

## RESEARCH

## Quantifier spreading: children misled by ostensive cues

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This paper calls attention to a methodological problem of acquisition experiments. It shows that the economy of the stimulus employed in child language experiments may lend an increased ostensive effect to the message communicated to the child. Thus, when the visual stimulus in a sentence-picture matching task is a minimal model abstracting away from the details of the situation, children often regard all the elements of the stimulus as ostensive clues to be represented in the corresponding sentence. The use of such minimal stimuli is mistaken when the experiment aims to test whether or not a certain element of the stimulus is relevant for the linguistic representation or interpretation. The paper illustrates this point by an experiment involving quantifier spreading. It is claimed that children find a universally quantified sentence like *Every girl is riding a bicycle* to be a false description of a picture showing three girls riding bicycles and a solo bicycle because they are misled to believe that all the elements in the visual stimulus are relevant, hence all of them are to be represented by the corresponding linguistic description. When the iconic drawings were replaced by photos taken in a natural environment rich in accidental details, the occurrence of quantifier spreading was radically reduced. It is shown that an extra object in the visual stimulus can lead to the rejection of the sentence also in the case of sentences involving no quantification, which gives further support to the claim that the source of the problem is not (or not only) the grammatical or cognitive difficulty of quantification but the unintended ostensive effect of the extra object.

**Keywords:** quantifier spreading; universal quantifier; exhaustivity; ostension; acquisition

## 1 Introduction

This paper argues that preschoolers' apparent difficulties with the interpretation of universal quantifiers arise from a methodological problem of the experiments, and provide no evidence of immature linguistic competence. We show that presenting a stimulus to a child in a test situation may elicit reactions that do not occur if the child attests the stimulus in natural conditions. The reason for the unexpected reactions is that the experimental stimulus presented to the child is devoid of any episodic details; it merely contains a few iconic symbols, which suggests to the child that the irrelevant details have been omitted; hence every element of the stimulus, including the one whose relevance the experiment aims to test, is to be interpreted as an ostensive signal, i.e., every element of the stimulus is significant.

The role of pragmatic factors in experiments testing child language has been pointed out repeatedly; however, the specific pragmatic factors identified in various experiments as the sources of non-adult-like linguistic behavior mostly seem to be accidental, non-generalizable.

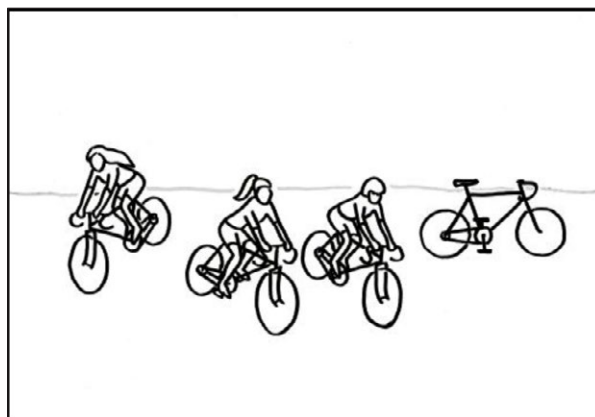
Our pragmatic explanation, on the contrary, is theory-based; we derive the significance of stimulus-internal and contextual episodic details in children's sentence interpretation from the Natural Pedagogy theory of Csibra and Gergely (2009), based on Sperber and Wilson's (1986; 1995) Relevance Theory, briefly introduced in Section 2. As Csibra and Gergely have shown by a great number of experiments, children are predisposed to distinguish ostensive communication from neutral talk, to pay attention to it, and to accept its content as relevant information or as generalizable knowledge. We claim that stimuli presented in obvious test situations, having no accidental details, assume an increased ostensive effect, which assigns relevance to otherwise irrelevant details of the stimulus.

We illustrate this point by an experiment involving quantifier spreading. As has been demonstrated over and over again, children often find a universally quantified sentence like *Every girl is riding a bicycle* to be a false description of Figure 1, showing three girls riding a bicycle, as well as a solo bicycle. We argue in Section 3 that children give non-adult-like reactions because they are misled to believe that all the elements in the visual stimulus are relevant, hence all of them are to be represented by the corresponding linguistic description. When we replaced the iconic drawings by photos taken in a natural environment rich in accidental details, the occurrence of quantifier spreading was radically reduced.

We show that the ostensive effect of iconic stimuli may distort the results of other types of acquisition studies, as well. In Section 4, we cite the results of an experiment by Pintér (2016) testing if children understand the exhaustivity of focus constructions. Pintér found that many children rejected not only focus constructions but also neutral sentences in non-exhaustive situations (e.g., they rejected the sentence "The bunny raised the flag" as a true description of a drawing showing a bunny and a bear each raising a flag). In a follow-up experiment, we compared the acceptance of such sentences in non-exhaustive situations represented by iconic drawings and in non-exhaustive situations represented by photos, and we found a significantly higher rejection rate in the case of the drawings.

## 2 The notion of ostension in Relevance Theory and in Natural Pedagogy

Ostension is a notion of the Relevance Theory of Sperber and Wilson (1986). Relevance Theory is built on the assumption that attention and thought processes automatically turn toward information that seems relevant, capable of yielding cognitive effects. To communicate is to imply that the information communicated is relevant. As the Principle of Relevance states, communicated information comes with a guarantee of relevance. The higher the cognitive effect of the information, and/or the more economically it is communicated, the greater its relevance. Communication can be achieved not only by encoding



**Figure 1:** Exhaustive Pairing.

and decoding messages but also by providing evidence for an intended inference about the communicator's informative intention.

Ostension is the behaviour when the communicator makes manifest his/her intention to make something manifest, i.e., perceptible or inferable, to the listener. Thus ostensive communication provides two kinds of information: information changing the listener's cognitive state, and information communicating that the first layer of information is presented intentionally. Humans try to obtain from every item of information as great a contextual effect as possible for as small a processing effort as possible. The ostensive nature of the stimulus signals to the addressee that he/she shall have expectations of high relevance.

The research of Csibra and Gergely (2009; 2011) has shown that children are particularly sensitive to ostensive communication; they are biased to interpret ostensive signals as conveying kind-relevant, generalizable information. As has been demonstrated in a series of experiments involving infants and preschoolers, children tend to give more credit to information derived from ostensive communication than to information obtained via direct experience (Csibra & Gergely 2006; Gergely et al. 2007; Csibra 2010; Futó et al. 2010; Gergely & Jacob 2012; Butler & Markman 2014). This is what makes the transmission of generic knowledge between generations possible. It is this communication system, called "Natural Pedagogy", that permits the fast and efficient social learning of cultural knowledge that would be hard to acquire based on observational learning mechanisms alone (Csibra & Gergely 2011: 1149).

We claim that a test situation, with the child intentionally removed from his/her normal environment, and manifestly made the addressee of the experimenter's communication, is inherently ostensive. The economy of the stimuli also enhances the ostensive effect. Thus, if the visual stimulus merely consists of a few iconic symbols, the child may very well conclude that everything irrelevant has been omitted from the picture, i.e., all the remaining elements are relevant. This false belief is bound to yield false results if the purpose of the experiment is to test whether or not an element of the stimulus is relevant for interpretation – as illustrated by our experiment involving quantifier spreading.

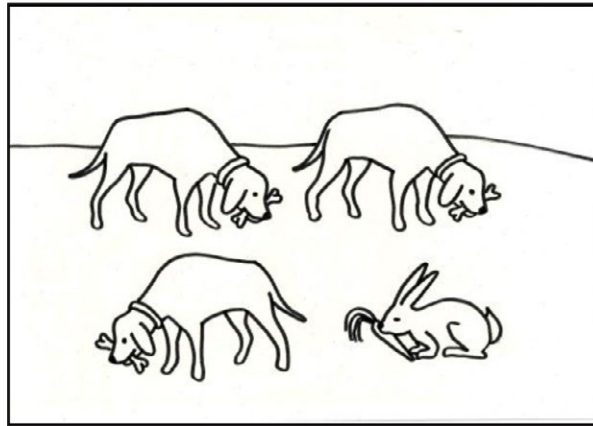
### 3 Quantifier spreading as an ostensive effect

#### 3.1 The phenomenon

Quantifier spreading is a problem attested when a sentence like (1), containing a constituent determined by the universal quantifier *every*, *each*, or *all*, is to be matched with a picture like Figure 1.

(1) Every girl is riding a bicycle.

Although every one of the three girls in the picture is riding a bicycle, many children find the sentence false. When asked "Why?", they point at the solo bicycle, and say something like "Not that bicycle", i.e., they show 'Exhaustive Pairing' under an extra object condition. This phenomenon has been attested in dozens of experiments among speakers of English (Bucci 1978; Philip 1995; Brooks & Braine 1996; Crain et al. 1996; Roeper et al. 2011), Dutch (Philip & Coopmans 1995; Drozd & van Loosbroek 1999; Hollebrandse 2004; Hollebrandse & Smits 2005; Philip 2011), Turkish (Freeman & Stedmon 1986), Russian (Sekerina & Sauermann 2015), Hungarian (Gyuris 1996), Korean (Kang 1999), Japanese (O'Grady et al. 2010; Minai et al. 2012), Norwegian, Spanish, and French (Philip 2011), etc. It has been found to be most common among preschoolers, but it has also been attested among older children (Philip 2011), as well as English adults and adult speakers of heritage Russian (Brooks & Sekerina 2005/2006; Sekerina & Sauermann 2015). The variability of the rate of its occurrence is exceptionally high; in some experiments, the



**Figure 2:** Perfectionist Response.

percentage of quantifier spreading among young children was above 80% (Philip 2011: 366), in some others, it was below 15% (Crain et al. 1996: 127) – depending on the age of the participants, and crucially, on the stimuli used in the experiments.

Quantifier spreading also has a somewhat less common variant, called “Perfectionist Response”.<sup>1</sup> It occurs when a universally quantified sentence like (2a) is to be matched with a picture like Figure 2, which contains an element that is neither identical with the referent of the subject, nor identical with the referent of the VP-internal complement.<sup>2</sup>

- (2) a. Every dog is eating a bone.  
b. No, not that one.

### 3.2 Theories of quantifier spreading

Inhelder and Piaget (1958; 1964) assumed that quantifier spreading demonstrates young children’s failure to understand the relation of inclusion, i.e., it is the manifestation of a cognitive deficit. Subsequent studies identified it as a linguistic problem. Bucci (1978) concluded that child grammar has no syntax associating the quantifier *every* with the nominal following it; children decode universally quantified sentences as a list of content words, and interpret them on the basis of the context or by guessing. Philip (1995; 1996) argued that child grammar is determined by the same principles as adult grammar, and quantifier spreading is due to children misanalyzing the universal quantifier quantifying over individuals as a quantifier quantifying over events. Whereas adults assign to the sentence in (1) the reading in (3a), children interpret it as (3b):

- (3) a.  $\forall(x)[ \text{Girl}(x) \rightarrow \exists(y) [ \text{Bicycle}(y) \ \& \ (x \text{ is riding } y) ] ]$   
‘For every girl  $x$ , there is a bicycle  $y$  such that  $x$  is riding  $y$ .’  
b.  $\forall(e)[ \text{PART}(\text{Girl}(e)) \text{ or } \text{PART}(\text{Bicycle}(e)) ] \rightarrow \text{Girl-is-riding-a-bicycle}(e)$   
‘For every event  $e$ , in which a girl participates or in which a bicycle participates (or both), a girl is riding a bicycle in  $e$ .’

<sup>1</sup> There are also other terms in use. E.g., Roeper et al. (2004) use Mentioned Object Spreading and Unmentioned Object Spreading instead of the terms Exhaustive Pairing and Perfectionist Response of Philip (2011). The informal names Classic Spreading versus Bunny Spreading are also popular (Roeper et al. 2004; Rakhlin 2007). Exhaustive Pairing is also referred to as Symmetrical Response.

<sup>2</sup> Universally quantified sentences occasionally elicit a further type of interpretive problem, as well. When a sentence like that questioned in (1a) is to be matched with a picture containing four girls, three riding bicycles, and the fourth walking, some children find the sentence to be true. This phenomenon, called “Underexhaustive Search”, may simply be due to children’s limited attention.

In fact, children are not fully consistent in assigning to universally quantified sentences interpretations of type (3b); the adult interpretation illustrated in (3a), too, appears to be accessible also to those favoring the spreading reading.

A version of the event quantification analysis of quantifier spreading has been formulated in syntactic terms. Roeper et al. (2004) argue that the syntactic and semantic properties of *every* are not learned at once but involve an acquisition path. *Every* is initially analyzed as an adverbial quantifier c-commanding the whole clause, then it is reanalyzed as a floating determiner akin to a floating *each*, until it is eventually restricted to being inside the DP.

The event quantification analysis of Philip (1995) has been criticized on several grounds. For example, it predicts that quantifier spreading is only attested in the case of eventive sentences. In fact, as shown by Philip (2011), it also occurs with sentences of type (4), which contain no event variable:

(4) Every girl is a bicycle rider.

Furthermore, as Crain et al. (1996) point out, the analysis of *every* as an event quantifier does not account for the “perfectionist” mistake, i.e., for the case when the sentence questioned in (1a) is found false in the presence of an extra participant that is neither a girl, nor a bicycle. The fact that children have initially access to two interpretations of universally quantified sentences (those of type (3b) and (3a)), one of which is later eliminated, raises a learnability problem, as well – under the assumption that children acquiring their mother tongue only have access to positive evidence.

An influential line of research, represented by Drozd (2001; 2004), Drozd and Loosbroek (1999; 2006), and Geurts (2003), among others, claims that the interpretation of strong quantifiers is difficult for young children, hence they often apply to them the simpler processing strategy of weak quantifiers. What makes strong quantifiers like *every* and *all* difficult is that they require the identification of two sets, one of which is determined by the context. E.g., (5a) is to be interpreted as (5c), where *every* establishes a relation between a contextually determined set of boys and the set of elephant riders. Instead of the complex operation of identifying a presupposed set (the domain of the universal quantifier), and establishing a relation between it and the set determined by the predicate phrase, children may choose the processing strategy of weak quantifiers such as *some* or *three*. Adopting the weak processing strategy to (5a) yields the semantic representation in (5b), which involves a single set, every element of which is a boy riding an elephant.

- (5) a. Every boy is riding an elephant.  
 b. <every> [x, y: boy(x), elephant(y), x rides y]  
 c. [x: boy(x)] <every> [y: elephant(y), x rides y]

Geurts (2003), nevertheless, assumes that children’s target representation is something like (6):

(6) [ ... : ... ] <every> [x, y: boy(x), elephant(y), x rides y]

This representation leaves the domain of quantification underdetermined, and the missing domain is provided by pragmatic inferencing based on the visual stimulus.

This theory has been criticized because its elements fail to form a causal chain; it is not clear how the difficulty of identifying the domain of the universal quantifier results in Exhaustive Pairing (Philip 2011: 368).

Several experiments on quantifier spreading have shown that the rate of spreading is affected by pragmatic factors, e.g., a rich linguistic or visual context reduces spreading (cf. Crain et al. 1996). However, some of the evidence concerning the role of extra elements appears to be contradictory; e.g., in the case of quantifier spreading, both the increasing of the number of extra objects (Freeman, Sinha & Stedmon 1982), and the decreasing of the size of the extra object (Philip 2011: 377) have been found to reduce the proportion of spreading, which has not been given a principled explanation.

Philip's recent theory of quantifier spreading (Philip 2011), called the Relevance Account, is a pragmatic extension of the theory of Drozd and Loosbroek (2006). Philip claims that the problem that children have to solve when assigning a domain to a universal quantifier is which objects in the context should be taken as relevant. Adults rely on their world knowledge in identifying the presupposed set. As formulated in the Normal World Constraint, "if an object is contextually relevant, then there is a normal situation that it is part of." Another constraint playing a role in assigning a relevant set to universal quantifiers is the Salient Object Strategy, according to which "if an object is contextually relevant, then it is salient" (Philip 2011: 370–371). These constraints help the speaker and the listener have the same common ground. Children who do not have sufficient world knowledge to identify a contextually relevant set determine relevance by means of a perceptual mechanism that causes objects that spoil a symmetrical pattern to become salient. This cognitive mechanism is claimed by Philip (2011: 371) to cause children and adults showing quantifier spreading to imagine the existence of the unseen object spoiling symmetry. However, Philip provides no clear evidence of these claims. It is not proven that universal quantification triggers symmetrical pattern recognition, and it is not demonstrated that all, or most, of the subjects showing quantifier spreading reject a quantified sentence like (1) as the true description of Figure 1 because they imagine the existence of a fourth girl who is not riding a bicycle.

Crain et al. (1996) have put forth a radically pragmatic view of quantifier spreading (see also Meroni et al. 2000; Gualmini et al. 2003). They claim that quantifier spreading is a methodological artifact, the consequence of flawed experimental design, which is shown, among others, by the fact that the rate of quantifier spreading is extremely variable, and is clearly stimulus dependent. What misleads children in the truth value judgement of quantified sentences is, in their opinion, that a *yes/no* question is appropriate only if it is plausible to entertain both a "Yes" and a "No" answer. That is, test sentences ought to be embedded in contexts that satisfy the Condition of Plausible Dissent. The question *Is every girl riding a bicycle?*, for example, would only be a legitimate question in a context where both the possibility of riding a bicycle and the possibility of not riding one has emerged for some or all of the girls. As it is difficult to graphically depict both of the alternative outcomes, it is ill-advised to use a single-picture task in such cases.

The theory of Crain et al. (1996) has elicited critical comments of various kinds (Philip 1996; Gordon 1998; Drozd & van Loosbroek 1999; Geurts 2000; 2003; Philip & Lynch 2000; Drozd 2004; Brooks & Sekerina 2005/2006). These critical studies have cited both experiments satisfying the Condition of Plausible Dissent while eliciting quantifier spreading, and experiments violating the Condition of Plausible Dissent, nevertheless eliminating quantifier spreading. Geurts (2003) argued against the claim that a *yes/no* question is pragmatically infelicitous unless both the affirmative and the negative answers are under consideration. On the contrary, part of the function of *yes/no* questions is to introduce alternatives into the discourse irrespective of whether or not they are already under consideration. Brooks and Sekerina (2005/2006) raise the point that Crain et al. always embed the test sentence in a story where the protagonist corresponds to the NP modified by the universal quantifier. This feature of their design provides children with

unambiguous cues as to which set of entities is the focus of attention. Highlighting one set of entities relative to another set serves to familiarize children with the intended domain of the universal quantifier.

The proposal we are presenting below maintains the basic claim of Crain et al. (1996). We, too, argue that quantifier spreading is not evidence of any grammatical deficit in child language; it is a pragmatic phenomenon, an experimental artifact elicited by misleading experimental methodology. In our view, however, what blocks the correct interpretation of the test sentences in quantifier spreading experiments is not a violation of the Condition of Plausible Dissent but an ostensive effect elicited by the stimuli. Creating a context introducing the possibility of plausible dissent is one of the ways of eliminating the ostensive effect.

### **3.3 Quantifier spreading is due to the increased ostensive effect of iconic stimuli**

We hypothesized that quantifier spreading is elicited in experimental situations where the stimulus is not embedded in a context, and is devoid of episodic details, as a consequence of which it gains a – potentially misleading – concentrated ostensive effect.<sup>3</sup> The presentation of a visual stimulus in a sentence–picture matching task is presumably always interpreted as relevant, ostensive communication. Crucially, however, when the stimulus only contains a few iconic symbols, every one of its elements gains an ostensive effect. A general feature of the drawings used in these experiments is that they lack accidental details (e.g., Figure 1, associated with sentence (1), represents three girls riding bicycles and a solo bicycle without any other vehicles, pedestrians, trees, fences, houses, street lights, clouds in the sky, etc.). The lack of irrelevant details makes children infer that everything in the picture is intended to be relevant, and is to be represented linguistically in the accompanying sentence. Hence when they have to judge the correspondence of the visual and the linguistic information, they often give a negative answer.

### **3.4 Experimental confirmation**

#### **Objectives**

Our experiment aimed to test the hypothesis that if the visual stimuli containing only a few icon-like elements are replaced by photos rich in accidental details, the ostensive effect associated with every detail of the picture is reduced, and quantifier spreading is greatly diminished.

#### **Participants**

We tested 82 children from 5 Budapest kindergartens, whose mean age was 5;3 years ( $SD = 0.73$ ). We also carried out the experiment with an adult control group consisting of 24 university students, whose mean age was 21 years ( $SD = 1.61$ ).

#### **Procedure**

The child, the experimenter, and a helper were seated at a table in front of a laptop in a quiet room of the kindergarten. The helper held a teddy bear. The experimenter told the child that they would look at pictures on the computer screen together. The

<sup>3</sup> Apparently, Rakhlin (2007) argues for a similar claim: children's performance with respect to quantifier spreading is facilitated by a richer context (either linguistic or visual). However, according to Rakhlin, the role of the enriched context is not to reduce ostension, but to increase the relevance of certain elements. In Rakhlin's approach, quantifier spreading seems to be an epiphenomenon: a question like *Is every girl riding a bicycle?* asked about Figure 1 elicits a negative answer when the salience of the extra bicycle induces children to assign wide scope to the indefinite, i.e., to expect every girl to ride the same single bicycle. I.e., if the picture contains a salient single individual with the property denoted by the indefinite, children allegedly tend to see its salience as an indication of its relevance for the speaker and construct the domain restriction for the indefinite to include exactly one individual.

bear had already looked at the pictures and told the experimenter what he saw, which was recorded. The bear was old, and had weak eyes, hence he could not always see the picture properly. They would listen to what the bear said about each picture, and the experimenter would ask the subject whether or not it was true. Stimuli were presented by OpenSesame 2.8.X; first the visual stimulus appeared, and the recorded sentence followed after 3 seconds. The subject's answers were marked by the experimenter on a sheet of paper, and the whole experiment was videorecorded.

### Materials

16 sentence–picture pairs (8 fillers and 8 test pairs) were presented to the subjects. Each test sentence involved the universal quantifier *minden* ‘every’. Four sentence–picture pairs were of the type which can elicit the Exhaustive Pairing mistake, i.e., they involved an extra object (see example (7) and Figures 3, 4), and four sentence–picture pairs were of the type which can elicit the Perfectionist Response, i.e., they contained an extra element neither identical with the referent of the subject, nor identical with the referent of the VP-internal complement (see example (8) and Figures 5, 6). The situations associated with the test sentences were represented both by an iconic drawing, and a photo containing many episodic details, e.g.:

- (7) Minden óvodás magas széken ül.  
 every preschooler high chair.on sits  
 ‘Every preschooler is sitting on a high chair.’

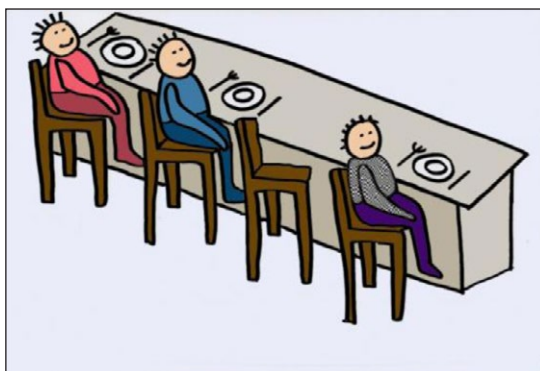
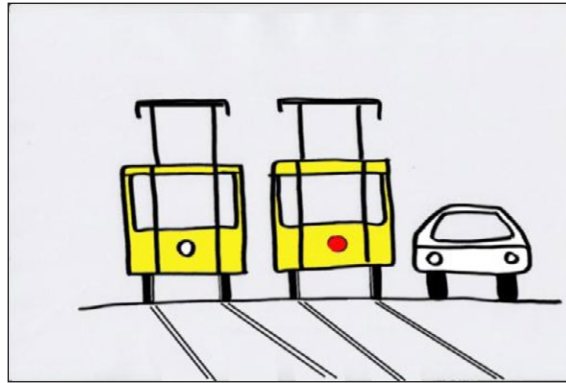


Figure 3.



Figure 4.





**Figure 5.**



**Figure 6.**

- (8) Minden villamos sárga.  
 every tram yellow  
 'Every tram is yellow.'

The test stimuli were presented in two sessions in different combinations. In the first session, half of the subjects were presented with eight test sentences, four accompanied by drawings, and the other four accompanied by photos. In the other session involving the other half of the subjects, the drawings and photos were reversed for the same sentences. The fillers were arranged in the same way.

### Results

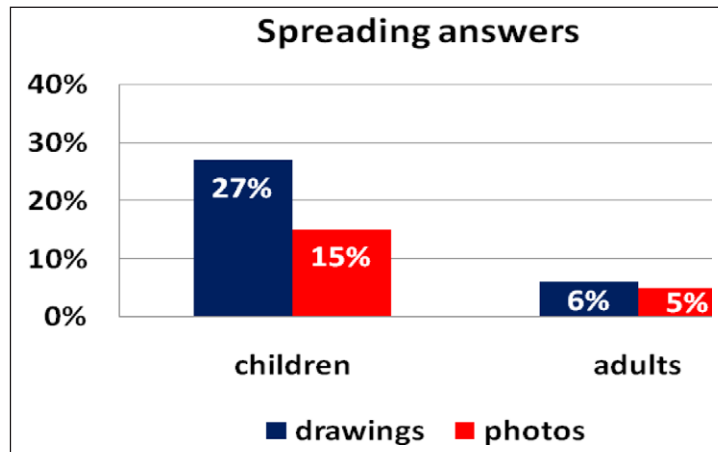
The two experimental sessions did not differ from each other in respect of the children's answers ( $\text{Mean}_{\text{session1}} = 0.23$  ( $SD = 0.4$ );  $\text{Mean}_{\text{session2}} = 0.18$  ( $SD = 0.39$ ),  $F = 2.26$  ( $df = 1/655$ ) n.s.). There was no difference between the two sessions in the adult control group, either ( $\text{Mean}_{\text{session1}} = 0.03$  ( $SD = 0.18$ );  $\text{Mean}_{\text{session2}} = 0.08$  ( $SD = 0.28$ ),  $F = 2.42$  ( $df = 1/191$ ) n.s.), so we combined the data into one group for further analysis.

The stimuli consisting of a quantified sentence and a drawing elicited quantifier spreading in 27% of the children's answers. In the case of the stimuli consisting of a quantified sentence and a photo, the rate of quantifier spreading dropped to 15%. Among the adults, the rate of quantifier spreading was 6% and 5%, respectively (see Figure 7).

Spreading answers of children:

Drawings:  $\text{Mean} = 0.27$  ( $SD = 0.44$ ),

Photos:  $\text{Mean} = 0.15$  ( $SD = 0.35$ ),  $F = 15.84$  ( $df = 1/655$ )  $p < 0,001$



**Figure 7:** The rate of quantifier spreading.

Spreading answers of adults:

Drawings: Mean = 0.06 ( $SD = 0.24$ ),

Photos: Mean = 0.05 ( $SD = 0.22$ ),  $F = 0.09$  ( $df = 1/191$ ) n.s.

### Discussion

In language acquisition experiments, experimenters tend to use iconic visual stimuli in order to eliminate irrelevant distractors, and to ensure that children only react to the controlled factor(s). Our results suggest that this method is mistaken when the experiment aims to test whether or not an element in the stimulus is relevant for the linguistic representation. If the visual stimulus is a minimal model devoid of episodic details, children tend to interpret all of its elements as ostensive clues to be represented linguistically. If the ostensive effect is diminished by the use of photos taken in natural environments, the proportion of QS is reduced by nearly 50%.

The individual examination of the visual stimuli provides further support for the hypothesized inverse correlation between the richness of episodic details and the rate of quantifier spreading. The only photo which elicited a relatively high proportion (36%) of quantifier spreading answers (Figure 8) is a picture of a fairly artificial-looking setup with remarkably few details:

- (9) Minden néni napozóágyon fekszik.  
 every woman sunbed.on lies  
 'Every woman is lying on a sunbed.'

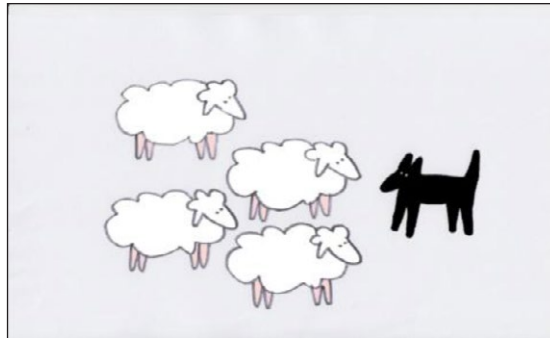
In the case of the test sentence in (10), the drawing and the photo turned out to generate the same proportion of quantifier spreading answers (23%). If we compare the drawing and the photo (Figures 9, 10), we do not see much difference in the presence of episodic details:

- (10) Minden bárány fehér.  
 every sheep white  
 'Every sheep is white.'

The fact that a richer linguistic or visual context reduces quantifier spreading has been pointed out by Crain et al. (1996), and the fact that either the increasing of the number of extra objects, or the decreasing of the size of the extra object has a similar effect has also been confirmed experimentally in prior studies (Freeman, Sinha & Stedmon 1982;



**Figure 8.**



**Figure 9.**



**Figure 10.**

Drozd & van Loosbroek 1999; Philip & Lynch 2000; Philip 2011; Minai et al. 2012; etc.). What has not been clarified in earlier studies is why this is the case. Decreasing the size of the extra object makes the object less salient; but increasing the number of the extra objects does not necessarily decrease their salience, and what is more, it is not clear why an increase in the salience of the extra object should result in the increased frequency of quantifier spreading responses.

We claim that the effect of presenting episodic details, the effect of providing rich linguistic and visual contexts, the effect of increasing the number of extra objects, and the effect of decreasing the size of the extra object can be given a unitary explanation in the framework of Natural Pedagogy. These factors all reduce the ostensivity of the extra object, whereby they reduce the illusion that the extra object is one of the intentionally introduced visual signals, whose linguistic equivalent must be present in the appropriate linguistic representation of the stimulus. Episodic details, a context, and an increase in the number of extra

objects all reduce the ostensivity of a particular extra object by introducing many, and/or many different kinds of extra objects. Decreasing the size of the extra object reduces the illusion that the extra object is of the same rank as the objects quantified over.

Naturally, the question may arise why our improved methodology, employing photos instead of iconic drawings, has merely reduced the rate of quantifier spreading, instead of eliminating it completely. We assume that the remaining 15% of quantifier spreading mistakes are mostly due to the ostensive nature of the test situation itself (and may also include some noise). As claimed by Sperber and Wilson (1986; 1995), the manifest informative intention of the communicator enhances the ostensive effect of communication. Not even the use of photos can eliminate this effect in test situations where the child is removed from his/her everyday environment, and is addressed by the experimenter directly.

#### 4 Misleading ostensive effect in other types of acquisition experiments

##### 4.1 An example: A test of exhaustivity

The misleading ostensivity of experimental stimuli is not restricted to quantifier spreading experiments; it may distort results in other areas of language acquisition studies, as well. Here we only cite one further example. It has been tested in several experiments (e.g., Beaver & Onea 2011; Kas & Lukács 2013; Pintér 2016) whether the exhaustivity of the preverbal focus of the Hungarian sentence (corresponding roughly to an English cleft constituent) is an inherent semantic property or a cancellable pragmatic implicature. The tasks involved truth value judgements; experimenters aimed to find out whether children and adults accept a focus construction like (11) as a true description of a non-exhaustive situation like that in Figure 11 (both cited from Pintér 2016):

- (11) A NYUSZI emelte fel a zászlót.  
 the bunny raised up the flag-ACC  
 ‘It was the bunny who raised the flag.’

The corresponding baseline sentence, assumed by Pintér to be definitely true, was the neutral sentence without any structural focus in (12):

- (12) A nyuszi fel emelte a zászlót.<sup>4</sup>  
 the bunny up raised the flag-ACC  
 ‘The bunny raised the flag.’

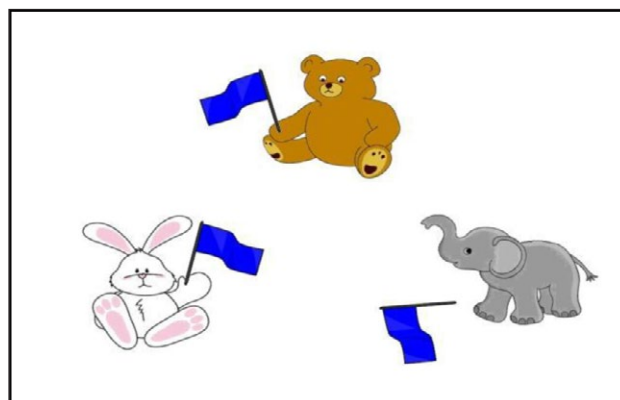


Figure 11.

<sup>4</sup> Whereas in the neutral (12) the subject is in topic position (Spec,TopP), followed by the verb and the verbal particle, in the focus construction in (11) the subject is in the post-topic focus slot (Spec,FocP), where it has attracted the verb across the particle.

Subjects had to evaluate how truly (11) and (12) describe the situation in Figure 11 on a 3-point scale, whose grades were represented for children by a happy, a straight and a sad smiley face:



Pintér tested four age groups: preschoolers, 7-year-old children, 9-year-old children, and adults. The recognition that the focus construction in (11) is not a fully adequate description of the non-exhaustive situation in Figure 11 was growing by age, and the “happy smiley” evaluation (preschoolers: 65%; 7-year-olds: 27%; 9-year-olds: 18%; adults: 13%) was gradually replaced by the straight smiley evaluation (preschoolers: 23%; 7-year-olds: 47%; 9-year-olds: 75%; adults: 78%). Surprisingly, however, subjects also marked the focusless (12) by the straight smiley (i.e., as only partially true) in many cases (preschoolers: 12%; 7-year-olds: 22%; 9-year-olds: 48%; adults: 19%). We assume that the children and the adults who did not find (12) true thought that the true linguistic representation of the situation in Figure 11 should also include reference to the bear raising his flag. That is, the presence of extra objects in the picture had the same misleading effect as in the case of quantifier spreading. The misleading effect must have had the same reason: the lack of episodic details suggested to the subjects that all the remaining elements in the visual stimulus were relevant. The fact that the partial rejection of this type of sentence–picture combination was highest among 9-year-old children seems to indicate that this is the age-group of those tested by Pintér that is most susceptible to information communicated ostensibly in test situations.

#### 4.2 A follow-up experiment

Our hypothesis that the partial rejection of neutral sentences in non-exhaustive situations found by Pintér (2016) was due to the misleading ostensive effect of the iconicity of the visual stimuli has been tested in a follow-up experiment. We focussed on preschoolers, the age group also targeted by our quantifier spreading experiment.

##### Participants

We tested 38 children from 2 Budapest kindergartens, whose mean age was 6;5 years ( $SD = 0.76$ ). The adult control group consisted of 15 subjects (5 males and 10 females), Mean age = 32 years ( $SD = 10.76$ ).

##### Procedure

The procedure was the same as in the quantifier spreading experiment reported above. The child, the experimenter, and a helper were seated at a table in front of a laptop in a quiet room of the kindergarten. The helper held a teddy bear. The experimenter told the child that they would look at pictures on the computer screen together. The bear had already looked at the pictures and told the experimenter what he saw, which was recorded. The bear was old, and had weak eyes, hence he could not always see the picture properly. They would listen to what the bear said about each picture, and the experimenter would ask the child whether or not it was true. I.e., *yes* or *no* judgements were requested, unlike in Pintér’s experiment, where subjects evaluated the sentence–picture pairs on a 3-degree Likert scale. Stimuli were presented by OpenSesame 2.8.X; first the visual stimulus appeared; the recorded sentence followed after 3 seconds. The child’s answers were marked by the experimenter on a sheet of paper, and the whole experiment was videorecorded.

### Materials

18 sentence–picture pairs (12 fillers and 6 test pairs) were presented to the subjects. (The fillers involved little challenges such as a numeral, a universal quantifier, or the comparison of quantities, but, crucially, there were no focus constructions among them in order to avoid any priming of exhaustivity.) The test sentences were simple intransitive and transitive sentences. The objects of the transitive sentences included preverbal bare nominals and postverbal indefinite and definite objects. The pictures associated with the sentences contained extra agents, or extra patients. Each picture had two versions: an iconic drawing, and a photo containing many episodic details, see Figures 12–13 accompanying example (13), Figures 14–15 accompanying example (14), and Figures 16–17 accompanying example (15).

(13) A bácsi korcsolyázik.  
the man ice-skates  
'The man is ice-skating.'

(14) A néni tyúkokat etet.  
the woman chickens-ACC feeds  
'The woman is feeding chickens.'

(15) A gyerekek fel-vágták a paradicsomot.  
the children up-cut the tomato-ACC  
'The children cut up the tomato.'

The test stimuli were presented in two sessions in different combinations. In the first session, half of the subjects were presented with eight test sentences, four accompanied by

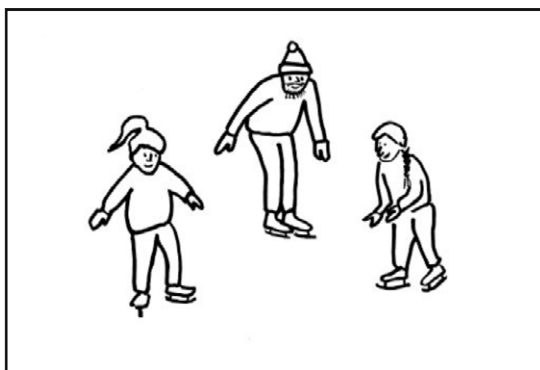


Figure 12.



Figure 13.

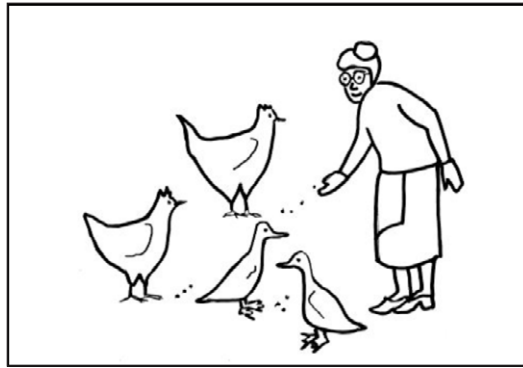


Figure 14.



Figure 15.



Figure 16.



Figure 17.

drawings, and the other four accompanied by photos. In the other session involving the other half of the subjects, the drawings and photos were reversed for the same sentences. The fillers were arranged in the same way.

### Results

The rate of rejection of the sentences as true descriptions of the visually represented situations significantly correlated with the type of the visual representation. The sentence–drawing pairs were rejected in 10.53% of the cases. In the case of the sentence–photo pairs, the rate of rejection was a mere 3.51%. Just as in Pintér’s (2016) experiment, the rate of rejection (i.e., the rate of the exhaustive interpretation of the sentences) was slightly even higher in the adult control group: 13.33% in the case of sentence–drawing pairs, and 8.88% in the case of sentence–photo pairs (see Figure 18). When we asked the subjects giving negative answers why e.g. (14) was not true of Figure 14, they consistently gave answers of the following type: “Because the woman is also feeding the ducks”.

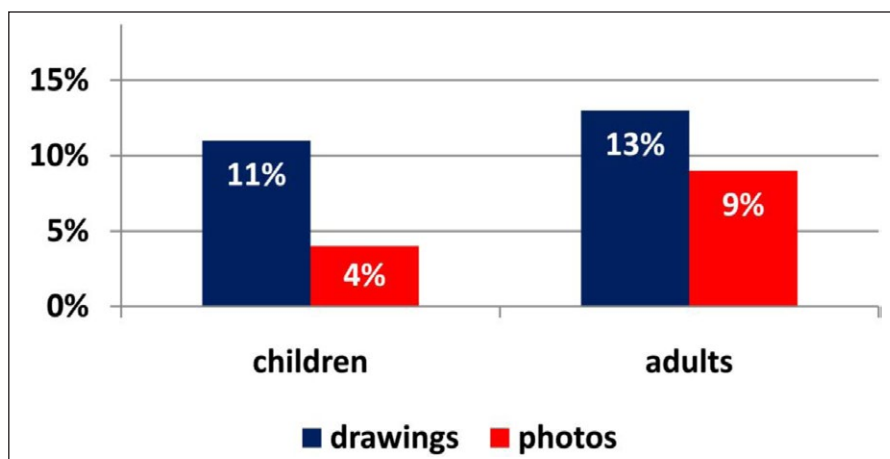
Children: Drawings: Mean = 0.11 ( $SD = 0.38$ );  
Photos: Mean = 0.04 ( $SD = 0.19$ ),  $F = 4.35$  ( $df = 1/227$ )  $p = 0.038$

Adults: Drawings: Mean = 0.13 ( $SD = 0.34$ );  
Photos: Mean = 0.09 ( $SD = 0.29$ ),  $F = 0.44$  ( $df = 1/89$ )  $p = n.s.$

15 children (39%) gave at least one negative answer. The number of children rejecting one or more sentence–drawing pairs was 11, whereas the number of children rejecting one or more sentence-photo pairs was merely 5.

### Discussion

The sentences tested in this experiment involved no special linguistic or cognitive difficulty; they were simple declarative sentences with no quantification, let alone universal quantification; nevertheless, 10.53% of the preschoolers evaluated them as false descriptions of the drawings intended to represent them visually. Since this rate is not high (though it is comparable to the 12% of partial rejection obtained by Pintér 2016 in this age group), we might be tempted to attribute it to noise (children’s failure to pay attention, etc.). However, if the 10.53% rate of rejection had been due to noise, it would not have dropped to 3.51% when the visual stimuli were represented by photos. The comments of the children giving negative answers made it clear that they rejected the given sentence–picture pair because the picture contained extra objects that were not repre-



**Figure 18:** Rejection rate of non-exhaustive-sentence – picture pairs.



sented linguistically. Crucially, the photos contained many more extra agents and extra objects than the drawings, still they elicited significantly less rejections. What made the presence of extra objects in the drawings ostensive was the minimality of the drawings, suggesting that everything irrelevant had been eliminated from them.

## 5 Conclusion

Our paper has called attention to a methodological problem of acquisition experiments. It has shown that the economy of the stimulus employed in child language experiments may lend an increased ostensive effect to the message communicated to the child, as a result of which the child may assign increased relevance to every element of the stimulus, assuming that these elements all represent information to be used in the given task. Thus, when the visual stimulus in a sentence-picture matching task is a minimal model abstracting away from the details of the situation, children often regard all the elements of the stimulus as ostensive clues to be represented in the corresponding sentence. The use of such minimal stimuli is mistaken when the experiment aims to test whether or not a certain element of the stimulus is relevant for the linguistic representation or interpretation. Quantifier spreading is the consequence of such a situation; it is the artefact of misleading experimental methodology. We have shown that an extra object in the visual stimulus can lead to the rejection of the sentence also in the case of sentences involving no quantification, which gives further support to the claim that the source of the problem is not (or not only) the grammatical or cognitive difficulty of quantification but the unintended ostensive effect of the extra object.

As shown by Csibra and Gergely (2009), children generally tend to accept ostensive communication as relevant information. Obviously, by the time they grow up they learn that ostensive signals can also be deceptive, and the likelihood of potentially misleading ostensive communication is particularly high in test situations. Nevertheless, even adults can fall prey to the ostensive effect of psycholinguistic stimuli, as shown by our experiment testing exhaustive interpretation. Quantifier Spreading, too, has also been attested among adults using their heritage language (Sekerina & Sauermann 2015). The fact that these adults used a language which they did not control perfectly, and which made extra demands on their grammatical and other cognitive resources presumably made them more exposed to the observed effect.

The role of pragmatics (the nature of the stimuli, their way of presentation, their context, etc.) in children's achievements has been pointed out repeatedly in language acquisition experiments (for example, by Crain et al. 1996; Crain and Thornton 1998); however, no shared principles underlying the different manifestations of pragmatic effects have emerged. Our experiments have shown that the Natural Pedagogy theory of Csibra and Gergely (2009), based on Sperber and Wilson's (1986; 1995) Relevance Theory, is a framework that is capable of reducing a wide range of pragmatic factors to basic principles of communication.

## Abbreviations

ACC = accusative

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## Competing Interests

The authors have no competing interests to declare.

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