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Scales and non-scales in (Hebrew) child language

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Abstract

This paper reports adult and child knowledge of the generalized scalar implicature (GCI) of disjunction, the non-scalar 'Allover' GCI and the particularized No-contrast implicature. The contributions of scales, generalization and relational complexity to the developmental difficulty of phenomena at the semantic-pragmatic interface are discussed. Results show that children as old as 9-years do not demonstrate adultlike knowledge of the scalar GCI of disjunction or the No-contrast PCI, while the 'Allover' GCI is demonstrated at 5 years. We conclude that the quaternary-level relational complexity of the later developing implicature and the ternary-level complexity of the earlier developing implicature, as analyzed by Halford, Wilson and Phillips' (1998) Relational Complexity Metric can account for this developmental pattern, and not scales or generality.

Keywords: first language acquisition, semantic-pragmatic interface, implicatures, relational complexity.

1. Introduction

This paper reports results from experiments on adult and child knowledge of one type of scalar implicature (based on the <*and*, *or*> scale) and two types of non-scalar implicatures (the first the No-Contrast implicature based on the reference set {*but*, *and*} and the second on reference sets of attributes – the 'Allover' Implicature). The results show that even at the age of 9;6 Hebrew speaking children do not yet have adultlike knowledge of either the scalar or non-scalar implicatures of coordination. However, they do calculate the non-scalar 'Allover' Implicature from the age of 5 years. We argue that for children, it is the relational complexity of the semantic and pragmatic relations involved (as measured by the relational complexity metric suggested by Halford, Wilson and Phillips, 1998) that determines the age of calculation of a given implicature.

When investigating children's performance on conversational implicatures, we examine three issues which we consider to influence the developmental difficulty of each implicature. The first is the participation of a scale in the implicature: is there a difference in the difficulty of scalar and non-scalar implicatures? Cross-linguistically, the majority of investigations into child acquisition of implicatures have been into scalar implicatures with relatively late ages being reported (e.g. Papafragou and Musolino, 2003). Note however, that at least one non-scalar implicature has also been found to develop relatively late (e.g. Noveck and Chevaux, 2002). Crucially, we consider acquisition to be demonstrated by behavior which does not differ significantly from adult behavior. Thus, results as high as 80% or even 90% adultlike responses are not considered to indicate acquisition if the adult control group provided responses significantly higher.

The second issue is the generalized versus particularized nature of the implicature. Levinson (2000) expands the Gricean concept of Generalized Conversational Implicatures (GCIs), defining these inferences as the default interpretation of an utterances, as opposed to Particularized Conversational Implicatures (PCIs) which are dependent on specific contexts. In the current investigation we examine the relative difficulties of GCIs versus PCIs. Cross-linguistically, the majority of implicatures which have been investigated are GCIs. Note that there are difficulties which arise in investigating the development of PCIs due to their non-uniform appearance in adult communication (Paltiel-Gedalyovich, 2008).

The third and final issue bearing on the acquisition of implicatures is the complexity of processing the specific implicature phenomena. Differences in the age of acquisition of

various implicatures may be independent of scalar involvement or of generalization and dependent on the complexity of the specific implicature as expressed by the relation which it involves. Crosslinguistically, allusion has been made to processing difficulty of various implicatures resulting from the processing of reference sets (e.g. Reinhart, 1999), however, no detailed explanation has been provided for differences in the difficulty of various phenomena. We make use of Halford, et al's (1998) relational complexity metric to provide a detailed analysis of the complexity of each implicature investigated, and thus predict and account for differences in developmental ages. We argue that non-adultlike child behavior is not related to the involvement or non-involvement of a scale, nor to whether the implicature is particularized or generalized, but rather to the complexity of the specific implicatures

We view adult behavior as a crucial factor in interpreting child acquisition data. Adult behavior serves as the reference point for determining 'correct' (= adultlike) and 'incorrect' (= non-adultlike) responses. We therefore report and discuss adult as well as child data.

2. Scales versus non-scales

We take scalar implicatures to be those implicatures that are calculated based on Horn's entailment scales (Horn, 1976), while non-scalar implicatures include those calculated based on reference-sets or non-scales (e.g. Levinson, 2000). Entailment relationships existing between the members of the set determine whether the set is a scale or not. In scales, there is a unidirectional entailment relationship between the members of the reference set. In non-scales, there is either no entailment relationship or a bidirectional entailment relationship between set members. Thus, the scalar implicature calculated with the use of disjunction involves rejection of the truth of conjunction based on the scale <*and*, *or*>, where disjunction entails conjunction but not vice versa.

The non-scalar No-Contrast implicature calculated from the use of the non-contrastive *and* involves rejection of contrast based on the reference set {*but*, *and*}. This is a non-scale; although *but*, which includes contrastive meaning, is more informative than *and*, the truth of each of the members of the set entails the truth of the other.

The use of a bare attribute, say the color *blue*, gives rise to an 'Allover' implicature specifically, 'blue allover' (Harnish, 1991). This implicature is calculated by considering a set of unordered alternates {*blue, red, green, yellow*…}. The use of one member of the set in an utterance implicates that the other members of the set are false, i.e. uttering *blue* gives rise to the implicature that none of the other colors are true of the described object. So *red* will be false and therefore, *blue and red* will be false. In the view adopted here, scales are formed by single terms. So, although *blue and red* entails *blue*, and not vice versa, the reference set {*blue and red*, *blue*} is not considered a scale, but a pseudo-scale (see Levinson, 2000).

There is no specific developmental prediction which arises directly from the involvement of non-involvement of an entailment scale. Accounts which discuss the complexity of processing reference sets (e.g. Reinhart, 1999), do not distinguish between the difficulty in processing an ordered set of the type representing a scale versus processing a non-ordered set of the type representing a non-scalar reference set.

3. Generalized versus particularized implicatures

We adopt Levinson's (2000) version of the theory of Generalized Implicatures. According to this theory, GCIs are default interpretations arising with every utterance of a term which evokes the implicature. Cases in which the GCI is not apparent in the interpretation are considered to be the result of a cancellation of the GCI. (Note that some researchers, working for instance within the context of Relevance Theory, have challenged

the default nature of implicatures which have hitherto been taken to be generalized, e.g. Bott and Noveck, 2004).

The implicature arising with the use of disjunction is considered to be a generalized conversational implicature or GCI (Levinson, 2000), while we take the No-contrast implicature to be a particularized conversational implicature (PCI), since the absence of contrast in *and* is context dependent and not part of the default interpretation. Uses of *and* may give rise to many other implicatures, for example an implicature of sequence based on the maxim of manner giving the interpretation that the first conjunct precedes the second conjunction chronologically. This is shown in (1). *And* can also give rise to an implicature of causality as demonstrated in (2).

(1) Implicature of sequence arising from conjunction
'The boy put on a coat *and* went outside.'
Implicature: he put on his coat before he went outside.

(2) Implicature of causality arising from conjunction
'The boy slipped and fell.'
Implicature: slipping caused the fall

Levinson (2000) suggests that the 'Allover' implicature may also be a GCI and we adopt this view.

Here, too, there is no specific developmental prediction which arises from the theory of GCIs. There is no definitive reason to predict that a GCI will be harder or easier than a PCI. However, there are three points which should be considered. First, the variable nature of PCIs may provide children with less exposure to them and inconsistent evidence regarding when they arise. Second, determining adultlike performance in children for PCIs may prove difficult since the adults themselves will calculate these implicatures inconsistently and the target for child development will be therefore unclear. Finally, children's inconsistent calculation of GCIs may reflect their miscategorization of the implicatures as PCIs.

4. Relational complexity of (some) implicature phenomena

The relational complexity of each of these implicatures may be determined using the relational complexity metric proposed by Halford, et al (1998). According to this metric the complexity of a given skill is determined by the number of elements which must be processed simultaneously. A developmental sequence indicating at which age each level of relational complexity is mastered is suggested and presented here in (3).

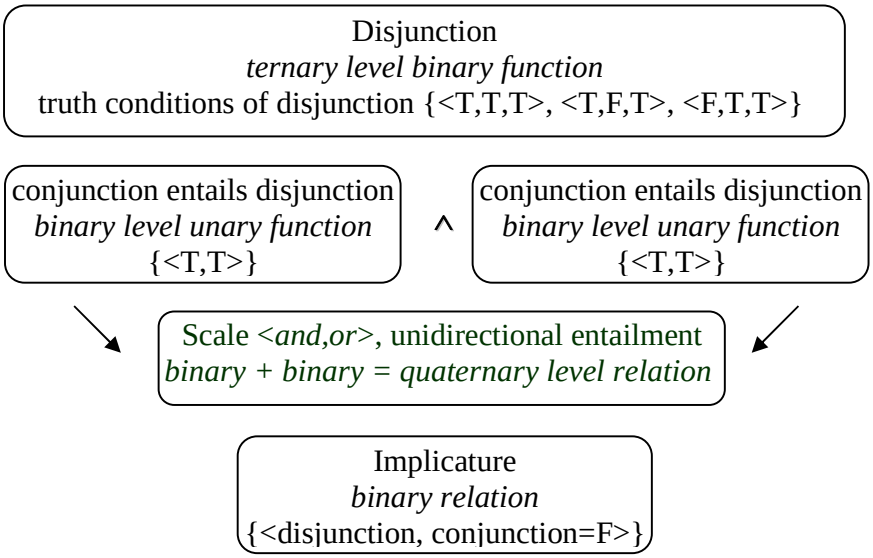
(3) Ages of mastery of different levels of relational complexity

Level of relational complexity	*Age of mastery*
Unary	1 year
Binary	2 years
Ternary	5 years
Quaternary	11 years

4.1. Relational complexity of the scalar implicature of disjunction

Within this framework, the scalar implicature based on the scale <*and*, *or*> is assigned quaternary level complexity, a level hypothesized by Halford, et al (1998) to be acquired only by age 11 years. The application of the relational complexity metric to this scalar implicature is illustrated in (4).

(4) Processing of scalar implicature based on <*and*,*or*>



If we apply the model given in (4) to the utterance *Bigbird is wearing a coat* ***or*** *a scarf* the result is as follows. The utterance itself is a *ternary* level binary function as interpretation involves application of the truth conditions of disjunction, the set of ordered sets {<T,T,T>, <T,F,T>, <F,T,T>}to the truth values of the conjuncts involved (*Bigbird is wearing a coat* and *Bigbird is wearing a scarf*).[1]

The next step involves the scale <*and*, *or*>. We have a unidirectional entailment which is the conjunction (a *ternary* level binary function based on the truth conditions of conjunction, the set of ordered sets {<T,T,T>}) of 'conjunction entails disjunction' and the negation of 'disjunction entails conjunction'. Entailment can be seen as a *binary* level relation based on the ordered set <T,T> where the truth of one sentence (a disjunction) yields a guarantee of the truth of a second sentence (a conjunction). In order for the entailment relation to be unidirectional, the second condition must also hold, namely the negation of an entailment relationship such that conjunction entails disjunction. Negation is seen as a *binary* level unary function, as represented by the set of ordered sets {<T,F>, <F,T>}. Thus we have *binary* level negation having scope over *binary* level entailment.

The *ternary* level conjunction of the *ternary* level binary function of disjunction couples with the *ternary* level binary function of the unidirectional entailment yields a *quaternary* level relation.

4.2. The relational complexity of the NO-contrast implicature of and

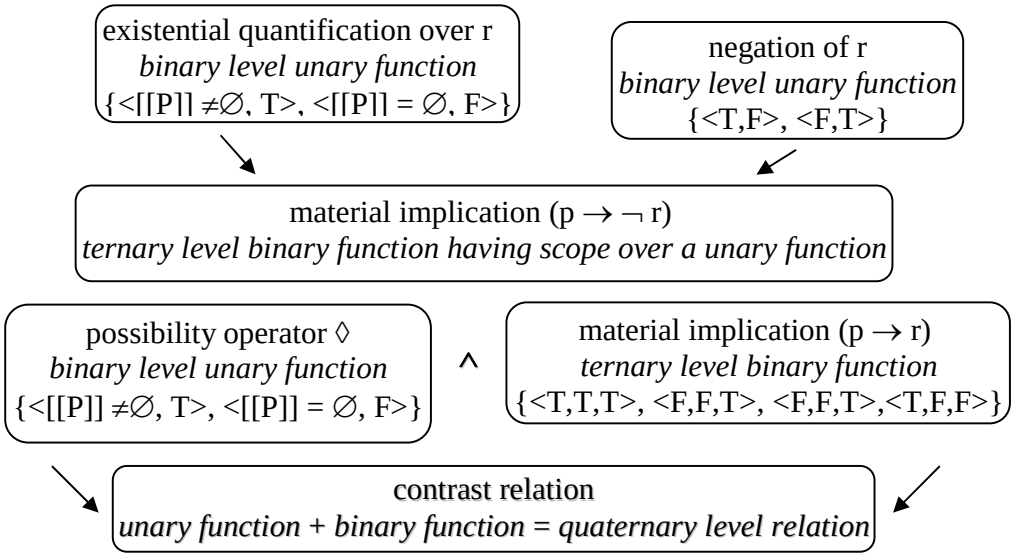
The relational complexity of the non-scalar No-contrast implicature based on {*but, and*} is quaternary because the relational complexity of the contrast relation of *but* is in itself quaternary. This application of the relational complexity metric is based on Winter and Rimon's (1994) analysis of *but*, shown in (5).

[1] Coordinated sentences are given a lower complexity in Halford, et al's (1998) own analysis, however, we see the current analysis as more accurate and supported by behavioral results. Ternary level complexity is predicted to be acquired by 5 years, and this is the age at which children have been shown to demonstrate knowledge of the truth conditions of the coordinators (Paltiel-Gedalyovich, 2003).

(5) Winter and Rimon's (1994:370) analysis of the contrast of but
presupposition of but: **p** implies *not* (**r**) and **q** implies **r**

The application of the relational complexity metric to this analysis is given in (6).

(6) Processing of the contrast relation of *aval*/but



If we consider the utterance *The man hates cucumbers but eats a lot of them*, the analysis of the complexity of the utterance based on (6) would be as follows.

The utterance itself as conjunction is a *ternary* level binary function based on the set of ordered sets {<T,T,T>, <T,F,F>, <F,T,F>, <F,F,F>, the truth conditions of conjunction.

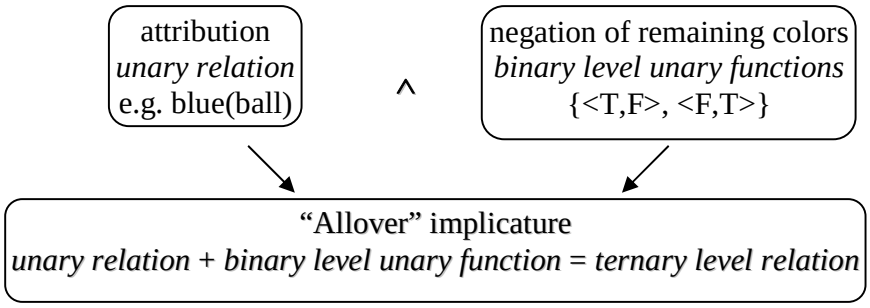
In addition, there is an expectation arising from the first conjunct, *The man hates cucumbers*, of a material implication, specifically, 'if the man hates cucumbers then it is not the case that he eats a lot of cucumbers'. This material implication is a *ternary* level binary function, the set of ordered sets {<T,T,T>, <T,F,F>, <F,T,T>, <F,F,T>}.

The conjunction of the *ternary* level binary function, the conjunction and the *ternary* level binary function of the implication yields (at least) a *quaternary* level relation, for the contrast relation. This would then feed into the implicature.

4.3 The relational complexity of the Allover implicature

Finally, the relational complexity of the Allover Implicature calculated with the use of attributes is ternary as shown in (7).

(7) Relational complexity of the Allover implicature



Following the analysis given (7) the relational complexity of the non-scalar implicature arising with the use of an attribute expression such as *the blue ball* will be as follows. The phrase itself involves attribution, a unary relation (blue(x)). The remaining attributes in the set are negated. This involves multiple negation of the remaining colors, multiple binary level unary functions based on the truth conditions of negation (the set of ordered sets {<T,F>, <F,T>}).These assertions of attribution of one attribute are conjoined in a ternary level binary function (based on the truth conditions of conjunction, {<T,T,T>, <T,F,F>, <F,T,F>, <F,F,F>}. Thus, the implicature is considered to have ternary level complexity. Ternary level relations are predicted to be acquired by 5 years (Halford, et al, 1998).[2]

5. Experimental predictions

Returning to the three issues which arose in the introduction, we can formulate experimental predictions in each area.

First, consider the question of scale versus non-scale. As far as adult behavior is concerned, there are no discriminating predictions based on this issue. For the children, the presence/absence of a scale itself may not predict developmental difficulty. The processing of any kind of implicature, scalar or non-scalar, requires the comparison with some sort of reference set. There is no reason to suppose *a priori* that a scalar reference set requires greater processing ability than a non-scalar contrastive reference set. Note however, that a scale is analysed as quaternary (requiring the quaternary level conjunction of entailment and negation of entailment constituting unidirectional entailment). Since quaternary level processing is considered to be mastered only at 11 years, we can formulate the predictions in (8) regarding scales and non-scales.

(8) Predictions for adult and child processing of scales and non-scales

a) There will be no difference in the frequency of adults' calculation of the scalar implicature of disjunction (as evidenced by their rejection of disjuncts as descriptions of pictures where both disjuncts are true), and the frequency of adults' calculation of the non-scalar implicatures of No-contrast (as evidenced by their rejection of the use of neutral *and* in cases where there is no contrast between the

[2] It has been suggested to us anonymously that the negation of the remaining colors has a greater ternary complexity. An alternative analysis would be that there is a double negation, *not not blue* resulting in a binary relation having scope over a binary relation which yields a quaternary level relation. We would, however, argue that the first analysis is more accurate, but that the multiple negations are chunked, thus reducing their combined complexity.

conjuncts) or the Allover implicature (as evidenced by their preference for a wholly attributed object over a partially attributed object).

b) (i) Children's calculation of the quaternary level scalar implicature (as evidenced by their rejection of disjuncts as descriptions of pictures where both disjuncts are true) will not reach adultlike levels until the age of 11.
(ii) Children's calculation of the non-scalar implicatures cannot be predicted based solely on the absence of the scale, although in general all other things being equal this calculation should occur earlier than for scalar implicatures since the processing of a scale is quaternary.

Now consider the question of the generalized nature of implicatures. According to the theory of GCI, GCIs are the default, typical interpretation of an expression in the absence of a special context, while PCIs arise only in specific contexts. The implicature associated with disjunction is considered to be a GCI, arising in all uses of disjunction and only canceled in particular contexts. As described above, we hypothesize that the Allover Implicature, like the scalar implicature of disjunction, is a GCI, while the No-Contrast Implicature of conjunction is a PCI. For adults there is a clear prediction that their performance on tasks requiring the calculation of a GCI will be very consistent, far more consistent than their performance on PCIs. These predictions are summarized in (9).

(9) Predictions for adults:
a) Adults will reject violations of the scalar GCI close to 100% of the time
b) Adults will interpret use of a bare attribute as completely attributed, calculating the non-scalar Allover GCI close to 100% of the time
c) Adults will show variability in rejection of violations of the No-Contrast PCI

For children, the consistency of the adult responses provides a very clear developmental target. Otherwise the generalized or particularized nature of an implicature should have no bearing on the developmental difficulty of the implicature. In the present case, the GCI of disjunction being quaternary will be predicted to develop only at 11 years while the Allover GCI will be predicted to develop by 5 years. The No-Contrast PCI of non-contrastive conjunction will also be predicted to develop only at 11 years, as this implicature is also quaternary. In short, we hypothesized that the acquisition of implicatures would be dependent on the relational complexity of the implicatures and be independent both of the nature of the reference set and whether the implicature is generalized or particularized, resulting in the predictions in (10).

(10) Predictions for children:
a) Children are not predicted to reject violations of the quaternary level scalar GCI before the age of 11 years
b) Children are predicted to interpret use of bare attribute as completely attributed, calculating the ternary level non-scalar 'Allover' GCI from the age of 5
c) Children will not reject violation of the quaternary level non-scalar No-Contrast PCI before the age of 11 years

The third and final issue we raised was the question of the relational complexity of the implicature phenomena involved. As is clear from the discussion to this point, we find this to be the crucial point in formulating developmental predictions for the implicatures. If we momentarily disregard the questions of scales and generalization we can derive the predictions given in (11).

(11) Predictions for children based on relational complexity alone

a) Children are not predicted to reject violations of the quaternary level No-Contrast implicature consistently before the age of 11 years.
b) Children are not predicted to reject violations of the quaternary level implicature associated with disjunction consistently before the age of 11 years.
c) Children are not predicted to reject violations of the ternary level Allover implicature before the age of 5 years.

We now turn to the experiments developed to test these predictions.

6. The experiments

6.1. Experiment 1: Investigating the scalar implicature associated with disjunction

6.1.1Procedures

In order to test predictions knowledge of the GCI of disjunction and the No-contrast PCI, we carried out a variant of the Truth-Value-Judgment Task (Crain and Thornton, 1998). Children participated in individual sessions in their homes or kindergarten/school settings. Adults participated in individual sessions in their homes. A total of 141 typically developing monolingual Hebrew speaking children aged 2;7 to 9;6 and 17 monolingual Hebrew-speaking adults were asked to judge the acceptability of a puppet's descriptions of pictures prepared using the Creative Wonders Sesame Street ArtWorkshop (Henson Productions, Inc., 1995).

One condition tested calculation of the GCI based on the scale <*and*, *or*>.[3] There were 10 target items and 5 filler items. The target items were true descriptions of the stimulus pictures using *or* with both disjuncts true. The filler items were false disjunctions. In each case the experimenter described the picture to the participant and to the puppet and then asked the puppet to describe the picture. The participant was then asked to judge the appropriateness of the puppet's description. For descriptions judged to be unacceptable, the participant was asked to 'teach' the puppet the correct description. The items were mixed with two other conditions and organized in two different random presentation orders with approximately half of the participants presented with each presentation order. Sample target and filler items appear in (12) and (13) respectively.

(12) Target item eliciting calculation of the scalar GCI based on scale <*and*, *or*>:
Picture stimulus: Cookie Monster eating cookies and holding a balloon.
Experimenter description: *hine ugifletset. hu maxzik balon. hu oxel ugijot.*
Here Cookie-monster.he holds balloon. He eats cookies.
'Here's Cookie-monster. He's holding a balloon. He's eating cookies.'
Puppet's description: *ugifletset maxzik balon o oxel ugiyot*
Cookie-monster holds balloon *or* eats cookies
'cookie monster is holding a balloon *or* eating cookies.'

(13) Filler item
Picture stimulus: Bigbird standing near a table which holds a drink and a sandwhich.
Experimenter description: *hine tsiporet. hi lo shota mits, hi lo oxelet senvich.*
Here Bigbird.she no drinks juice she no eats sandwhich
'Here's Bigbird. She's not drinking juice, she's not eating a sandwhich.'

[3] This was part of a larger experiment into semantic and pragmatic knowledge of coordinators. Only the relevant conditions are reported here.

Puppet's description: *tsiporet shota mits o oxelet senvich.*
Bigbird drinks juice or eats sandwhich
'Bigbird is drinking juice or eating a sandwhich.'

6.1.2 Results and discussion

As predicted, adults consistently rejected true picture descriptions violating the scalar GCI associated with disjunction (97.1% of the time). This supports the prediction that as a GCI, this implicature will be consistently calculated by adults. The scalar nature of the implicature was not predicted to influence the consistency of the adults' responses and therefore will be discussed by comparison with performance on non-scalar implicatures below. In terms of complexity, the complexity of the implicature was analyzed as quaternary, within the predicted processing abilities of adults.

Even the oldest children failed to calculate the GCI with adult level consistency. Their rejection of the stimulus items ranged from 11% rejection for the 3 year olds, increasing gradually to 50.5% rejection for the 9 year olds. Even the oldest children's responses differed significantly from the adult responses ($F(7,115)=13.07$, MS error=11.623, $p < 0.05$). The fact that the adults calculated this implicature as a GCI provides a clear target for child acquisition such that the children's inconsistent performance can be interpreted as immature language development. The source of the children's difficulty is predicted by the complexity of the specific implicature, analyzed as quaternary, and thus predicted to develop only at 11 years. The involvement of a scale in the implicature in itself did not lead to a prediction of non-adultlike behavior, and therefore in itself does not account for this result.

6.2. Experiment 2: Investigating the non-scalar implicature associated with non-contrastive conjunction

6.2.1 Procedures

A further condition of this same experiment tested calculation of the non-scalar, No-contrast PCI based on the set {*but, and*}. This second condition deals with the non-scalar particularized implicature based on the non-scale of contrastive conjunction represented in Hebrew by *aval*, and what we may call neutral conjunction, the Hebrew *ve*. Participants and materials were the same as for the previous condition, however, this time the target items involved the use of *ve* to coordinate two contrasting conjuncts while the filler items used *aval* to coordinate two contrasting conjuncts. Examples of target and filler items appear in (14) and (15) respectively.

(14) Target item the No-Contrast PCI based on reference set {*but, and*}:
Picture stimulus: Hungry dog walking away from bone
Experimenter's description:
hine kelev. hu raev. hu ohev etsem. hu mashir et haetsem. muzar!
here dog. he hungry. he likes bone. he leaves 'et' the-bone. strange.
'Here's a dog. He's hungry. He likes bones. He leaves the bone. Strange!'
Puppet's description: *hakelev raev ve mashir et haetsem*
The-dog hungry *and* leaves 'et' the-bone
'The dog is hungry *and* leaves the bone.'

(15) Filler item
Picture stimulus: Man eating a large pile of cucumbers.
Experimenter's description:
hine ish. haish sone melafefonim. hu oxel harbe melafefonim. muzar!
here man. The-man hates cucumbers. he eats many cucumbers. strange.
'Here's a man. The man hates cucumbers. He eats lots of cucumbers. Strange!'

Puppet's description: *haish sone melafefonim aval oxel harbe.*
The-man hates cucmbers *but* eats many.
'The man hates cucumbers but eats alot.'

6.2.2 Results and discussion

As predicted, the adults rejected the use of the less informative *ve/and* when the contrast allowed the use of the more informative *aval*/*but*, but only 50% of the time, thus demonstrating that they calculate the implicature based on the non-scale PCI optionally. This does not indicate chance levels, but rather individual differences with individual participants consistently (> 80% of the time) calculating/failing to calculate the implicature. This is consistent with prediction that the No-contrast implicature is a PCI.

The majority of the children failed to demonstrate knowledge of the contrastive nature of *aval/but* in that they accepted the use of *aval/but* in non-contrastive coordinations. Thus, they showed no preference for the more informative *aval*/*but* in contexts where contrast was indicated (20% rejection of the less informative *ve/and)*. The children's failure to calculate the non-scalar No-Contrast PCI we interpret as, a product of the difficulty of calculating the contrastive meaning of *aval*/*but* which is considered quaternary. In this case, the children do not see *aval*/*but* as more informative than *ve/and* and no implicature is calculated. Of those children who did demonstrate knowledge of the contrast of *aval/but,* only one (of 5) calculated the No-Contrast PCI. Conclusions about children's knowledge of particularized implicatures such as this are difficult to draw due to the inconsistency of adult calculation of these implicatures.

6.3. Investigating the 'Allover' implicature associated with some adjectives

6.3.1. Procedures

In order to test knowledge of the 'Allover' implicature associated with some adjectives, we carried out a pointing task with 38 typically developing monolingual Hebrew-speaking children aged 2;11-12;0 and 12 adults on their knowledge of non-scalar conversational implicatures in a pointing task. Participants heard target picture descriptions in two sets. The first set included 10 items using colors and the second set included18 items using other attributes. The target items were equally divided between two experimental conditions: in the first the target picture was a completely attributed object compared with a partially attributed object and two other distracters, in the second the target picture was a partially attributed object compared with 3 distracters. Each set also included filler items where the items where different object of different colors/attributes were depicted. Children were pre-tested for knowledge of the colors and attributes before testing. Examples of experimental items for the 'allover' and 'partially' appear in (16) and 0 respectively, while a sample filler item appears in (18).

(16) Target item for Non-scalar 'Allover' GCI – 'allover' condition
Picture display of four balls: blue striped ball, all blue ball, all green ball, blue middle changing to green border
Stimulus: *tari li et hakadur hakaxol*
show me 'et' the-ball the-blue
'show me the blue ball.'

(17) Target item for partially condition
Picture display of four shirts: red shirt with yellow circle, green shirt with red circle, red shirt gradually changing to blue, green shirt with floral square on one shoulder
Stimulus: *tari li et haxultsa hapirxonit*
show me 'et' the-shirt the-flowery

'Show me the flowery shirt.'

(18) Filler item
Picture display of four objects: red ball, black giraffe, black parakeet, green hat
Stimulus: *tari li et ha-dʒiraffa ha-xamuda*
show me 'et' the-giraffe the-cute
'Show me the cute giraffe.'

6.3.2 Results and discussion

As predicted, adults calculated the 'Allover' GCI consistently for colors, selecting the completely attributed object picture 100 % of the time, and slightly less consistently for attributes, selecting the completely attributed object picture 99% of the time. The consistency of the Allover Implicature supports the existence of at least one type of default non-scalar implicature, much the same as that of default scalar implicatures (cf Levinson, 2000).

Children in the 5-6 year old age group exhibited adultlike preference for a completely attributed object 90% for attributes and 95% of the time for colors. The result for colors did not differ significantly from the adults' results ($p>0.05$), however, for the other attributes, this result was marginally significantly different from the adults ($p=0.57$) and adult consistency was only obtained by the 7-8 year old group $9p> 0.05$). The later acquisition of the attribute adjectives is attributed to the later lexical acquisition of these types of adjectives (see e.g. Berman, 2004).

7. General discussion and conclusions

The first question we asked related to the scalar versus non-scalar nature of implicatures: Are scalar implicatures more difficult and therefore acquired later than non-scalar implicatures, simply because scales themselves are difficult to process? In the studies reported here, for adults, the fact that an implicature includes a scale rather than a non-scale, or vice versa, does not appear to have an effect on the pattern of calculation of the implicature since one scalar and one non-scalar implicature were calculated consistently. In other words, even if scales are more difficult than non-scales, their difficulty is well within the abilities of adults.

As for children, is it the presence of a scale that makes an implicature difficult for children? In the studies reported here, one scalar (that of disjunction) and one non-scalar (the No-contrast) implicature were not mastered even by the oldest children participating in the study (the 9 year old group). There was also evidence from the non-scalar 'Allover' implicature that at least one type on non-scalar implicature is acquired relatively early. Taking these two points together we may conclude that the presence of a scale suggests a more difficult implicature, but the absence of a scale in itself does not guarantee that the implicature will be easy/early developing. For non-scalar implicatures the difficulty of the relations involved in the lexical/semantic content of the utterance appears to determine the difficulty and age of acquisition. The late development of the No-contrast implicature can be explained in terms of the late development of the underlying (semantic) contrastive meaning of the coordinator *aval*/*but*. Similarly, the later age of calculation of the 'Allover' implicature for denominal and resultative adjectives, is related to the age of development of these adjectives. In terms of the implicature, there is no difference in the difficulty of calculation of the 'Allover' implicature for color adjectives and for denominal and resultative adjectives. The greater difficulty of calculating the implicature for these adjectives results from the greater difficulty of the adjectives themselves. This is evidenced by the later comprehension and spontaneous use of these types of adjectives in Hebrew child language (e.g. Berman, 2004). For scalar implicatures, even given relatively simple

lexical/semantic content, such as the semantic meaning of conjunction/disjunction, the implicature itself is complex.

The second question we asked concerned the acquisition of generalized versus particularized implicatures. This question was found to distinguish adult behavior. GCIs were calculated far more consistently than PCIs. There was primarily variation between individuals such that adult participants could be divided into two groups: those who consistently calculated the PCI and those who consistently failed to calculate the PCI. Yet, there was also some (20%) variation within individuals. This amount of variation although clearly not at chance levels differs from the approximately <5% variation found in the calculation of the GCIs.

The implications for the child data are not clear. We found that one GCI and one PCI were acquired relatively late with adultlike behavior not obtained even by the oldest participants, while one GCI was mastered at a relatively young age (5-6 years). At first glance this may appear to suggest that PCIs are mastered late while the mastery of GCIs is variable, dependent on some other factor. It is possible that PCIs are more difficult to acquire just because of their inconsistent nature. The input to children regarding the calculation of these implicatures will be inconsistent and even contradictory, and therefore more difficult to learn. Furthermore, regarding the inconsistent calculation of the GCI, it could be argued that the children know the implicature but are not aware that it is generalized and therefore calculate it only optionally. We find this explanation to be contradictory since it results in particularized implicatures being both easier and harder at the same time. Thus, we consider that the generalized or particularized nature of an implicature is insufficient to predict its difficulty or age of acquisition.

Thus, viewing our data in terms of the first two questions yields equivocal results. We now turn to our third question. Is the determining factor in the acquisition of implicatures the complexity of the relations involved? Of the three implicatures studies, two were considered to have quaternary relational complexity, as determined by Halford, et al's (1998) Relational Complexity Metric. As predicted by their high complexity level, these implicatures were not demonstrated to be calculated by the oldest children participating in the studies, aged 9 years. Similarly, the implicature which was demonstrated by 5-6 year olds is analyzed as having ternary level complexity, a complexity level predicted to be mastered by 5 years. Thus, of the three possible factors we suggested as possible explanations for the developmental pattern for three implicatures, the relational complexity of the implicature phenomena provides the best account for the children's data.

We cannot explain the late acquisition of the No-contrast PCI in terms of a specific difficulty with scales or with GCIs so we suggest that either the processing of the quaternary level relation is too difficult for these children (and note the difficult step in the process is the unilateral entailment).As far as the non-scalar PCI of contrastive conjunction, we saw individual differences within the adult group. For children, it appears that the problem here is not with non-scales being difficult, or of a PCI versus a GCI, but rather related to difficulty due to specific complexity of the contrastive meaning, before the stage of implicature calculation. This explanation is supported by the fact that for those children who did demonstrate knowledge of the contrastive meaning the results were very similar to the adults. Finally, the difficulty the children under the age of 5 showed appears to be related to the ternary complexity of the relation. Ternary level relations are predicted to be mastered by 5 years. Of course, here, too, it could be argued that they are not aware of the generalized nature of the implicature, but since the age matches the prediction based on the Relational Complexity Metric, the processing difficulty explanation seems more likely.

In summary, Hebrew speaking adults consistently calculate generalized implicatures, both scalar implicatures, such as that of disjunction, and non-scalar, such as the ‘allover’ implicature. Furthermore, Hebrew speaking adults calculate a particularized implicature far less consistently. Lastly, the consistency of the adult responses does not appear to be related to the involvement of a scale in the implicature.

For children, the age at which they master calculation of implicatures appears to be a result of the relational complexity of the phenomenon and not related to the participation of a scale, or to the generalized or particularized nature of the implicature

Concluding, the results from these experiments exemplify the calculation of quantity implicatures using both entailment scales and non-scales; however, the consistency of calculation of the GCIs is much greater than the calculation of PCIs. Children's knowledge of these implicatures are argued to be adultlike dependent upon the complexity of the relations involved. The ages of acquisition found are consistent with the complexity of the skills being acquired as determined by Halford et al's (1998) Relational Complexity Metric given above, 5 years for the ternary non-scalar GCI and 11 years for the quaternary scalar GCI and No-Contrast PCI.

But there are many questions which remain to be answered. Some of these relate to the limited number of implicatures investigated to date. Are there scalar implicatures which can be demonstrated in the preschool years? If so, this would challenge the analysis of the scale as contributing quaternary level complexity to scalar implicatures. What is the complexity of other implicatures? Particularly, we need more investigations of non-scalar implicatures. Regarding the generality of implicatures, which implicatures show cross-linguistic generalization and which do not, and why? And regarding the complexity of various implicatures, is the complexity of some implicatures so great as to account for adult inconsistency? At what age do children actually become adult-like in their calculation of the more complex implicatures? We need data from older children – and we are in the process of collecting these data for the implicatures investigated here.

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