On the Relation between Implicit and Explicit Measures of Child Language Development: Evidence from Relative Clause Processing in 4-Year-Olds and Adults

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The existence of early syntactic competence in the first years of life is a matter of debate. On the one hand, it has been argued for a discontinuity between the child and adult language systems (e.g., Tomasello, 2003). These accounts assume that the ability to compute the sentence structure is not available from the start. Rather, in the first years of life, children's mastery of their native language is confined to a restricted set of lexical items (the so-called verb islands) and children are not able to generalize beyond these prototypical and frequently occurring combinations of linguistic elements. Analyses of either spontaneous speech production or behavioral responses in act-out and pointing experiments are almost exclusively used to support this theoretical position. In contrast, a continuity between the child and adult language systems is advocated by researchers who claim that grammatical knowledge is accessible from early on (e.g., Guasti, 2004). Under this perspective, non-adult-like productions and/or responses in experimental tasks can be seen as the outcome of a tension between (fully-specified) grammatical competence and a (still developing) performance system (Rizzi, 2005), where the latter can be, among other factors, heavily affected by working memory capacities and by the development of executive functions (EFs).

Complementary to corpus analyses and off-line behavioral paradigms, in the last few decades, psycholinguists have started to use on-line tasks to assess, for example, the time-course of sentence processing. Arguably, on-line methods are a more sensitive measure of children's linguistic competence than pointing or act-out tasks, being less cognitively demanding and less prone to the use of heuristic strategies (e.g., Trueswell & Gleitman, 2007). Against this background, we take the acquisition of restrictive relative clauses (RCs) as a testing case to contribute to the (dis)continuity debate and to shed more light on the relation between implicit and explicit measures of language development. The study of RCs is suited to these purposes for a number of reasons. First, it allows the comparison

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of structures with canonical word order (i.e., subject-extracted RCs, SRC henceforth) and non-canonical (i.e., object-extracted RCs, ORC henceforth) word orders. The former show the prototypical linear order of constituents (e.g., S(ubject)-V(erb)-O(bject) in English, German and most Romance languages) while in the latter, the linguistic constituents display an order that is derived from the canonical one. Hence, in order to interpret non-canonical sentences, the application of a heuristic strategy such as ‘agent-first’ would fail. In other words, correct interpretation of a non-canonical sentence requires the linguistic structure to be fully parsed. Second, SRCs are more frequent in the input than ORCs (Diessel & Tomasello, 2000). Therefore, should young children’s linguistic awareness be limited to factors such as frequency and proto-typicality, they would be expected to fail on non-canonical sentences. Third, it is widely reported in the literature that ORCs with two full NPs as verb arguments are difficult for 5-year-olds when tested with picture pointing or act-out (e.g.,, Friedmann, Belletti, & Rizzi, 2009). However, to date, the systematic comparison of implicit and explicit measures of RC comprehension remains unexplored and, therefore, it is not possible to conclude whether poor performance in off-line tasks mirrors what the child really knows about RCs or whether previous research on RC comprehension might have underestimated young children’s abilities due to the complexity of the response required. To address these open questions, we designed a visual-world eye-tracking experiment to test SRCs and ORCs in German. In our experimental set up, we strived to minimize the task demands to test RCs in a pragmatically appropriate context (see, Adani, 2011 for a discussion). Moreover, we provide a direct comparison of explicit and implicit measures of comprehension and of child and adult participants, using exactly the same method. Before entering in the details of the study (section 4), we will review some of the relevant properties of RCs in German (section 1), the existing literature on acquisition and processing of RCs (section 2) and on the relation between explicit and implicit measures of language development (section 3).

1. Relative clauses in German

The German language is particularly suited for our study purposes given that the verb appears in sentence final position in both SRC (1) and ORC (2). Hence, word order is not a confound in this case, as it is for many languages previously tested (e.g.,, English, Italian, Portuguese, Hebrew, French).

(1) Wo ist die Kuh die den Hund jagt?
Where is the cow who the-ACC monkey chases
‘Where is the cow that is chasing the dog?’

(2) Wo ist die Kuh die der Hund jagt?
Where is the cow who the-NOM dog chases
‘Where is the cow that the dog is chasing?’

Moreover, RCs in German can be constructed in such a way that there is a temporal ambiguity until the relative pronoun is encountered. After that, the nominative vs. accusative case morphology on the embedded determiner can disambiguate between the SRC or ORC readings.

As in other languages, RCs are noun modifiers, i.e., they operate in a way similar to adjectives. Importantly, their function is to restrict the set of potential head referents to one uniquely identifiable referent (Heim & Kratzer, 1998). This means that, in order to test RCs in a pragmatically appropriate context, at least two potential referents of the head noun (i.e., two cows in examples (1) and (2)) must be present in the context. Seminal work by Hamburger and Crain (1982) has shown that children's performance on experimental tasks improves significantly when these pragmatic requirements are met, in contrast with previous (and also much recent) work in which this factor was not taken care of (see, Adani, 2011 for a discussion).

2. Acquisition and processing of RCs

In those languages where the head noun precedes the embedded clause, it is widely established that ORCs are harder to process, interpret, and also to produce than SRCs. This asymmetry is attested in adults as well as in children. Seminal work conducted with English speakers has shown that unimpaired adults find ORCs harder to read and interpret than SRCs (King & Just, 1991) and that adults affected by aphasia also show a below chance performance in ORCs (Caramazza & Zurif, 1976). More recently, the extra processing cost associated to ORCs was also found in on-line experiments conducted with adults, speakers of different languages during reading or listening, including German (e.g., Friederici, Steinhauer, Mecklinger, & Meyer, 1998), English (e.g., Traxler, Morris, & Seely, 2002, a.o.), and Italian (De Vincenzi, 1990). As for the developmental studies conducted in a variety of head-initial languages, it was shown that 3-to-5-year-old children perform poorly on ORCs but the comprehension of SRCs is well above chance. This performance pattern was found in Hebrew (e.g., Arnon, 2010; Friedmann et al., 2009), Italian (Arosio, Adani, & Guasti, 2009), Portuguese (Corrêa, 1995), English (e.g., Adani, Forgiarini, Guasti, & van der Lely, 2014). Arosio, Yatsushiro, Forgiarini and Guasti (2012) found that German-speaking 7-year-olds are still more accurate on SRCs than on ORCs in a sentence-picture-pointing task and that the performance on ORCs is modulated by working memory abilities (i.e., the larger the digit span is, the greater the ORC accuracy). This finding reflects what Friederici et al. (1998) found in adults speakers of German. Overall, this convergence of profiles in different populations "challenges, on grounds of parsimony, any account that appeals to a specific structural deficit as the explanation for the comprehension difficulties associated with these structures. […] It is clear that the relatively greater difficulty with object-relatives in normal adults cannot be attributed to the absence of linguistic principles, because grammatical knowledge is intact in this population" (Crain, Ni, & Shankweiler, 2001: 301).

A few published studies investigated on-line processing of RCs in children, showing that processing routines of preschoolers or school-aged children are not different from the ones of adults. Love (2007) used a cross-modal picture priming task to investigate whether a group of English-speaking 5;6-year-olds are able to re-activate an early encountered RC head noun (the so-called ‘filler’) as the direct object of a verb (the so-called ‘gap’). A priming effect of the RC head noun was attested at the gap position in children as well as in a group of adults. Contemori and Marinis (2014) and Arosio, Guasti and Stucchi (2011) employed a self-paced listening task to explore the processing of RCs manipulating number (singular vs. plural) or animacy (animate vs. inanimate) on nouns. Using the number manipulation on ORCs, Contemori and Marinis (2014) found that English-speaking 7-year-olds revealed a processing profile similar to adults, despite their reactions times being overall longer and their off-line accuracy scores lower. Both Love (2007) as well as Contemori and Marinis (2014) argue for a continuity between the adult processing system and the one of children in school age. Arosio et al. (2011) manipulated Italian SRCs and ORCs with subject and object nouns with mismatching number and animacy properties. The results reveal that working memory (as measured by the digit span) has a huge impact on 9-year-olds’ ability to interpret structural relations as the sentence unfolds and being able to revise these analyses when needed. In particular, children with higher digit-span where behaving very much in line with the adults participants documented in the literature. To date, none of the published studies has tested on-line comprehension of RCs in children younger than 5 years of age. In our study, we have designed a method that allowed us to test children as young as 4 years, collecting both on-line eye gazes and off-line accuracy scores.

Building up on Crain et al.’s (2001) claim cited above and in line with the existing on-line results, we argue that the type of the dependent measure that is collected crucially affects the conclusions that can be drawn regarding children’s availability of linguistic principles and their ability to process sentence structure. This remark takes us to the distinction between implicit and explicit measures of language development.

3. The relation between implicit and explicit measures

While linguistic knowledge and its use are by and large implicit, the assessment of this knowledge in language acquisition research mostly relies on explicit measures, i.e., requiring a deliberate response in a specific task (e.g., judgments, pointing, acting out). Such a response introduces additional cognitive demands or might be affected by extra-linguistic processes independent of the (linguistic) phenomenon under investigation. The use of implicit measurement paradigms for young children (e.g., eye-tracking or EEG) allows to avoid or, at least, dramatically reduce these potential confounding factors. However, this comes at a cost that the interpretation of implicit measures is not always as straightforward as of explicit ones.

Since Trueswell, Sekerina, Hill, & Logrip's (1999) seminal study, eye-tracking has been *the* implicit measure for assessing children's grammatical abilities. Another advantage of this method is that it allows to uncover transient effects during on-line processing. These effects remain invisible in explicit responses, which reflect the outcome of several processes. Brandt-Kobele and Höhle (2010) have shown that implicit and explicit measures can give diverging results even within the same age group using identical materials. Moreover, in their study with 3- and 4-year-olds, an additional pointing task reduced the effects in the eye gaze data, thereby masking the ability that was present in the implicit measure. Hence, findings from explicit measures reporting an inability have to be handled with care, especially in the light of reports on adults' shallow processing (Ferreira, 2003). Ferreira measured adults' explicit responses to non-canonical structures and showed that they were relying on heuristics and strategies, something that children might do as well.

Children are, furthermore, sensitive to grammatical structure from very early on: 21-month-olds distinguish word order variations in their native language (i.a. Lassotta, Omaki, & Franck, 2014) and use this information to derive verb meanings at the age of two years (Naigles, 1990). These abilities have been discovered using visual attention – an implicit measure. Thus, the type of measurement needs to be taken into account when evaluating linguistic development. A failure to find evidence for syntactic competencies in an explicit measure does not preclude the child from showing these abilities in an implicit assessment. A number of recent studies (Höhle, Fritzsche, & Müller, submitted; Huang, Zheng, Meng, & Snedeker, 2013; Minai, Jincho, Yamane, & Mazuka, 2012) have already put forward the idea that still-developing EF abilities (among other factors) might affect children's performance during experimental tasks. Hence, we hypothesize children's eye gazes to be a more sensitive measure of their language development as they are less affected by the maturation of EFs. Comparing adults with children using the same method allows us to address the highly debated issue as to whether there is continuity between the developing language parser and the final-state (adult) parser. The few existing studies (Love, 2007; Contemori & Marinis, 2014) that have directly compared on-line processing of RCs in child and adult groups employed methodologies (cross-modal priming, self-paced listening) that are not suitable for very young children. One of the novelties of the present study is the use of an eye-tracking paradigm, which allowed us to test SRCs and ORCs in children as young as 4 years (4;0–4;11).

In the light of the existing literature, we formulate the following predictions. We expect to find a subject-object asymmetry in the child pointing data, with higher accuracy score for SRC and at or below chance performance in ORC. Off-line, adults are predicted to perform at ceiling. In line with the continuity hypothesis, similar looking patterns are expected in children and adults. Namely, we predict an increase in target looks after the disambiguation point (the embedded DP) in both sentence types. In line with the off-line data, we also predict a SRC preference in the eye gaze data, where the target in SRC is fixated earlier than in ORC. Finally, if the presence of the pointing task interferes with the looking patterns (cf. Brandt-Kobele & Höhle, 2010), we predict reduced target looks in the condition where participants are asked to point as well as looking.

4. Method

4.1. Participants

Sixty-three 4-year-old children and 52 adults participated in the study. All participants were monolingual speakers of German and none had a reported history of linguistic, hearing or other cognitive disorders. For children, parents gave their consent for participation. Data from seven additional children had to be excluded due to more than 50% data loss, calibration difficulties or other technical problems. The remaining participants were randomly assigned to one of the two conditions: 'Looking only' or 'Looking and Pointing' (cf. 4.3 for a description of the two conditions). Table 1 reports the properties of each subgroups.

Table 1. Participant subgroups

Condition		Children	Adults
Looking only	N (female/male)	32 (13/19)	25 (23/2)
	Mean Age (range)	4;4.22 (4;1.0–4;11.11)	23.5 (20–33)
Looking and Pointing	N (female/male)	31 (14/17)	27 (23/4)
	Mean Age (range)	4;5.2 (4;0.2–4;11.20)	25.9 (19–44)

4.2. Material

The visual stimuli for the test trials were short movie clips (duration: 23 sec). In each trial, participants saw three cartoon animals. The animals were placed as far apart from each other as possible, either along the diagonal or in a horizontal row. The animal in the center was always different from the two animals on the sides, which were identical. The center animal (which was the referent of the embedded noun) was always masculine (i.e., der Hund 'the dog'; der Affe 'the monkey'), to allow for sentence disambiguation based on the case morphology on the determiner at the embedded noun (cf. examples (1) and (2) above). The animals on the sides (which were the referents of the RC head noun) were either feminine or neuter (die Kuh 'the cow'; das Schwein 'the pig'), so that the test sentence was ambiguous up to the off-set of the relative pronoun. Each animal pair was presented twice, once with a SRC and once with an ORC. The animals performed one of two actions: jagen 'chasing' and nass spritzen 'splashing'. The two verbs were chosen because they did not require contact between the agent and patient. Thus, target and distractor animals could be positioned as far as possible from the animal in the center. There were eight trials for each of the verbs. On half the trials, animals performed the action facing left and on the other half, they were facing right. On test trials, the target animal appeared equally often on the left or right-hand side of the screen.

The visual setup for filler trials was very similar and included the same four animals used in the test trials. For fillers, we used a matrix question such as Wo ist der Hund? 'Where's the dog?' while only one dog was on the screen with two different animals (e.g., a monkey and a pig). Just like in the experimental trials the animals performed an action. The fillers were included to confirm that the children were able to associate the cartoons of animals with their names. They had a duration of 18 sec. For fillers as well, the target position (left or right) was balanced for each participant. Each participant was presented with 8 SRCs, 8 ORCs and 4 filler sentences, yielding a within-subject design with a total of 20 trials.

Each video was synchronized with the auditory presentation of a sentence. A young female native speaker of German recorded all sentences. Her speaking rate was slow and she produced the sentences in a child-directed manner. A comparison of the overall duration, average intensity and average pitch for SRCs vs. ORCs revealed no differences between both sentence types (all p-values > .5).

4.3. Procedure

All participants were tested individually. In the 'Looking only' condition, participants were instructed to simply watch and look wherever they chose based on the auditory stimuli they heard. The instruction in the 'Looking and Pointing' condition was to point to the animal that represented the correct answer to the question heard. Participants were seated in a quiet and child friendly, dimly lit room at a distance of 60 to 70 cm from a 22 inch TFT monitor with a resolution of 1680 x 1050. The SMI RED 250 eye-tracker was mounted below the screen and connected to a notebook that was operated by the experimenter who controlled the experiment using SMI's Experiment Center software. The eye-tracking sample frequency was set to 60 Hz. The experimenter sat next to the participant, observing the tracking quality and supervising the stimulus presentation. The experiment lasted for approximately 10 minutes. Each testing session started with the calibration procedure. A colorful looming circle accompanied by the sound of wind chimes was moving to 5 pre-defined screen positions. Upon the successful calibration a 20 sec preamble was presented, in which a puppet was saying (English translation): 'Hello! I'm Emma the monkey. I'm going to introduce you to my animal friends! They are always very silly! Would you like to play with us? Look for the right animal!'. This preamble was used to engage the participant's attention and introduce the rest of the experiment. If the child was ready, the experimenter started the first trial. The order of presentation of the trials was randomized across participants.

A trial consisted of three parts: an introduction, a test interval, and a question with optional time for pointing responses. The test interval (highlighted in grey in Figure 1) was further subdivided into windows of about the same size (1.7 sec each) for the statistical analysis: Baseline, Matrix Clause (the matrix question including the relative pronoun), Relative Clause (starting with the embedded NP), and two silence periods. During the introduction, each of the three animals appeared one after the other. Each animal was named as it appeared on the screen. The animal in the middle was always the last to appear to center the child's gaze prior to the test sentence. During the baseline interval the three animals remained on the screen in silence. The verb action did not start until the presentation of the sentence. The duration of the matrix and relative clause windows were based on the specific pronunciation lengths of the clauses while the following silence intervals started immediately after the sentence offset and were identical in length to allow for eye movement responses that are not immediate. The question 'Can you see it?' served to increase target looks and to prompt the pointing response for the participants in the 'Looking and Pointing' condition.

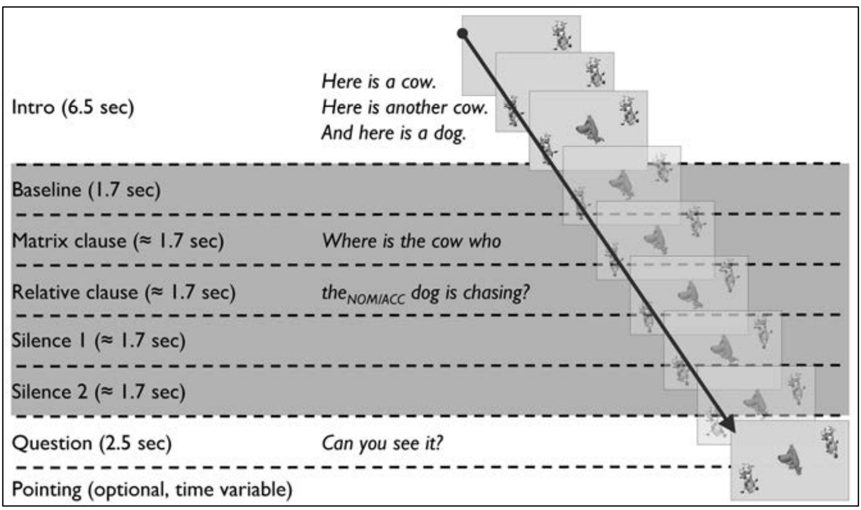

Figure 1. Trial structure in the eye-tracking experiment. Only time windows in grey were analyzed statistically.

5. Results

5.1 Accuracy data

Four-year-olds point significantly more accurate (t=6.01, p<.001) in SRCs (M=0.82; SE=0.04) than ORCs (M=0.36; SE=0.05), which is below chance level (t=2.19, p<0.05). Adult participants are at ceiling (M=1.00) in both conditions. In sum, the accuracy data are in line with existing studies showing that ORCs are less accurate than SRCs and that 4-year-olds are performing below chance level on ORCs.

5.2 Eye gaze data

The eye gaze data are analyzed by computing a Target Looking Score (TLS), which is calculated by dividing the looking proportions to the target animal by the sum of looking proportions to all three animals on the screen. We fitted a linear mixed model with TLS as a dependent variable and GROUP (Children/Adults) and CONDITION ('Looking only'/'Looking and Pointing') as a between-subject factor and SENTENCE TYPE (SRC/ORC) and TIME WINDOW (levels: BASELINE, MATRIX CLAUSE, RELATIVE CLAUSE, SILENCE1, SILENCE2) as within-subject factors[1]. The model included two random components: participants and SENTENCE TYPE for each participant. Figure 2 illustrates the mean looking proportion to the target animal in SRC and ORC for each group and condition.

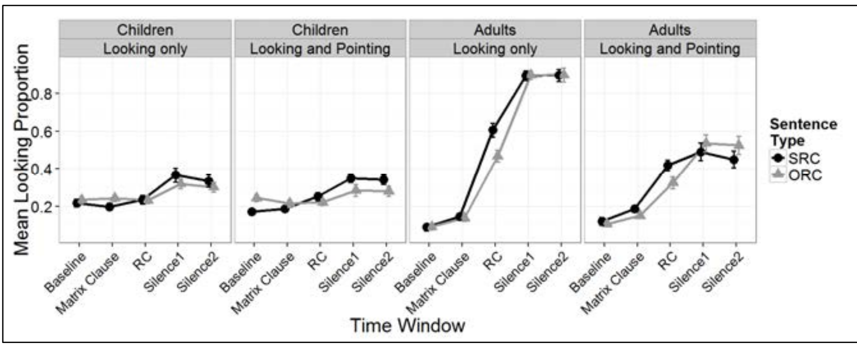

Figure 2. Mean target looking proportion in SRCs and ORCs in each time window for children (2 left panels) and adults (2 right panels) in both conditions ('Looking only' and 'Looking and Pointing').

We found a main effect of GROUP, with adults showing an overall significantly higher TLS than children (coef.=.16; t=11.7, p<.001). In children the TLS increases significantly passing from the RELATIVE CLAUSE window to SILENCE1 (coef.=.09; t=7.06, p<.001). This increase is even stronger in adults as the interaction with GROUP shows (coef.=.16; t=8.01, p<.001). The TLS change in the previous window (from MATRIX CLAUSE to RELATIVE CLAUSE) is different in both sentence types: it is reduced in ORCs compared to SRCs (coef.=–.06; t=2.16, p<.05) in children and similarly so in adults (coef.=–.04; t<1, n.s., cf. footnote 1). In other words, the increase that is visible in the plot for SRC in these windows is absent for ORC in children and weaker in adults, an early SRC-ORC asymmetry. For children all other effects do not reach significance (all t-values<1.56, all p-values >.11). In addition, for adults there is a significant TLS

[1] Each level of each factor was compared to the following one. Only for the factor GROUP, the level children was specified as a baseline. In consequence, an effect that does not interact significantly with GROUP allows us to infer that adults are not behaving differently from children with respect to this effect.

increase already in the first three windows independent of SENTENCE TYPE, passing from BASELINE to MATRIX CLAUSE (coef.=.06; t=3.20, p<.01) and from MATRIX CLAUSE to RELATIVE CLAUSE (coef.=.28; t=14.4, p<.001). In the time windows RELATIVE CLAUSE to SILENCE1, the increase in TLS found for all participants (see above) interacts with SENTENCE TYPE in adults (coef.=.17; t=4.49, p<.001) such that it is less pronounced in SRCs compared to ORCs. This means the early advantage for SRC in the previous window is neutralized in adults, i.e., target looks in ORC "catch up" with target looks in SRC. CONDITION also affected adults' looking behavior: overall the TLS was significantly reduced in 'Looking and Pointing' compared to 'Pointing only' (coef.=–.17; t=6.24, p<.001). This reduction due to the additional pointing task in adults was even stronger in passing from MATRIX CLAUSE to RELATIVE CLAUSE (coef.=–.21; t=5.404, p<.001) and RELATIVE CLAUSE to SILENCE1 (coef.=–.19; t=4.87, p<.001). All other effects did not reach significance in adults (all t-values<1.39, all p-values >.16).

To summarize, all effects found in children are also present in adults with the same direction, sometimes just larger in size. For all participants we found an early advantage (stronger increase in target looks) for SRC over ORC shortly after the presentation of the disambiguating information, i.e., the determiner of the embedded NP. After having heard the complete RC, target looks increase for both RC types, even in children. In children the asymmetry between SRCs and ORCs is persistent until the end of the trial while it is neutralized in adults after the complete presentation of the sentence. The advantage of a fully-developed processing system in adults could account for the overall higher proportion of target looks as well as the earlier and steeper increase of the TLS. It is notable that the effect of CONDITION was only present in adults. We speculate that, in absence of an explicit task, adults simply continue to stare at the early-identified target picture until the trial ends. However, they seem to shift their gaze away from the target in the 'Looking and Pointing' condition, probably after identifying the target awaiting the end of the trial in order to perform the pointing, in agreement with the instructions. This effect is not going to be discussed any further.

6. Discussion

We investigated the off-line accuracy and on-line processing of SRCs and ORCs using the same method for German-speaking 4-year-old children and adults. The central aim of the study was to compare explicit (e.g., pointing) and implicit (e.g., eye movements) measures of language development during sentence processing. We argued that the poor performance on ORCs with two full DPs as verb arguments that is often reported in the literature up to, at least, 5 years of age is the result of extra-linguistic processes that appear to hinder 4-year-old's ability to respond to ORCs correctly.

The pointing data reveal the well-documented SRC-ORC asymmetry, i.e., that 4-year-olds are interpreting SRC accurately, while their performance on ORC is significantly less accurate (Arnon, 2009; Friedmann et al., 2009; Arosio et al., 2009; Corrêa, 1995; Adani et al., 2014). The extra difficulty associated with ORC has recently been explained as a violation of intervention locality (Grillo, 2009; Friedmann et al., 2009; Adani, 2011), a proposal which assumes sensitivity to similar computational processes in the adult and child language systems, with the latter being more affected by performance (extra-linguistic) factors (Rizzi, 2005). However, the here presented eye gaze data uncover a more fine-grained pattern. Despite an overall higher rate of looks to the target and a faster increase of this rate over time in adults, target looks increase for both RC types in all participants, with a steeper increase for SRCs compared to ORCs at the earliest possible time (i.e., the presentation of the embedded NP). Thus, looking at the RC head referent is faster for SRCs in both groups, adults as well as 4-year-olds. This on-line SRC preference, however, is short-lived for adults but long lasting for children – a behavior that might be related to the response patterns in the explicit task.

The on-line data are consistent with the proposal that similar computational processes are available and used by children and adults while processing temporally ambiguous RCs (Friedmann et al., 2009; Trueswell & Gleitman, 2007). In contrast to the off-line data, they also uncovered an early processing of non-canonical word order sentences and the application of restrictions on referent set members, two abilities that are necessary to identify the correct referent of the head noun in ORCs.

What is it then, that makes an explicit measure (e.g., pointing) of sentence comprehension more prone to disruption than an implicit one (e.g., eye gazes)? EF may be a factor that helps explaining the differences between the two measurements. As we have briefly explained, fully matured EFs help in handling all kinds of conflict resolution, an ability also crucial in language processing (Mazuka, Jincho, & Oishi, 2009). Whenever alternative structures compete for selection, both need to be held in memory until the processing is completed. The RC structures we used were temporally ambiguous between the canonical (SRC) and non-canonical (ORC) forms. While the parser might have access to both structures and the corresponding interpretations are available (and temporarily affecting eye movements) heuristics such as agent-first or frequency always favor canonical forms. These heuristics – whilst helpful most of the time – need to be suppressed or overridden when preparing a response to a non-canonical structure. Thus, knowledge of the linguistic structure itself is not enough for evaluating this structure by making a decision. These explicit responses require additional processing steps and are influenced by non-linguistic abilities. EFs are one of these abilities.

In summary, 4-year-old's on-line data reveal a SRC parsing advantage, as found in adults and older children. Furthermore, 4-year-olds' eye movements are also guided to the correct referent by ORCs, which points towards an early comprehension of ORCs that remains hidden in the pointing data. This ability is independent of an explicit task and holds whether a pointing response is required or not. These results indicate that, similarly to adults and consistent with the continuity hypothesis, children as young as four years resolve temporal ambiguity locally, apply restrictions on referent set members, and process argument structural relations in relativized sentential contexts. These abilities show up only when measured implicitly as explicit measures are influenced by extra-linguistic factors.

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