold day *but* Katy put on a pagle.
- 5c. It was a warm day *so* Katy put on a pagle.
- 5d. It was a warm day *but* Katy put on a pagle.

We used a Latin Square design to generate four lists of 20 test items, with 10 items in each condition per list. Each list was counterbalanced for the presentation side of the target image, creating eight lists in total (see [the OSF](#) for the complete set of stimuli and lists). Pictures were presented as PowerPoint slides on a laptop computer. The stimuli were presented by the experimenter who carefully articulated each connective with strong emphasis.

2.2.1.3. Procedure. The study was administered in a quiet room in local nurseries or the developmental lab at the University of Edinburgh. Participants were presented with a picture-selection task, introduced as a guessing game with words and pictures, and they were instructed to listen carefully to a short description and guess the meaning of a made-up word and match it

to one of two pictures that best describes its meaning. Unlike in Study 1 the images were presented as slides on a laptop or tablet (see [the OSF](#) for a script with instructions).

2.2.1.4. Analysis. As in Study 1 we analysed these data in terms of the proportion of trials on which participants chose the picture that was semantically associated with the context. We used bootstrapped confidence intervals to compare behaviour against chance, and mixed effects models to compare behaviour in this study with that found in Study 1.

2.2.2. Results

As Figure 2 shows, Study 2 replicated the key findings of Study 1. On *so* trials, older participants were increasingly more likely to choose the associated picture. By contrast on *but* trials, 3- and 5-year-old children chose the associated picture, just as in the prior study (Age 3: $\underline{M}=.60$ [95%CI= .49-.71]; Age 5: $\underline{M}=.83$ [95%CI=.74-.91]). It was only at seven years that children began to reliably choose the non-associated picture ($\underline{M}=.23$ [95%CI=.09-.39]).

Notably, the new stimuli in Study 2 did seem to affect participants' inferences. Compared to Study 1, participants within each age group chose the associated picture at a higher rate in the *so* condition (although these consistent differences between Study 1 and 2 were not statistically significant). Moreover, in this study's *but* condition, 7-year-olds and adults were less likely to choose the associated picture compared to those in Study 1⁵ (Beta=-1.8(.75), $z=2.5$, $p=.01$), suggesting that the new stimuli led them to generate more robust contrastive inferences. But importantly, with these new *but* stimuli, 5-year-olds actually chose the associated picture more

⁵ glmer(ChooseAssociate ~ Study + (1|Participant)), applied to 7-year-old and adult data from Studies 1 and 2

often in Study 2 than in Study 1⁶ (Beta=0.98(.47), $z=2.1$, $p=.04$). Thus, while these stimuli seemingly made it easier for older children and adults to draw contrastive inferences, they simultaneously appeared to make it harder for younger children to draw contrastive inferences.

Finally, we tested whether our younger participants were less likely to choose the associated picture for the *but* than *so* conditions.⁷ This difference was found for both 3-year-olds (Beta=-0.6(0.3), $z=-1.98$, $p=.048$) and five-year-olds (Beta=-1.3(0.6), $z=2.2$, $p=.03$).

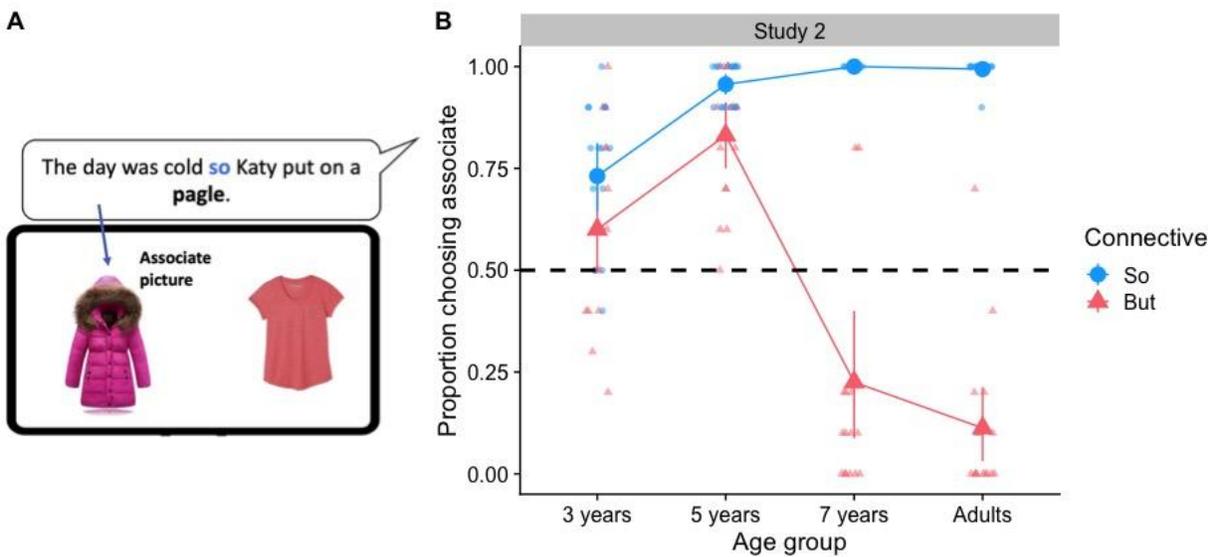


Figure 2. A. Example Stimuli for Study 2. B. Proportion of participants selecting the associated meaning by age and condition in Study 2.

2.3. Discussion

⁶ `glmer(ChooseAssociate ~ Study + (1|Participant))`, applied to 5-year-old data from Studies 1 and 2

⁷ `glmer(ChooseAssociate ~ Connective + (1+Connective|Participant))`

Children's acquisition of *but*

Studies 1 and 2 document and then replicate a striking limit to younger children's ability to comprehend discourse: a failure to understand that the connective *but* implies a contrast between two clauses, and to use that contrast for word learning. While children as young as 2- or 3-years could use discourse-supported associations to determine a word's meaning, it was not until age 7 that children were able to reliably override those associations when *but* conveyed a contrastive discourse relationship between two clauses.

Importantly, children's difficulty with *but* up to age 5 years was robust across both our initial stimuli and a second stimuli set that made it easier for adults and older children to infer contrast. The fact that the second set did not also make it easier for younger children to infer a contrastive relation, but instead appeared to make it harder, provides a strong cue that children of this age have a genuine difficulty interpreting *but*, at least in this experimental context.

Younger children's apparent difficulty with *but* is both unsurprising and surprising. On the one hand, these data are unsurprising because they are consistent with prior reports that children have difficulty comprehending *but* (e.g., Spenader, 2018; Kail & Weissenborn, 1984). Even though our study used a simpler task than prior work, the only slight difference that we found compared to those reports is a slightly lower age at which *but* is first well-comprehended – where those studies suggested that children as old as 8 still struggle, we found robust success at age 7 in Study 2.

On the other hand, these data are surprising because it does not make intuitive sense that children as old as five years would struggle with *but* in this simple two-clause context with no other syntactic complexities or unusual scenarios with several characters — both corpus studies and the lived experiences of parents suggest that children use *but* frequently and do not appear to often use it in unlicensed contexts. Indeed, caregivers who observed the study often expressed

their disbelief about their child's behaviour. In our remaining studies, we thus tested a number of potential explanations for why children may struggle to understand *but* contrastively.

3. Part 2: Testing three factors behind five-year-olds' difficulties with *but*

We tested three potential explanations for why children under 7 years did not appear to interpret *but* contrastively in Studies 1 and 2. Study 3 examined explanations based on the design of our task, Study 4 examined explanations based on limits to children's language processing skills, and Study 5 examined explanations based on limits to children's ability to generate pragmatic inferences. Figure 3 provides an overview of these three explanations and the tasks that we designed to evaluate them.

All of these studies focused on 5-year-olds, chosen because they had robustly misinterpreted *but* in both Studies 1 and 2 (i.e., consistently choosing the associated picture above chance) and because it was particularly surprising that children of this age would be unable to interpret *but*. Our running hypothesis was that these children do in fact possess a sophisticated understanding of the meaning of *but*, but that they failed to use it in our previous two experiments, perhaps because of task design or another aspect of their psycholinguistic competence, such as language processing skills or inferencing ability. However, as we show, that running hypothesis was not supported.

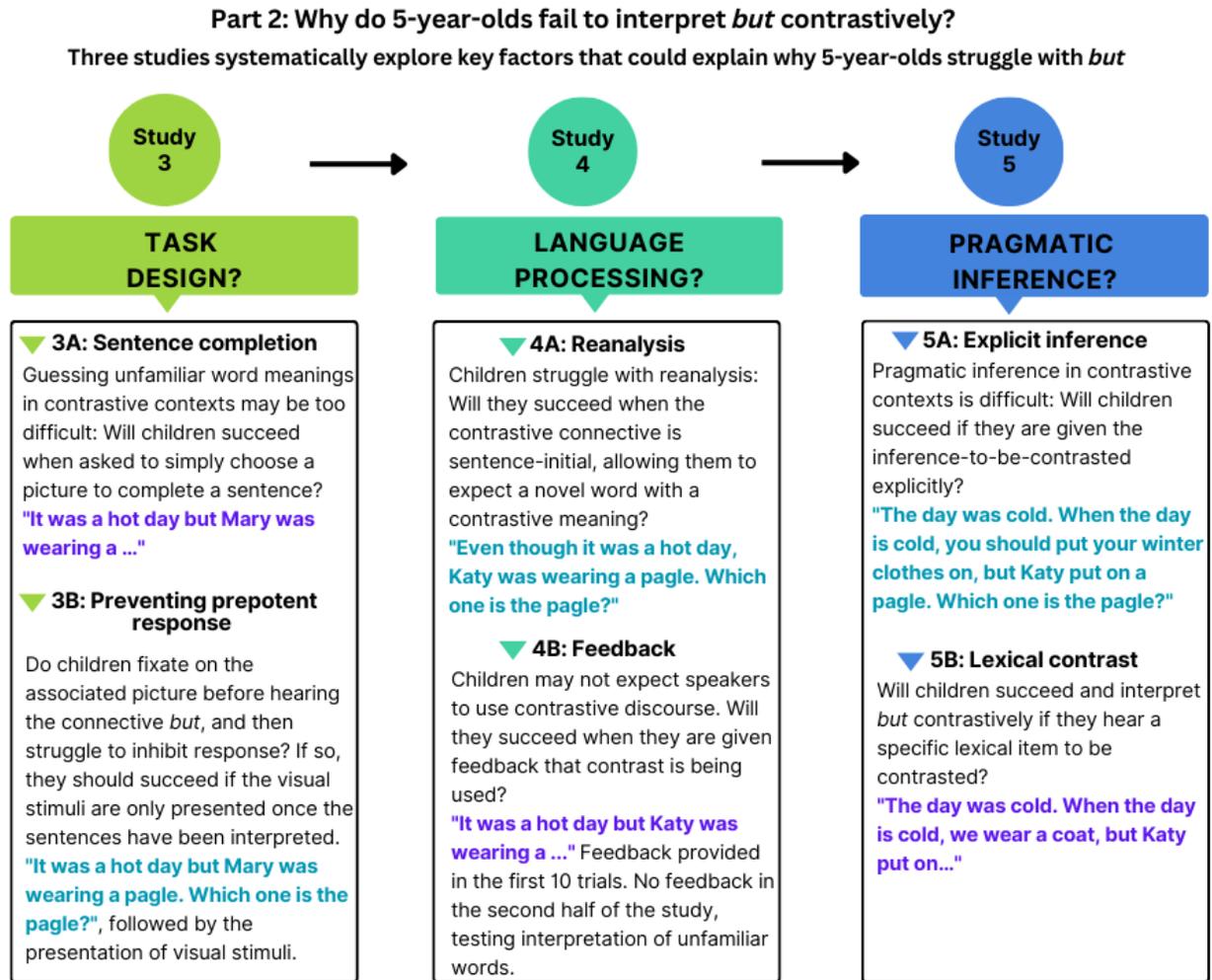


Figure 3. Progression of Studies 3-5 exploring sources of 5-year-olds' difficulties with *but*

3.1. Study 3: Task Design

While our task was relatively simple, it had features that could conceivably limit children's ability to draw contrastive inferences from the word *but* and use those inferences for word learning. We tested two that we considered most likely. First, it is possible that children were not expecting contrastive discourse in a task that required guessing the meaning of made-up words. Previous studies showed that a discourse bootstrapping paradigm is suitable for young participants and that even two-year-olds can infer meanings of unfamiliar words from the surrounding linguistic discourse (Sullivan & Barner, 2016). However, contrastive contexts are

rarer than non-contrastive contexts, and require non-standard inferences on the part of the listener as to how discourse segments connect (see Sanders, 2005). Thus, it is possible that children struggled with our task simply because we posed them the unusual task of inferring new word meanings under contrastive contexts. Study 3A therefore tested whether evidence for contrastive interpretation of *but* might emerge in a task that does not build on unfamiliar words, specifically a sentence-completion task.

A second potentially confounding aspect of our task is the relation between the linguistic and visual stimuli. It has previously been suggested that children may generate non-adult interpretations of a sentence if a) it requires reanalysis, and b) it is heard alongside a visual stimulus that is consistent with an initial (not reanalysed) interpretation. For instance, Hamburger and Crain (1984) found that children generate non-adult-like interpretations of phrases like *the second green ball* (where they interpret *second* to modify only *ball* not *green ball*) if they can concurrently see a line of balls where the second-positioned one is green, but do not do so if the line of balls is only revealed after the phrase is heard. They argued that the concurrent visual stimulus caused children to initially fixate on the second-positioned ball (rather than the second of two green balls, see also Meroni & Crain, 2003), and they then struggled to move beyond this initial interpretation. For the present context, we reasoned that hearing the initial clause of each stimulus item (e.g., *The day was cold...*) might cause children to focus on the associated picture, either because they were implicitly predicting that it would be named (Mani & Huettig, 2012) or simply because of priming based on semantic associations (Jerger, Martin & Damian, 2002; Arias-Trejo & Plunkett, 2009). Children would then struggle to move beyond that associated interpretation on hearing the contrastive connective. This reasoning implies that children may

provide better evidence for understanding contrastive *but* if they cannot see an associated picture while listening to a sentence. We tested this in Study 3B.

3.1.1. Study 3A: Sentence completion

Study 3A tested whether 5-year-old children would show more evidence for contrastive interpretation of *but* when the task design did not require guessing the meaning of an unfamiliar word. Instead, children heard stimuli as before but with the final unfamiliar word removed (e.g., *It was a cold day so Katy put on a...*) and then chose which of the two pictures completed the sentence, using either a verbal report or a point. Otherwise, the methods here were identical to Study 2 when children participated in a picture-matching task, except that only 16 5-year-olds (8 female) were assessed (the list of stimuli accessible via [the OSF](#)).

However, this change to the method did not provide evidence that 5-year-olds would contrastively interpret *but*. As before, and as Figure 4 shows, they chose the associated picture above chance on both *so* trials and on *but* trials (So: $\underline{M}=.86$ [95% CI=.73-.96], But: $\underline{M}=.77$ [95% CI=.59-.92]), indicating that they did not treat *but* as contrastive. Additionally, a comparison between *so* and *but* trials indicated no significant difference (Beta=-0.4(1.1), $z=0.4$, $p=.72$)⁸.

3.1.2. Study 3B: Preventing prepotent response

Next, we assessed whether performance would change if 5-year-olds could not see the images while listening to the sentences. Here, we followed the method and protocol from Study 2, using the same verbal and visual stimuli, except that only 16 5-year-olds (8 female) participated and that children were presented with a blank screen while listening to the sentences, and were only shown the pair of visual stimuli once they had listened to the entire stimulus sentence.

⁸ `glmer(ChooseAssociate ~ Connective + (1+Connective|Participant)`

Children's acquisition of *but*

Again, however, this change to the procedure did not affect children's behaviour. As before, they robustly chose the associated picture on both *so* and *but* trials (Figure 4). When children had to process the sentence before seeing the images, they still chose the associated meanings at above chance rates for both connectives (So: $\underline{M}=.95$ [95% CI=.82-1], But: $\underline{M}=.72$ [95% CI=.60-.85]), indicating that participants did not treat *but* as contrastive. In addition, a comparison between conditions indicated that participants were somewhat less likely to choose the associate on *but* trials (Beta=-7.4(3.5), $z=2.1$, $p=.03$)⁹.

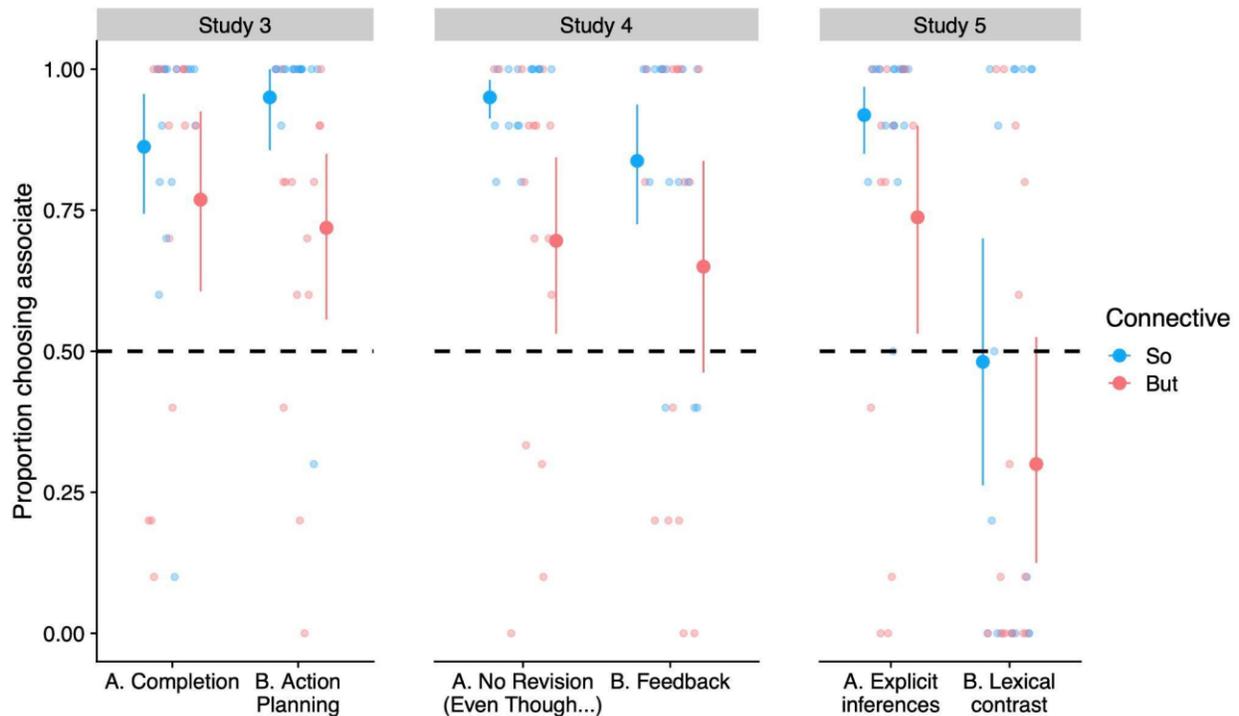


Figure 4. Choice of the associated picture by condition in Studies 3A/3B (Task Design), 4A/4B (Language Processing) and 5A/5B (Pragmatic Inference).

⁹ `glmer(ChooseAssociate ~ Condition + (1+Condition|Participant))`

3.2. Study 4: Language Processing

We next tested whether children's difficulty with *but* might be driven by limitations in their language processing ability. Again, we considered two possibilities. First, that difficulty with *but* may result from a general difficulty with reanalysis. There have been a number of demonstrations that children struggle with reanalysis during sentence processing (e.g., Trueswell, Sekerina, Hill, & Logrip, 1999; Huang et al., 2013; and see Study 3B above), and interpreting *but* contrastively in *It was a cold day but Katy put on a pagle* would to some degree require the participant to revise their expectations about what is likely to be said following *It was a cold day...* To test this possibility, in Study 4A we examined how 5-year-olds generated contrastive inferences when the contrast was indicated at the start of the sentence, rather than after the first clause.

To do this, we needed to use a connective other than *but*, because *but* cannot be used sentence-initially to introduce a conflict or contrast between two subsequent propositions. English has a small set of items that allow this, including *even though*, *although*, *despite/in spite of the fact*, although we are not aware of any studies that examine their acquisition in the preschool years. These items are of course much more rare in parent-child conversations than the highly-frequent connectives *but* and *so*, yet are still also clearly part of children's input. For example, an analysis of the Gelman corpora indicates that children hear *even though* approximately as often as they hear the verb *kick* (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Gelman, Taylor & Nguyen, 2004; Gelman, Ware, Kleinberg, Manczak, & Stilwell, 2014; Jipson, Gülgöz & Gelman, 2016). In addition, corpus-based English language descriptions argue that *even though* is more colloquial than the other connectives and makes a stronger contrast than *although* (Carter, McCarthy, Mark & O'Keeffe, 2011; Dušková et al., 1988). For these reasons, *even though* was selected as the best candidate for the study (e.g., *Even*

though it was a cold day, Katy put on a pagle). If difficulty with *but* is actually a difficulty with revision, then we expected that children should be more capable of inferring contrastive meanings when *even though* is used, as it allows them to infer contrast before they build up expectations about the rest of the sentence.

Second, we considered the possibility that failure to understand *but* could be a consequence of so-called noisy channel processing (Gibson, Bergen & Piantadosi, 2013; Yurovsky, Case & Frank, 2017; de Carvalho, Dautriche, Fievet, & Christophe, 2021), in which children interpret sentences not just on the basis of what they hear, but on the basis of what they expect people to communicate as well. If children do not expect speakers to communicate contrastive meanings, especially meanings that describe less conventional scenarios, then they may ignore evidence for those meanings, and interpret a sentence as having contained a different connective besides *but*. To test this, Study 4B examines whether children would generate more contrastive interpretations of *but* if they were first provided with greater evidence that the speaker intended to communicate a contrastive meaning. Specifically, children received feedback in the first ten trials offering evidence that *but* was being used contrastively, and *so* was being used non-contrastively.

3.2.1. Study 4A: Reanalysis and *even though*

Study 4A tested whether children would show stronger evidence for contrastive interpretations when *but* was substituted with the connective *even though*. The method follows Study 2 when children had to guess the meaning of an unfamiliar word, but again only using 5-year-olds (n=16, 8 female), and replacing sentences using *but* with sentences beginning with the contrastive connective *even though* (e.g., *Even though it was a cold day, Katy put on a pagle*) (see [the OSF](#) for verbal stimuli).

Again, however, children did not show strong evidence of generating contrastive interpretations (Figure 4). In both the *so* and *even though* conditions, they consistently chose the associated picture (So: $M=.95$ [95%CI=.91-.98]; Even though: $M=.70$ [95%CI=.54-.83]). This suggests that children's difficulty with *but* is not specific to reanalysis and extends to multiple connectives that imply contrastive discourse relations. Additionally, a comparison between conditions indicated that participants were marginally less likely to choose the associated picture on *even though* trials than *so* trials (Beta=-1.6(0.8), $z=1.9$, $p=.052$)¹⁰.

3.2.2. Study 4B: Feedback

Study 4B assessed whether increasing children's beliefs that the speaker will use contrast would then lead to more contrastive, rather than associated, interpretations. 16 5-year-olds (8 female) took part in both a feedback and a test phase of the study. In the first part of the experiment (Trials 1-10), children participated in the Feedback phase when they were invited to complete sentences in a similar manner to Study 3A, either by saying a familiar word or by pointing at one of the pictures. During this phase, they received feedback on their choices (e.g., if they chose the associated picture on a *but* trial or non-associated picture on a *so* trial, then the experimenter would say 'not quite right' and invite the child to listen carefully as they provided the correct target form embedded in the stimulus sentence as they pointed to the target image; no further explanation was provided). At the end of this phase, children were told that the game was changing and they now had to guess the meaning of a made-up word given. ("Now, we will change the game. I will finish the sentence with a funny word. Listen carefully and then guess what the word means and point to the picture that best describes the new word. Ready?"). In the subsequent Test phase (Trials 11 through 20), no feedback was provided.

¹⁰ $\text{glmer}(\text{ChooseAssociate} \sim \text{Connective} + (1+\text{Connective}|\text{Participant}))$

Children's acquisition of *but*

In the Feedback phase, children chose the associated meaning on the large majority of *so* trials ($\underline{M}=0.94$ [0.83-1]) and also on the majority of *but* trials ($\underline{M}=0.8$ [0.69-0.91]), meaning that children rarely received feedback on *so* trials but received feedback on the majority of *but* trials. Importantly, in the critical Test phase, we found that this feedback had not caused children to interpret *but* contrastively. Again, on the majority of trials, children chose the associated meaning even when the connective *but* was used (Figure 4), although the 95% confidence interval now overlapped chance (So: $\underline{M}=0.84$ [95% CI=.71-.94], But: $\underline{M}=0.65$ [95% CI=.48-.84]). Moreover, in this study, a comparison between *so* and *but* trials during the Test phase indicated no significant difference (Beta=-0.87(0.9), $z=0.95$, $p=.34$).¹¹

Finally, we ran an analysis comparing children's responses during the Feedback and Test phases, examining whether feedback caused children to interpret *but*, but not *so*, more contrastively – a result that one might expect given that children were often given feedback that *but* trials were contrastive but never given feedback that *so* trials were contrastive. Overall, children were more likely to choose the associate on *so* rather than *but* trials (Beta=0.85(0.21), $z=4.1$, $p<.001$)¹². However, the effect of the feedback was not particular to *but* trials. Across the two connectives, children were less likely to choose the associate in the Test phase rather than the Feedback phase (Beta=-0.64(0.2), $z=3.2$, $p=.002$), and the interaction term showed that the effect of phase did not differ between the *so* and *but* trials (Beta=-0.09(0.19), $z=0.47$, $p=.64$). Interestingly, an analysis of the individual datapoints suggested that these results were mostly driven by a small number of children (3/16) for whom the training led to consistently generating

¹¹ `glmer(ChooseAssociate ~ Connective + (1+Connective|Participant))`

¹² `glmer(ChooseAssociate ~ Phase * Connective + (1|Participant))`

contrastive meanings for both *but* and *so*, rather than all children showing a small effect of feedback.

The major implication of Study 4B is that children's difficulty with *but* is unlikely to be due to contrastive meanings being rare and thus downweighted as a possible interpretation. When given explicit feedback that the speaker wanted them to interpret *but* trials contrastively, children still did not robustly interpret subsequent *but* trials contrastively. Therefore, it does not appear that noisy channel principles can explain children's unexpected behaviour here.

Moreover, a striking additional finding is that the feedback actually caused some children to start treating both *but* and *so* contrastively. Even though children were never given feedback that *so* should be interpreted contrastively, a small number of children inferred that feedback on *but* trials should cause them to interpret both *but* and *so* sentences contrastively. This pattern of data is quite interesting because it is consistent with the possibility that children do not understand the distinct discourse functions of both connectives, *but* as well as *so*. It thus raises the question of whether 5-year-olds actually understand the meaning of *so*, despite their accuracy with it on our task. We return to this in Study 5B.

3.3. Study 5: Pragmatic Inferencing

We next considered the possibility that children's difficulty with *but* may be driven by difficulties in the pragmatics of deriving contrastive readings. Specifically, in order to interpret *but* contrastively, children need to understand what information is being contrasted, and inferring this information may be either difficult for them (*cf.* the analysis of children's scalar implicature difficulties in Barner, Brooks & Bale, 2011), or it may be contextually underdetermined in the verbal stimuli used so far. As an example, consider the item *It was a cold day but Katy put on a*

pagle. To get a contrastive interpretation in which *pagle* means t-shirt, the child needs to first infer that on a cold day we wear heavier clothing like a winter coat, and then contrast that inference. Thus, children may struggle to generate the contrastive interpretation because they either do not generate an inference with which to create a contrast, or they generate an inference that, when contrasted, does not lead to the interpretation that *pagle* refers to a t-shirt (e.g., generating the inference that when it is a cold day one is likely to get chilly, and so it is contrastive for a character to be able to overcome such a problem by wearing a warm clothes like a coat that will stop them from getting chilly).

We approached this possibility in two ways. In Study 5A we specified the relevant inference that the participants could then contrast (e.g., *The day was cold. When the day is cold, you should put your winter clothes on, but Katy put on a pagle*). In Study 5B we went beyond this by specifying not only the inference, but a specific lexical item that the participants could contrast (e.g., *The day was cold. When the day is cold, we wear a coat, but Katy put on a ...*). In both of these studies, the key logic was the same: if difficulty with *but* is due to a failure to generate the right inferences, then children's interpretation of *but* contrastively should be facilitated by making the inference or lexical item to be contrasted explicit.

3.3.1. Study 5A: Explicit Inference

Study 5A followed the same protocol from Study 2 with 16 5-year-olds (8 female) who guessed the meaning of an unfamiliar word, using the same visual stimuli, while the verbal stimuli from Study 2 were modified to make the relevant inference explicit (see 5a-d) (stimuli available via [the OSF](#)). If children's difficulty lies in determining the inference to contrast, then we expect them to treat *but* as contrastive under these conditions.

Children's acquisition of *but*

5a. The day was cold. When the day is cold, you should put your winter clothes on, *so*

Katy put on a pagle.

5b. The day was cold. When the day is cold, you should put your winter clothes on, *but*

Katy put on a pagle.

5a. The day was hot. When the day is hot, you should put your summer clothes on, *so*

Katy put on a pagle.

5b. The day was hot. When the day is hot, you should put your summer clothes on, *but*

Katy put on a pagle.

However, even when the inference was made explicit, we still found no evidence that 5-year-olds would interpret *but* contrastively (Figure 4). Again, participants were more likely to choose the associated picture in both the *so* condition and in the *but* condition (So: $\underline{M}=.91$ [95% CI=.84-.98], But: $\underline{M}=.74$ [95% CI=.53-.91]). Thus, making an inference explicit – at least at this level of granularity – did not cause children to reliably treat *but* as contrastive. Moreover, in this study, the comparison between *so* and *but* trials indicated no significant difference (Beta=-0.5(1.5), $z=0.3$, $p=.75$).¹³

3.3.2. Study 5B: Lexical Contrast

Finally, we asked whether 5-year-olds would interpret *but* contrastively if we provided a precise lexical item to contrast against. The study followed the protocol from Study 2 with two modifications. First, we modified the verbal stimuli to specify the relevant inference that participants needed to draw and also, importantly, mention a specific lexical item that would be part of that inference. As a result, the modified sentences referred directly to one of the pictures

¹³ `glmer(ChooseAssociate ~ Connective + (1+Connective|Participant)`

(see 6 below). Second, we used a sentence completion task rather than a task that requires guessing unfamiliar labels. This was to avoid a confound in which children might use mutual exclusivity to infer that the unfamiliar label could not refer to the picture that had just been previously mentioned.

6. The day was cold. When the day is cold, we wear a coat, *so* Katy put on...

An important aspect of the new contexts in Experiment 5B's stimuli is that – unlike all the previous studies – they intuitively provide a better fit for a contrastive continuation than a non-contrastive one, as the latter would involve the repetition of the object label. For example, it is more marked to say *When the day is cold, we wear a coat, so Katy put on a coat* than to say *When the day is cold, we wear a coat, but Katy put on a t-shirt*. This raises the intriguing possibility that, if five-year-olds have only fragmentary knowledge of the two connectives *but* and *so*, we might expect globally more contrastive interpretations in this study for both connectives as a result of children's sensitivity to discourse features and strategies related to referential communication, including the expectation that objects of transitive clauses tend to introduce new referents (see Allen, Hughes & Skarabela, 2015; DuBois, 1987, 2003). The possibility that children may have fragmentary knowledge of *so* was raised in Study 4B that showed that some children started giving contrastive readings to both *so* and *but* in response to feedback that their *but* responses were incorrect. Moreover, while children across our studies were highly accurate in the *so* conditions, it is not clear that *so* was actively driving their interpretation, as they behaved very similarly in the control (no connective) condition of Study 1.

Children's acquisition of *but*

Because of the coronavirus pandemic, data for this study was collected online and participants were assessed on a video call. We used a sentence completion task, as in Study 3A, with the same visual stimuli as Study 2 delivered as a slide presentation on a shared screen, and the linguistic stimuli spoken by the experimenter. The two pictures appeared on different colour backgrounds (blue or green). Participants typically completed the sentences by naming one of the two pictures, and some also named the colour of the background the picture appeared on, or pointed to the picture.¹⁵ 5-year-olds participated (7 female), along with one 6-year-old (female, 77 months).

Unlike the prior seven studies, the 5-year-olds in Study 5B did not show a robust tendency to choose the associated meaning on *but* trials. Instead, as Figure 4 shows, they were now more likely to choose the non-associated, contrastive meaning (But: $\underline{M}=.30$ [95% CI=.12-.51]). While the confidence interval around this proportion just overlapped chance, the rate of choosing the associated picture was significantly lower than in Study 5A¹⁴ (Beta=4.16(1.5), $z=2.7$, $p=.007$). However, this apparent new success on *but* trials was complemented by a striking failure on *so* trials. Unlike all our prior studies, the 5-year-olds were now at chance on whether they chose the associated or non-associated meaning (So: $\underline{M}=.48$ [95% CI=.28-.7]), and the comparison between *so* and *but* trials indicated only a marginal difference (Beta=-2.6(1.5), $z=1.7$, $p=.09$).¹⁵ Thus, in this context where children apparently could derive a contrastive meaning for *but*, they now no longer derived a reliably non-contrastive meaning for *so*.

To understand these importantly distinct data better, we broke the group-level results down at an individual child level (Figure 5). Eight children clearly interpreted both *but* and *so*

¹⁴ `glmer(ChooseAssociate ~ Study + (1|Participant))` applied to the two But conditions in Studies 5A and 5B

¹⁵ `glmer(ChooseAssociate ~ Connective + (1+Connective|Participant))`

Children's acquisition of *but*

contrastively, four clearly interpreted both *but* and *so* non-contrastively (as in our prior studies), two children showed an adult-like pattern of interpretation, and the remaining children were either at chance for *but* or at chance for *so*. Thus, while children as a group were at chance when interpreting *so*, few individuals showed this result. Instead, most children either interpreted *so* contrastively or interpreted *so* non-contrastively. Importantly, the individual-level data provides little evidence that children distinguished the meanings of *but* and *so* in these contexts. If children interpreted *but* contrastively then they tended to also interpret *so* contrastively, and if they interpreted *but* non-contrastively then they interpreted *so* non-contrastively.

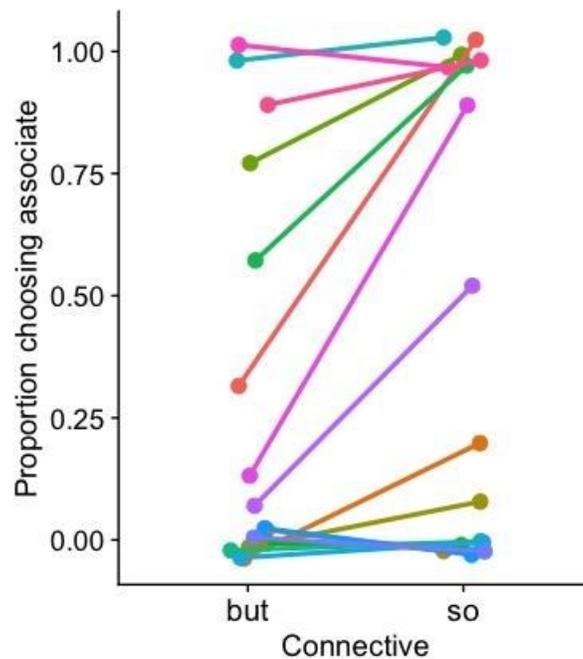


Figure 5. Individual child data from Experiment 5B. Each line connects the two means of the two conditions from each individual child.

3.4 Exploring individual differences in children's understanding of *but*

Finally, building on the individual child analysis from Study 5B, we examined the degree to which children across our studies showed variation in their understanding of *but* and *so*. We focused on

Children's acquisition of *but*

Studies 3A through 5A, not incorporating Study 5B, where children's responses importantly differed. Figure 6A shows individual children's performance across these tasks. The data are notable because they suggest two clusters. The large majority of children chose associated meanings at roughly similar rates in both the *so* and *but* conditions, but a significant minority of children, about 25%, showed an adult-like pattern of choosing the associated meaning for *so* and the non-associated, contrastive meaning for *but*.¹⁶ Thus, some of the children in this study did in fact interpret *but* contrastively.

We then conducted a set of regression analyses to test what could predict whether children would interpret *but* contrastively. Initial comparisons suggested that children's behaviour was not predicted by their gender. However, a regression analysis suggested that children who showed the more adult-like pattern tended to be older. We regressed proportion choosing the associate in the dataset above against the connective use and age, and found that the two interacted so that the effect of connective was larger in older 5-year-olds (interaction between connective and age, $\text{Beta}=-0.66(0.28)$, $z=-2.4$, $p=.019$, see Figure 5B)¹⁷. Thus, it seems that while most 5-year-olds in our sample did not understand the contrastive meaning of *but*, a small number of children, typically the older children in our sample, had already learned it.

¹⁶ To more formally confirm this intuition we applied a k-means cluster analysis to the data; the resulting elbow plot suggested that there were in fact three clusters in our data. The Elbow plot can be found on the [OSF repository for this paper](#).

¹⁷ `glmer(ChooseAssociated ~ scale(Age) * Connective + (1|Participant))`, data from studies 3A through 5A.

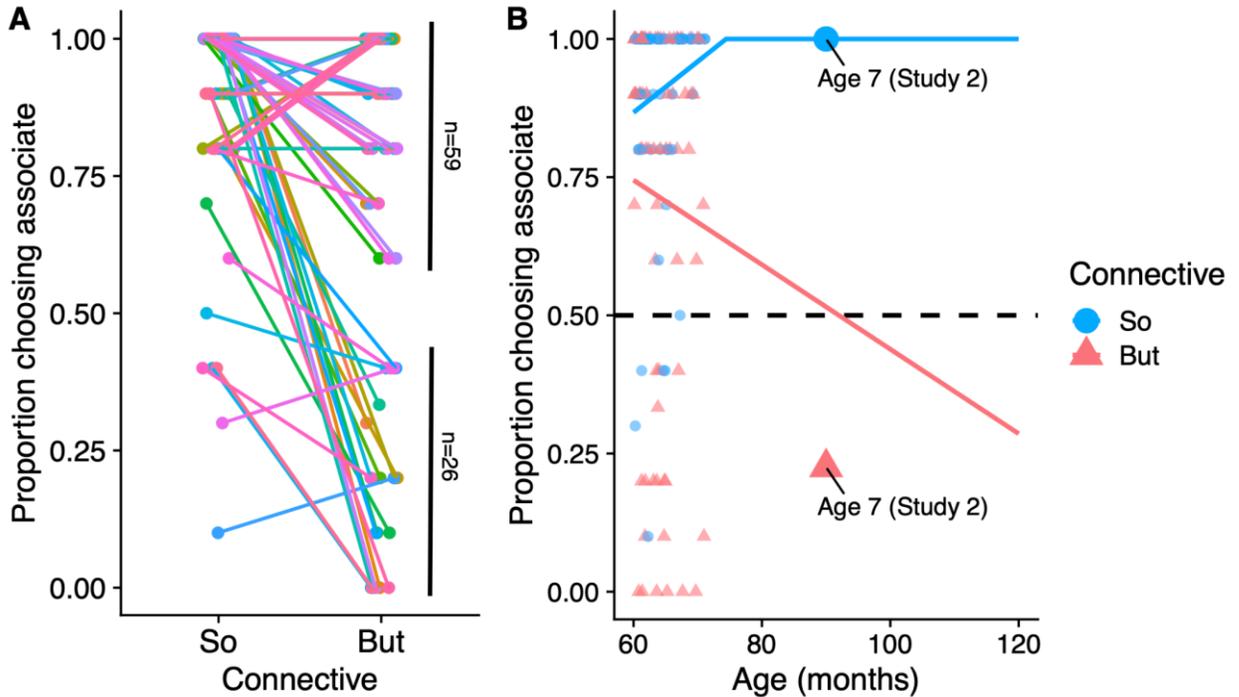


Figure 6. A. Individual-level behaviour of the 80 5-year-olds from Studies 3A to 5A. Each line connects data points from an individual child **B.** Age differences in 5-year-olds' performance across Studies 3A to 5A (small points indicate individual children) alongside logistic best fit lines to the 5-year-old's data, and mean performance at age 7 in Study 2 (large points).

3.4. Discussion

Studies 3 through 5 were designed to examine a number of factors that could explain away children's misinterpretation of contrastive *but* that we documented in Studies 1 and 2. Focusing on five-year-olds, we tested the contributions of task design, language processing, and pragmatic inferencing. The results provided striking evidence for a genuine difficulty interpreting *but*. Despite our manipulations, children in five out of six of the studies continued to interpret *but* non-contrastively, and in the one study where children did succeed in interpreting *but* contrastively, they simultaneously failed to reliably interpret the connective *so* non-contrastively.

Children's acquisition of *but*

Specifically, children failed to interpret *but* contrastively in both manipulations of Study 3, where we removed the emphasis on guessing the meaning of unfamiliar words (Study 3A), and where we made it harder for children to generate a prepotent response by removing the concurrent visual stimuli (Study 3B, *cf.* Hamburger & Crain, 1984). Children also failed to recover a contrastive interpretation in both manipulations of Study 4. First, in Study 4A, where we minimised the need to perform semantic reanalysis by using the sentence-initial connective *even though*, suggesting that the difficulty with *but* is not a difficulty with revision and reanalysis (*cf.* Trueswell et al., 1999). Second, in Study 4B, where we gave children explicit feedback that the experimenter was using *but* contrastively, suggesting that difficulty with *but* is not because of a prior about which meanings are likely (*cf.* de Carvalho et al., 2021). Finally, children's difficulty with *but* could not be explained by difficulty generating the pragmatic inferences necessary to understand the intended contrast (*cf.* Barner et al., 2011). When the relevant inferences were explicitly specified, children still failed to interpret *but* contrastively (Study 5A).

Only in Study 5B did children show evidence of interpreting *but* contrastively. In that case, the stimuli not only made the relevant inferences explicit, but provided a lexical item to contrast against (e.g., *The day was cold. When the day is cold we wear a coat, but Katy put on...*). Unlike in our prior studies, children now chose the non-associated picture for sentences using the connective *but*, indicating that they had derived a contrastive interpretation. However, also unlike the prior studies, children now no longer chose the associated picture for sentences using *so*, indicating that they did not derive a causal interpretation for *so*. This pattern suggests that in Study 5B children were generating lexically driven contrastive interpretations from the global context of the stimuli sentences, rather than because they understood that *but* was being used contrastively. Consistent with this, an individual-level analysis indicated that the majority

of children in this study did not interpret sentences containing *but* and *so* in different ways: they either interpreted both of the connectives contrastively or interpreted neither connective contrastively. Moreover, an individual-level analysis of Studies 3A to 5A also showed that most children did not distinguish the meanings of *so* and *but*, and that the relatively small proportion of children who did distinguish their meanings tended to be older.

Thus, none of our follow-up studies provided evidence that 5-year-olds, as a group, understand that the connective *but* highlights a contrastive discourse relation, and some of our data even suggest that children of this age do not know that the connective *so* highlights a causal discourse relation.

4. General discussion

How do children learn the meanings and discourse relations that are expressed by connectives like *but*? Prior corpus analyses suggested that children use *but* in a sophisticated way by their third birthday, but prior experimental work had suggested that children's comprehension may be far more fragile, perhaps not emerging until the school years. Our eight experiments evaluated this claim. Using a discourse bootstrapping paradigm, we tested whether children could use the connectives *but* and *so* to infer different discourse relations (contrast versus causality, respectively) and inform their interpretation of an unfamiliar label or production of a familiar word. The findings provided a striking confirmation of the prior experimental work. While even 2- and 3-year-old children selected meanings in keeping with a causal interpretation of *so* (Studies 1 and 2), by choosing associated meanings for novel words, we did not find evidence that children reliably interpreted *but* contrastively – by choosing contrastive, non-associated meanings for novel words – until age 7. Instead, younger children reliably chose

associated meanings when the connective *but* was used (albeit at a lower rate than for *so*) indicating that they had interpreted *but* non-contrastively.

Studies 3 through 5 confirmed and clarified this finding. Five-year-olds still did not reliably interpret *but* contrastively when: 1) The task was simplified and did not involve guessing unfamiliar labels (Study 3A), 2) When participants could not see the response pictures while listening to the sentences, thus preventing premature associations between the sentences and the pictures (Study 3B), 3) When the need for semantic reanalysis was removed, by indicating that the sentence would be contrastive from the start by placing the connective *Even though* sentence-initially (Study 4A), 4) When children were explicitly told that their associative responses on *but* trials were incorrect (Study 4B), and 5) When children were explicitly provided with the inference that *but* was supposed to contrast against (Study 5A).

The only occasion on which children consistently interpreted *but* contrastively was in Study 5B, when the context explicitly provided a lexical item that *but* could potentially contrast against. However, these contexts also made non-contrastive continuations pragmatically more marked (Givón, 1983; DuBois, 1987, 2003), and indeed children in Study 5B also often interpreted the connective *so* as having a contrastive meaning. Given this, we suggest that children's contrastive interpretations in that study were mainly driven by the particular context used and, at least for some of the children, by their sensitivity to referential strategies related to contrast and newness (Allen et al., 2015), rather than by the meaning conveyed by the connective *but* itself. Moreover, the pattern of data in this study raise the possibility that, like with *but*, children may actually not fully understand the discourse contribution made by the connective *so*: With these stimuli, many participants interpreted sentences with *so* to be contrastive rather than causal, and this thus raises the possibility that, for many children, their accuracy with *so* trials in our prior studies was also

driven mainly by the contexts that they were hearing, rather than by the presence of that connective.

Thus, our eight studies provided evidence that, as they enter formal education, children still have only a limited understanding of the meanings of discourse connectives, particularly the contrastive meaning of the connective *but*. In this Discussion we evaluate the strength of that evidence and whether alternative accounts might explain our findings, discuss why children may be able to fluently use these words without fully understanding them, and suggest why children may have difficulty learning these words, and how they eventually do come to understand them.

4.1. Do 5-year-olds really not understand the meaning of *but*?

The claim that children struggle to acquire the meaning of *but* is striking. After all, even 3-year-olds use *but* frequently, and in a variety of licensed ways, including to mark protest and contrast (e.g., Bloom et al., 1980; French, 1981; Gallivan, 1986). And as mentioned before, caregivers who observed our studies frequently expressed their disbelief that their child had been unable to reliably infer contrast for sentences containing *but*. Given this, it is worth considering the possibility that our studies misestimate children's competence with connectives.

One possibility is that our data patterns are unreliable, but this does not appear likely. Instead, across our 8 studies, we observed a remarkable consistency in how children interpreted the connectives *but* and *so*, across a range of experimental features. Only in Study 5B was the pattern of responses different. Thus, children's misinterpretation of *but* in these contexts appears to be a reliable developmental pattern.

A second possibility is that our tasks underestimated children's competence with *but*, and that a different methodological approach would elicit more adult-like behaviour. Our

Children's acquisition of *but*

experiments aimed to reveal an adult-like competence through a range of different means, including different sets of stimuli, different types of response measures (sentence completion, word learning), explicit interventions such as feedback, and a variety of contexts designed to make inferences about contrast easier. Few appeared to make a significant difference to children's behaviour. For example, one suggestion is that children were simply making their choices based on associations between the pictures and the words that they were hearing, rather than processing the sentences more deeply for their discourse structure. However, several of our findings show that this is not likely. When children could not see the pictures while hearing the sentences (and thus could not generate associations online, Study 3B) they still tended to choose the associated picture on *but* trials. Moreover, in Study 5B, when associations between the pictures and the sentences were maximised, with one picture even being directly mentioned, children now did not choose the associated image. Thus, associations do not seem a parsimonious explanation of children's choices.

Another potential methodological explanation of children's difficulties, based on a common feature across our studies, is the use of a within-subjects design to assess comprehension of both *but* and *so*. Within-subjects designs are typically preferred as they reduce measurement error. However, as suggested by a Reviewer, there are also cases where within-subjects designs can increase a chance of a spillover effect, in which responses in one condition may impact responses in the other (e.g., Snedeker & Yuan, 2008). It could therefore be that a between-subjects design in which children only respond to contrastive *but* trials, rather than *but* trials mixed with *so* trials, would better highlight children's competence with the connective. This needs explicit testing in the future. However, a reanalysis of our current data provides some potential initial evidence against the idea that children's interpretation of *but* in our studies was influenced by exposure to

so examples. In particular, a spillover explanation predicts that children should become less able to interpret *but* as the study proceeds, which was not the case in our dataset¹⁸. Moreover, spillover also predicts that when children answer *but* trials before hearing any *so* trials, then they should show contrastive behaviour, but that was again not the case in our dataset. When children's very first trial was a *but* trial¹⁹, they still chose the associated meaning on more than half of the trials ($M=0.58[0.43-0.73]$). Thus, we are confident that our methods did not radically underestimate children's competence, and we suggest that our variety of studies provide a reliable and broad test of children's lack of ability to infer contrastive discourse relations in these contexts.

Still, while our data generally make the case that children, especially 5-year-olds, have a surprisingly limited understanding of *but*, there are also some qualifications to that conclusion. For example, our individual child analysis of Studies 3A through 5A (Section 3.4) indicated that, while most of our participants did not distinguish the meanings of *so* and *but*, a proportion (about 25% of participants) were able to do so, choosing the associated picture on *so* trials and the non-associated picture on *but* trials. Importantly, those 5-year-olds who did interpret *but* contrastively also tended to be older, a point that we return to below, but which indicates that children's understanding of *but* has begun to emerge at this age. Further support for this comes from the group-level performance of 5-year-olds who were less likely to choose associated meanings on *but* trials than on *so* trials. Thus, our data provide some evidence that an understanding of *but* is present amongst some children at age 5, even if most children failed to understand it.

¹⁸ Specifically, for the *but* data from 5-year-olds in Study 2 and from Studies 3A thru 5A, we conducted the regression $\text{glmer}(\text{SelectAssoc} \sim \text{scale}(\text{ItemOrder}) + (1|\text{Participant}))$, both for the full dataset and for the first five trials and the first ten trials. In no case was there a significant effect of item order.

¹⁹ With data taken from the same set described in Footnote 8.

Finally, an important further limitation to our data is that it did not provide a detailed characterisation of all of the different senses of meaning that connectives such as *but* or *so* can take. Namely, the focus in our study was on *but*'s use to indicate contrast through a violation of expectations, a sense that is often discussed in theories of discourse structure (e.g., Sanders, Spooren, & Noordman, 1992) and that has often been studied in prior work with children (Kail & Weissenborn, 1984; Champaud & Bassano, 1994; Florit et al., 2017). However *but* is also used with a variety of other senses of meaning, such as marking protest (e.g., *but I don't want to*) or lexical contrast (e.g., *this dog is big but that dog is little*, and see also the stimuli in Experiment 5B). It may be that while children struggle with the violation of expectations sense of *but*, they may be able to interpret *but* contrastively when it is used in alternative contexts where its contrastive meaning can be supported by other aspects of discourse, sentence structure or lexical choices. That possibility remains to be tested, and is likely to be an important component for building strong theories of how children acquire the semantics of terms like *but*.

To summarise, given all the considerations above, we suggest that the most parsimonious interpretation of our experiments is that, even at age 5, most (but not all) children fail to understand the contrastive meaning of *but*, at least when it is used to indicate a violation of expectations. We do not think it is likely that our experiments provide an unreliable measure of children's competence, nor that our experiments are an invalid measure of children's competence. Detailed examination of our data suggest that a small percentage of children have acquired *but*'s contrastive meaning by age 5, however 5-year-olds as a group did not provide good evidence that they understand *but* to be contrastive.

4.2. Production without comprehension

Children's acquisition of *but*

If most children cannot understand *but* by 5 years, then why do studies of production suggest that even younger children use it in competent and sophisticated ways? We suggest two reasons for this, one uncontroversial and one potentially controversial. The first, and uncontroversial, possibility is that children may often use *but* in the context of common multiword constructions (e.g., *but I don't want to*), without a full understanding of all individual lexical items (see Morris, 2008 for evidence of item-based learning of the connectives *and* and *or*). This is a fairly-well established phenomenon (e.g., Hurewitz, Papafragou, Gleitman & Gelman, 2006 for similar asymmetry in quantifiers like *some*), and could give the false impression that children know a wide range of *but*'s senses.

The second, and more controversial, possibility is that children's competence may have been overestimated because *but*'s meaning is not only subtle but also interpretable in many different contexts. This means that even if a child is using *but* erroneously, then listeners (including researchers) may not recognise that the child has committed an error, because they are flexible and accommodating in the way that they interpret the child's use of *but*. As a result, children may use *but* in ways that adults take to be competent, without the child fully understanding *but*'s contrastive meaning. To illustrate, consider this example of how one 5-year-old used *but* in the Gelman corpus (Gelman, Taylor & Nguyen, 2004):

Mother: What's this?

Child: Yeah, it's inside but I don't know what it is.

Mother: Well, it's kinda hard to tell.

Children's acquisition of *but*

The child appears to competently use *but* to express contrast. But consider the possibility that this child actually misunderstands *but* to be synonymous with *so*, as with our experimental data. In this scenario, the child is expressing a meaning that is not adult-like, but that is also coherent in this context (equivalent to *Yeah, it's inside so I don't know what it is*). However, that non-adult-like meaning will not be at all obvious to the mother listening to the child, or to an annotator reading the transcript, who both would instead interpret the child as producing a sentence with a contrastive discourse relation. The key point is that a child can misunderstand the meaning of the word like *but*, and use it to express a non-contrastive discourse relation, yet because *but* can be interpreted in many different ways, then an adult hearing (or reading transcripts of) these uses may still assume the child's use to be correct and contrastive.

These two points in combination mean that there is plausible reason to believe that prior work on production may have overestimated children's knowledge of *but*. First, children may often use *but* in the context of frequent sentence frames, without understanding the meaning. Second, even if children do use *but* with an incorrect meaning, then this misuse may be difficult for an adult to detect (see also Clark, 1971 on the difficulty of detecting these types of errors in children's speech).

4.3. How do children acquire discourse connectives?

Finally, we turn to the major open question: if children do not understand the meaning of *but* at age 5, how do they learn it by age 7? Or put another way, if children can understand *but* by age 7, then why are they not able to understand it at age 5?

We suggest the following hypothesis: the full range of adult meanings of words like *but* are extremely hard to acquire by attending to informal conversational discourse alone. That is partly

Children's acquisition of *but*

because those meanings are subtle (and, as suggested above, their misuse is difficult to detect in conversations), and partly because the distribution of meanings used in informal conversations may differ from the distribution used in formal discourse and writing (e.g., Chafe & Danielewicz, 1987; Taboada & Gómez-González, 2012). As a result, most children have not acquired the meaning of *but* as an explicit marker of contrast at the point at which they enter formal education. However, once children enter formal education and begin to systematically engage with written language and formal discourse, their understanding of these terms becomes explicit and transformed.

This hypothesis breaks down into three components: a claim that the adult meaning of *but* is hard to acquire from informal conversations alone, a claim that the wider range of adult meanings of *but* is learned through literacy and exposure to written language, and a claim that the major effect of literacy on learning begins when most children start school. We discuss these claims in reverse order.

The data in Figure 6B provide evidence that children's understanding of words like *but* transforms suddenly, and so offers circumstantial evidence that formal education – with new systematic exposure to print and formal discourse as well as instruction – contributes to this transformation. Specifically, Figure 6B shows 5-year-olds' performance on *but* and *so* trials in Experiments 3A through 5A, plotted by age in months, along with logistic best fit lines for that data. The best fit lines show gradually improving performance on *but* and *so* within the age range of 60 to 72 months; as argued earlier, we suggest that this is because an increasing proportion of children have learned the meaning of *but*, rather than all children getting slightly better. However, when the best fit lines are extrapolated to older ages, we see that – for *but* – the improvements between ages 5 and 6 do not actually predict behaviour at age 7 (while

performance at *so* is at ceiling). Instead, a much higher proportion of children can understand *but* by age 7 than we would expect given the observed improvement from ages 5 to 6 (see Janssens, Drooghmans, & Schaeken, 2015 for further evidence that age is not a good predictor of children's interpretation of *but*). One way to interpret this non-linearity is the potential addition of a new factor that causes children to rapidly develop their knowledge of connectives between ages 5 and 7. Since the major environmental change for children who participated in our studies during this age period is the beginning of formal education, and with it an introduction to reading and writing, we suggest that it is these activities that provide a key trigger for children's learning of the wider meaning of connectives.

Is it plausible that literacy and schooling would change children's understanding of connectives? Yes. First, literacy opens routes to wider discourse contexts. The language of schooling, formal discourse, and literacy activities, including story reading, differs from informal conversations (Chafe & Danielewicz, 1987; Halliday, 1994; Schleppegrell, 2001; Crain-Thoreson, Dahlin, & Powell, 2001). Moreover, the way that *but* is used in text and in school may be quite different from the way that *but* is used in conversations with caregivers. These educational contexts, therefore, are likely to push children to engage with the meaning of *but* in quite a different way. Second, exposure to text offers learning opportunities that are not available in informal conversations. Readers, but not listeners, can focus on individual words, including terms like *but*, and explore and discuss their functions and meanings. Third, elementary and primary school curricula specifically focus on building children's knowledge of words like *but* through explicit instruction and practice. For example, the National Curriculum for England mandates that children be able to link sentences using conjunctions such as *but* during Year 3 (ages 7 to 8) (English programmes of study: key stages 1 and 2, 2013), while Scotland's

Children's acquisition of *but*

Curriculum for Excellence mandates that children be taught to write sentences linked by connectives such as *but* during the first level of primary school (ages 6 to 9) (Education Scotland Benchmarks: Literacy and English, 2017), a stage at which our participants begin to interpret *but* contrastively. In textbooks for this age range, knowledge of connectives is built through exercises in which children choose the right connectives for different situations, or offer completions for partial sentences that finish with different connectives. These exercises appear to be effective at changing children's understanding of *but*: a 15-minute formal instruction, for only seven days, raised children's understanding of connectives (Soltis & Pflaum, 1979), both in terms of meta-linguistic awareness and reading ability. Thus, there is ample reason to believe that even a short formal instruction and targeted practice could trigger children's attention to these terms and affect how they understand connectives such as *but*. Once children become aware of their function, they can begin to detect the terms in a wider range of settings and meanings, some of which may be restricted to the formal register and school settings (e.g., Schleppegrell, 2001).

This relates to the third claim of our hypothesis, that the contrastive meaning of *but* is difficult to acquire from spoken input alone. First, *but*'s contrastive meaning may be hard to acquire because it does not predict strong differences in word use. For example, a parent may say *They can see us through that mirror but we can't see them*, an example found in the Gelman corpus (Gelman, Ware, Kleinberg, Manczak, & Stilwell, 2014). However, it would not be anomalous to say *They can see us through that mirror but we can also see them* (i.e., the antithesis). *But* signals contrast in both examples, yet they are semantically direct opposites. If *but*'s meaning does not restrict word use, as these examples illustrate, it may be hard for a child to learn.

Children's acquisition of *but*

Second, as suggested above, *but*'s usage may be systematically different in informal and formal discourse. For example, an informal analysis of the conversational usage of *but* in the CHILDES database (MacWhinney, 2000) indicates that it very often occurs turn-initially. This type of usage may be far more rare in children's (and adult's) literary material. Thus, the relative frequency of the different senses of *but* that children are exposed to in their conversational input – such as *but* as a marker of protest, or as an interjection – may be quite different from the relative frequency of senses that they are exposed to in written stories and school settings (see Crain-Thoreson, Dahlin, & Powell, 2001 for style differences between conversations and during story reading). This, along with the ambiguity of *but*'s meaning discussed in the previous paragraphs, may make it particularly hard for children to learn its contrastive usage from conversational input alone. For the minority of children who have learned the contrastive meaning of *but* by age 5 (see above), we hypothesise that they may have received a particularly rich and advanced literary input, presumably from being read by their caregivers (e.g., Volodina & Weinert, 2020; de Ruiter, Lieven, Brandt & Theakston, 2020).

To summarise, we propose that children have not mastered the contrastive meaning of *but* before school, both because their spoken input provides only ambiguous evidence for that meaning, and because the input may be dominated by other senses of *but*, such as protest or opposition. At school, children quickly acquire this contrastive meaning because of increased exposure to print and formal discourse, reinforced by formal instruction. This causes the step-change that we documented in children's understanding of discourse connectives in the early years of formal education. We would also highlight that this step-change may not only occur for connectives like *but*, but for a range of other discourse devices whose use in written language differs from spoken language.

From one perspective, we can see that this proposal may be considered deflationary – it is quite rare in studies of language development to admit that children acquire higher order linguistic knowledge from explicit instruction. But from another perspective we think that this proposal offers important explanatory value and opens new research questions. For example, the present perspective explains why children, before schooling, struggle to interpret discourse relations in a range of complex sentence types beyond the ones studied here, including sentences conjoined by adverbs like *before* and *after* (Clark, 1971; French & Brown, 1977; Keller-Cohen, 1987; Johnson, 1975; Trosborg, 1982; de Ruiter, Lieven, Brandt & Theakston, 2020). This perspective also highlights the potential for literacy to change children's higher-order knowledge of language, not just in its written form but also in face-to-face interactions. While the role of reading in raising phonemic awareness and manipulating speech sounds is well-established (e.g., Morais, Cary, Alegria & Bertelson, 1979), the role of reading in building new pragmatic and discourse skills for spoken language has been less explored. Together, this perspective suggests a route to supporting children's literacy instruction, by providing a clear documentation of their pre-literate discourse skills, and a pathway from written to spoken discourse.

5. Conclusion

These eight experiments highlight a striking limit to children's discourse comprehension that lasts until the early school years. At age 5, children systematically fail to interpret the contrastive connective *but*, despite a range of different facilitating conditions (Studies 3 through 5A), and they may also not understand the causal connective *so* (Study 5B). These limits to interpretation occur even though children use these terms in their spontaneous speech. We speculate that these

limits can be explained in terms of an increasing exposure to print and the formal discourse of schooling.

Declaration of Competing Interest

The authors declare no competing interests.

Acknowledgements

We are indebted to all children, parents, carers and preschools for their help and willing participation in our studies.

Funding

This work was supported by the Economic and Social Research Council grants [ES/V012878/1 and ES/N005635/1] awarded to Hugh Rabagliati.

References

- Allen, S. E., Hughes, M., & Skarabela, B. (2015). The role of cognitive accessibility in children's referential choice. *The acquisition of reference*, 15, 123-153.
- Arias-Trejo, N., & Plunkett, K. (2009). Lexical–semantic priming effects during infancy. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1536), 3633-3647.
- Asher, N. & Lascarides, A. (2003). *Logics of Conversation*. Cambridge: Cambridge University Press.
- Bach, K. (1999). The myth of conventional implicature. *Linguistics and philosophy*, 327-366.

Children's acquisition of *but*

- Barner, D., Brooks, N., & Bale, A. (2011). Accessing the unsaid: The role of scalar alternatives in children's pragmatic inference. *Cognition*, 118(1), 84-93.
- Education Scotland Benchmarks: Literacy and English (June 2017).
<https://education.gov.scot/nih/Documents/LiteracyEnglishBenchmarks.pdf>
- Blakemore, D. (1989). Denial and contrast: A Relevance Theoretic Analysis of "But". *Linguistics and philosophy*, 15-37.
- Bloom, L., Lahey, M., Hood, L., Lifter, K., & Fiess, K. (1980). Complex sentences: Acquisition of syntactic connectives and the semantic relations they encode. *Journal of child language*, 7(2), 235-261.
- Blything, L. P., Davies, R., & Cain, K. (2015). Young children's comprehension of temporal relations in complex sentences: The influence of memory on performance. *Child Development*, 86(6), 1922-1934.
- Braunwald, S. R. (1985). The development of connectives. *Journal of pragmatics*, 9(4), 513-525.
- Cain, K., & Nash, H. M. (2011). The influence of connectives on young readers' processing and comprehension of text. *Journal of Educational Psychology*, 103(2), 429.
- Carter, R., McCarthy, M. J., Mark, G. and O'Keeffe, A. (2011). *English Grammar Today*. Cambridge: Cambridge University Press.
- Champaud, C., & Bassano, D. (1994). French concessive connectives and argumentation: an experimental study in eight-to ten-year-old children. *Journal of Child Language*, 21(2), 415-438.
- Clark, E. V. (1971). On the acquisition of the meaning of before and after. *Journal of verbal learning and verbal behavior*, 10(3), 266-275.

Children's acquisition of *but*

- Chafe, W., & Danielewicz, J. (1987). Properties of spoken and written language. In R. Horowitz & S. J. Samuels (Eds.), *Comprehending oral and written language* (pp. 83–113). Academic Press.
- Crain-Thoreson, C., Dahlin, M. P., & Powell, T. A. (2001). Parent-child interaction in three conversational contexts: Variations in style and strategy. *New directions for child and adolescent development*, 2001(92), 23-38.
- de Carvalho, A., Dautriche, I., Fiévet, A. C., & Christophe, A. (2021). Toddlers exploit referential and syntactic cues to flexibly adapt their interpretation of novel verb meanings. *Journal of Experimental Child Psychology*, 203, 105017.
- de Ruiter, L. E., Lieven, E. V., Brandt, S., & Theakston, A. L. (2020). Interactions between givenness and clause order in children's processing of complex sentences. *Cognition*, 198, 104130.
- Du Bois, J. W. (1987). The discourse basis of ergativity. *Language*, 805-855.
- Du Bois, J. W. (2003). Argument structure: Grammar in use. *Preferred argument structure: Grammar as architecture for function*, 14, 11-60.
- Dušková, L., Strnadová, Z., Knittlová, D., Peprník, J., & Tárnyiková, J. (1988). *Mluvnice současné angličtiny na pozadí češtiny*. Prague: Academia.
- English programmes of study: key stages 1 and 2 (2013). Department for Education, UK Government.
- https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/335186/PRIMARY_national_curriculum_-_English_220714.pdf

- Florit, E., Cain, K., & Levorato, M. C. (2017). Understanding the semantic functions of *but* in middle childhood: The role of text-and sentence-level comprehension abilities. *First Language*, 37(2), 109-129.
- Fraser, B. (1988). Types of English discourse markers. *Acta Linguistica Hungarica*, 38(1/4), 19-33.
- French, L. (1981). *But of course preschoolers understand the meaning of 'but!'*. Paper presented at the 6th Annual Boston University Conference on Language Development, Boston, MA.
- French, L.A. (1988). The Development of Children's Understanding of "Because" and "So". *Journal of Experimental Child Psychology* 45, no. 2: 262–79.
- French, L. A., & Brown, A. L. (1977). Comprehension of before and after in logical and arbitrary sequences. *Journal of Child Language*, 4(2), 247-256.
- French, L. A., & Nelson, K. (2012). *Young children's knowledge of relational terms: Some ifs, ors, and buts* (Vol. 19). Springer Science & Business Media.
- Frege, G. (1956). The thought: A logical inquiry. *Mind*, 65(259), 289-311.
- Gallivan, J. (1986). Children's Understanding of "But": Evidence from Spontaneous Production. *Psychological Reports*, 58(2), 425-426.
- Gelman, S. A., Coley, J. D., Rosengren, K. S., Hartman, E., Pappas, A., & Keil, F. C. (1998). Beyond labeling: The role of maternal input in the acquisition of richly structured categories. *Monographs of the Society for Research in Child development*, i-157.
- Gelman, S. A., Taylor, M. G., & Nguyen, S. P. (2004). Mother-child conversations about gender: Understanding the acquisition of essentialist beliefs: III. How children and mothers express gender essentialism. *Monographs of the Society for Research in Child Development*.

Children's acquisition of *but*

- Gelman, S. A., Ware, E. A., Kleinberg, F., Manczak, E. M., & Stilwell, S. M. (2014). Individual differences in children's and parents' generic language. *Child development, 85*(3), 924-940.
- Gibson, E., Bergen, L., & Piantadosi, S. T. (2013). Rational integration of noisy evidence and prior semantic expectations in sentence interpretation. *Proceedings of the National Academy of Sciences, 110*(20), 8051-8056.
- Givón, T. (1983). Topic continuity in discourse: The functional domain of switch reference. *Switch reference and universal grammar, 51-82*.
- Grice, H. P. (1975). Logic and conversation. In *Speech acts* (pp. 41-58). Brill.
- Halliday, M. A. K. (1994). Spoken and written modes of meaning. *Media texts: Authors and readers, 7, 51-73*.
- Hamburger, H., & Crain, S. (1984). Acquisition of cognitive compiling. *Cognition, 17*(2), 85-136.
- Hobbs, J. R. (1979). Coherence and coreference. *Cognitive Science, 3*(1): 67–90.
- Horowitz, A. C., Schneider, R. M., & Frank, M. C. (2018). The trouble with quantifiers: Exploring children's deficits in scalar implicature. *Child development, 89*(6), e572-e593.
- Huang, Y. T., Zheng, X., Meng, X., & Snedeker, J. (2013). Children's assignment of grammatical roles in the online processing of Mandarin passive sentences. *Journal of memory and language, 69*(4), 589-606.
- Hurewitz, F., Papafragou, A., Gleitman, L., & Gelman, R. (2006). Asymmetries in the acquisition of numbers and quantifiers. *Language learning and development, 2*(2), 77-96.
- Janssens, L., Drooghmans, S., & Schaeken, W. (2015). But: do age and working memory influence conventional implicature processing? *Journal of Child Language, 42*(3), 695-708.
- Jerger, S., Martin, R. C., & Damian, M. F. (2002). Semantic and phonological influences on picture naming by children and teenagers. *Journal of Memory and Language, 47*(2), 229-249.

Children's acquisition of *but*

- Jipson, J. L., Gülgöz, S., & Gelman, S. A. (2016). Parent-child conversations regarding the ontological status of a robotic dog. *Cognitive development, 39*, 21-35.
- Johnson, H. L. (1975). The meaning of before and after for preschool children. *Journal of Sullivan Experimental Child Psychology, 19*(1), 88-99.
- Kail, M., & Weissenborn, J. (1984). A developmental cross-linguistic study of adversative connectives: French 'mais' and German 'aber/sondern'. *Journal of Child Language, 11*(1), 143-158.
- Kehler, A. (2002). *Coherence, reference, and the theory of grammar*. Stanford, CA, USA: CSLI Publications.
- Kehler, A., Kertz, L., Rohde, H., and Elman, J. L. (2008). Coherence and coreference revisited. *Journal of Semantics, 25*(1):1-44.
- Keller-Cohen, D. (1987). Context and strategy in acquiring temporal connectives. *Journal of Psycholinguistic Research, 16*, 165-183.
- Koornneef, A. W. and Sanders, T. J. M. (2013). Establishing coherence relations in discourse: the influence of implicit causality and connectives on pronoun resolution. *Language and Cognitive Processes, 28*:1169-1206.
- Lakoff, R. (1971). If's, and's and but's about conjunction. In C. J. Fillmore & D. T. Langendoen (eds.), *Studies in Linguistic Semantics*. Irvington. pp. 3-114.
- Lidz, J., & Musolino, J. (2002). Children's command of quantification. *Cognition, 84*(2), 113-154.
- Mani, N., & Huettig, F. (2012). Prediction during language processing is a piece of cake—But only for skilled producers. *Journal of Experimental Psychology: Human Perception and Performance, 38*(4), 843.

- Mann, W. C. & Thompson, S. A. (1988). Rhetorical Structure Theory: Toward a functional theory of text organization. *Text* 8(3), 243-281.
- MacWhinney, B. (2000). *The CHILDES Project: Tools for analyzing talk*. Third Edition. Mahwah, NJ: Lawrence Erlbaum Associates.
- Meroni, L., & Crain, S. (2003). On not being led down the kindergarten path. In *Proceedings of the 27th Boston University Conference on Language Development* (pp. 531-544). Boston, MA: Citeseer; Cascadilla Press.
- Morais, J., Cary, L., Alegria, J., & Bertelson, P. (1979). Does awareness of speech as a sequence of phones arise spontaneously? *Cognition*, 7(4), 323-331.
- Morris, B. J. (2008). Logically speaking: Evidence for item-based acquisition of the connectives AND & OR. *Journal of Cognition and Development*, 9(1), 67-88.
- Noveck, I. A. (2001). When children are more logical than adults: Experimental investigations of scalar implicature. *Cognition*, 78(2), 165-188.
- Papafragou, A., & Musolino, J. (2003). Scalar implicatures: experiments at the semantics–pragmatics interface. *Cognition*, 86(3), 253-282.
- Potts, C. (2007). Conventional Implicatures: A Distinguished Class of Meanings. In: G. Ramchand, and C. Reiss (eds), *The Oxford Handbook of Linguistic Interfaces*.
- Prasad, R., Dinesh, N., Lee, A., Miltsakaki, E., Robaldo, L., Joshi, A., & Webber, B. (2008). The Penn Discourse Treebank 2.0. In *Proceedings of the 6th International Conference on Language Resources and Evaluation (LREC 2008)* (pp. 2961-2968). Marrakech, Morocco.
- Pyykkönen, P., & Järvikivi, J. (2012). Children and situation models of multiple events. *Developmental Psychology*, 48(2), 521.

- Sanders, T. (2005). Coherence, causality and cognitive complexity in discourse. In *Proceedings/Actes SEM-05, First International Symposium on the exploration and modelling of meaning* (pp. 105-114). Toulouse: University of Toulouse-le-Mirail.
- Sanders, T.J.M., Spooren, W.P.M.S., & Noordman, L.G.M. (1992). Toward a taxonomy of coherence relations. *Discourse Processes* 15(1), 1-35.
- Schleppegrell, M. J. (2001). Linguistic features of the language of schooling. *Linguistics and education*, 12(4), 431-459.
- Seligman, M. (1985). *But: What and how it means*. Technical Report, Dept. of Linguistics, UC Berkeley.
- Snedeker, J., & Yuan, S. (2008). Effects of prosodic and lexical constraints on parsing in young children (and adults). *Journal of memory and language*, 58(2), 574-608.
- Soltis, J. M., & Pflaum, S. W. (1979). The effect of instruction in connectives on reading comprehension. *Literacy Research and Instruction*, 19(2), 179-184.
- Spenader, J. (2018). Children's comprehension of contrastive connectives. *Journal of Child Language*, 45(3), 610-640.
- Sullivan, J., & Barner, D. (2016). Discourse bootstrapping: Preschoolers use linguistic discourse to learn new words. *Developmental science*, 19(1), 63-75.
- Sullivan, J., Boucher, J., Kiefer, R. J., Williams, K., & Barner, D. (2019). Discourse coherence as a cue to reference in word learning: Evidence for discourse bootstrapping. *Cognitive Science*, 43(1), e12702.
- Taboada, M., & Gómez-González, M. (2012). Discourse markers and coherence relations: Comparison across markers, languages and modalities. *Linguistics and the Human Sciences*, 6(1-3), 17-41.

Children's acquisition of *but*

- Trosborg, A. (1982). Children's comprehension of 'before' and 'after' reinvestigated. *Journal of Child Language*, 9(2), 381-402.
- Trueswell, J. C., Sekerina, I., Hill, N. M., & Logrip, M. L. (1999). The kindergarten-path effect: Studying on-line sentence processing in young children. *Cognition*, 73(2), 89-134.
- Volodina, A., & Weinert, S. (2020). Comprehension of connectives: Development across primary school age and influencing factors. *Frontiers in Psychology*, 11, 814.
- Wilson, D. (2016). Reassessing the conceptual-procedural distinction. *Lingua*, 175, 5-19.
- Winograd, T. (1972). *Understanding Natural Language*. Academic Press. New York.
- Wolf, F. & Gibson, E. (2005). Representing discourse coherence: A corpus-based study. *Computational Linguistics*, 31(2):249-287.
- Yurovsky, D., Case, S., & Frank, M. C. (2017). Preschoolers flexibly adapt to linguistic input in a noisy channel. *Psychological Science*, 28(1), 132-140.