Session 1: Syntax and Grammatical Categories

Is Structural Priming Children Influenced by Animacy-Syntax Interactions?

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Theme: Knowledge

Pickering and Branigan's (1998) residual activation theory proposes that structural priming occurs where the syntactic information that is activated upon hearing a prime is reused to produce target sentences. However, it cannot explain how structural priming could be influenced by animacy syntax interactions (e.g. priming of passives by Gámez & Vasilyeva, 2015). The influence of animacy-syntax interactions on priming of datives is yet to be explored. Double-object datives usually contain animate goals before inanimate themes while prepositional datives tend to feature inanimate themes before animate goals. However, previous priming research has not controlled for these animacy-semantic role mappings. Chang, Bock and Goldberg (2003) consequently argue that it unclear whether structural priming occurs due to the repetition of abstract syntactic frames or the repetition of noun animacy ordering. We therefore assessed the extent to which animacy-semantic role mappings might influence the magnitude of dative structural priming over the course of development.

143 participants (47 three-year-olds, 48 five-year-olds and 48 adults) alternated with the experimenter in describing animations. Animacy mappings for themes and goals were either prototypical (animate goal & inanimate theme) or non-prototypical (animate theme & inanimate goal) and either matched or mismatched across the experimenter's prime scenes and participants' target elicitation scenes. Prime sentences were either double-object datives (DOD) (e.g. *the girl brought the monkey a ball)* or prepositional datives (PD) (e.g. *the girl brought the ball to the monkey*). Participants' target sentences were coded for syntactic form.

Mixed effects regression models revealed that all age groups exhibited a structural priming effect, producing more DOD targets after DOD primes, as compared to PD primes. Animacy-semantic role mappings increased the magnitude of three year olds' PD sentence priming where there was prime-target match in non-prototypical mappings (animate theme & inanimate goal). Animacy had no effect on DOD sentence priming in three year olds or any kind of structural priming in older participant groups (Figure 1).

Our results reveal that structural priming fundamentally relies on the repetition of abstract syntactic frames and not noun animacy orders. Methodological issues with earlier research had previously made this unclear (Chang, Bock & Goldberg, 2003). Participants produced more DOD targets following DOD primes regardless of whether primes contained non-prototypical inanimate-animate or prototypical animate-inanimate noun ordering. However, animacy mappings were sometimes specified and represented relatively strongly in three year olds. Increased priming with more salient non-prototypical, rather than prototypical primes indicated error-based learning (supporting Chang, Dell & Bock, 2006). The developmental decrease in

error-based learning effects of animacy on priming may be due to older participants' increased exposure to non-prototypical sentences (consistent with Rowland, Chang, Ambridge, Pine & Lieven, 2012). Nevertheless, our findings from three year olds cannot be explained by Pickering and Branigan's (1998) residual activation theory since it does not suggest that semantic information could influence structural priming. Our results demonstrate the changing influence of animacy cues on sentence production through interactions with syntactic structure over the course of development. We therefore suggest that theories of structural priming should consider the possible role of animacy-syntax interactions.

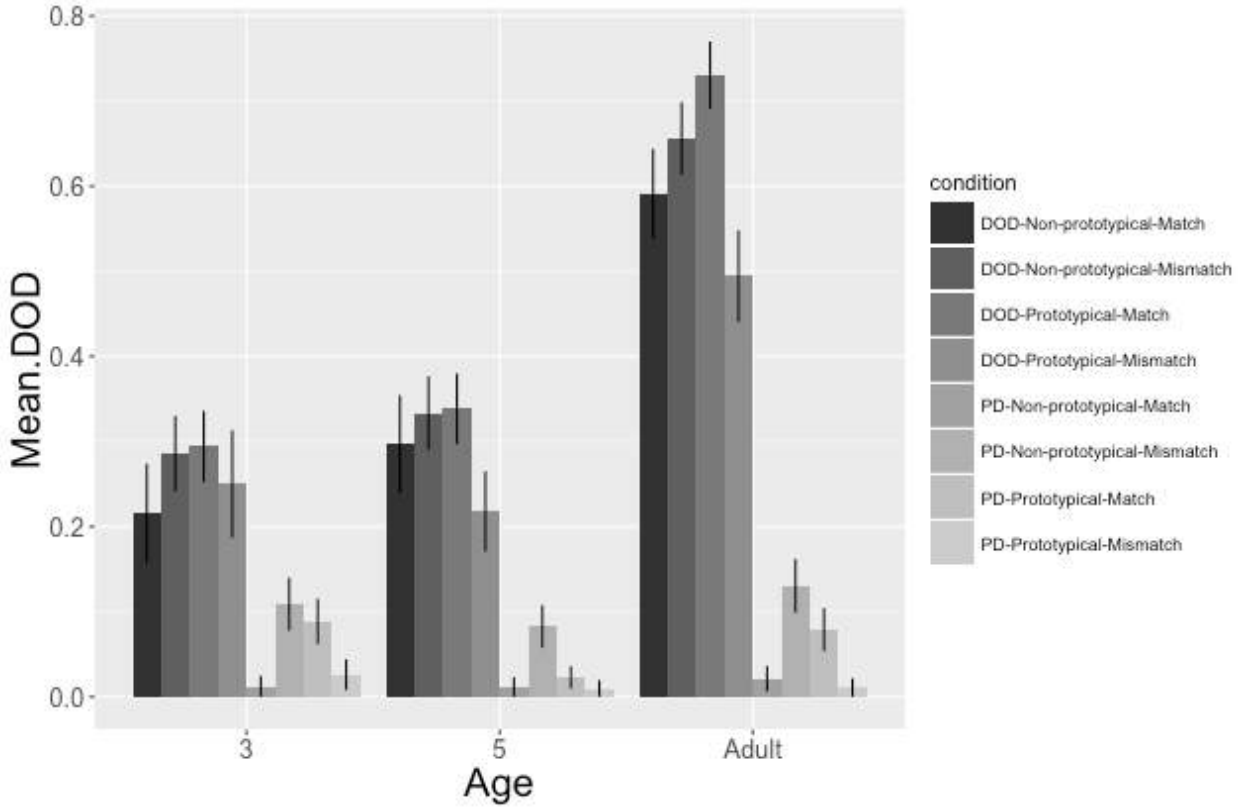

Figure 1: The mean proportion of DOD responses following DOD and PD primes where primes contained either prototypical or non-prototypical animacy-semantic role mappings and these mappings were either matched or mismatched across primes and targets (*SE* in error bars).

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The influence of animacy on children's online processing of restrictive relative clauses

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Subject relative clauses (SRCs, "the deer *that is chasing the cow"*) are typically processed more easily than object relative clauses (ORCs, "the deer *that the cow is chasing"*), but this difference is diminished by the presence of an inanimate head-noun in ORCs ("*the tractor that the cow is chasing*") (Mak, Vonk, & Schriefers, 2002). We investigated the influence of animacy on children's online processing of SRC and ORC sentences. Forty-eight English-speaking children (aged 4;5–6;5) and 32 adults listened to sentences that varied in the animacy of the head-noun (Animate/Inanimate) and the type of relative clause (RC) used (SRC/ORC) (Table 1). Concurrently, participants saw two images depicting the same two agents, carrying out reversed actions (e.g. deer chasing cow/cow chasing deer, Figure 1) and were asked to choose the picture matching the sentence using a game-pad. We hypothesised that children would find ORC sentences more difficult in the animate condition than the inanimate condition. Participants' eye-movements were monitored to investigate online processing as a RC unfolds. Specifically, we focussed on anticipatory fixations after the onset of the RC ("*that…*"). We predicted more anticipatory looks to the picture matching a SRC-sentence in the animate condition compared to the inanimate condition.

Both child and adult participants were quicker to respond to SRC sentences and children were more accurate with SRCs (adult performance reached ceiling). As expected, children were significantly more accurate with ORCs with an inanimate head-noun rather than an animate head-noun, but animacy had no effect on the response time for ORCs.

Surprisingly, for SRCs, after the onset of the RC ("*that*…") children made more looks more quickly to the target in the inanimate rather than animate condition (Figure 2), suggesting greater anticipation for SRCs with inanimate head-nouns. Adults showed no preference for SRCs in the animate condition but they did in the inanimate condition, although this preference emerged earlier than it did with the children. These results appear counter-intuitive given children's performance in the forced-choice selection task. Children were more accurate with ORC sentences in the inanimate condition, yet during the RC they looked at the target less in this condition. The seemingly increased anticipation for SRCs in the inanimate condition may be due to surprisal at inanimate objects acting on animates, resulting in the inanimate SRC-image (e.g., the tractor chasing the cow) capturing more attention during the RC (or earlier in the case of adult participants). Alternatively, it may be due to the inanimate objects being more distinct from their animate competitors, making the SRC-image easier to identify more quickly, leading to earlier looks to this image. We are currently investigating these possibilities by repeating our experiment with animate-inanimate and inanimate-inanimate pairs. If surprisal at inanimate agents led to our eye movement results, we would again expect more looks to the inanimate SRC-image, however if the effects were driven by the animate-inanimate contrast we would expect more looks to the animate SRC-image. Regardless of the cause, our results show children's anticipatory fixations at RC-onset do not consistently predict performance.

Table and Figures

Table 1. Example SRC and ORC sentences in the animate and inanimate conditions

Relative Clause condition	**Animacy condition**	
	Animate	Inanimate
SRC	*"Where is the deer that is chasing the cow?"*	*"Where is the tractor that is chasing the cow?"*
ORC	*"Where is the deer that the cow is chasing?"*	*"Where is the tractor that the cow is chasing?"*

Fig 1: Animate and Inanimate condition images – The head nouns were "deer" and "tractor"

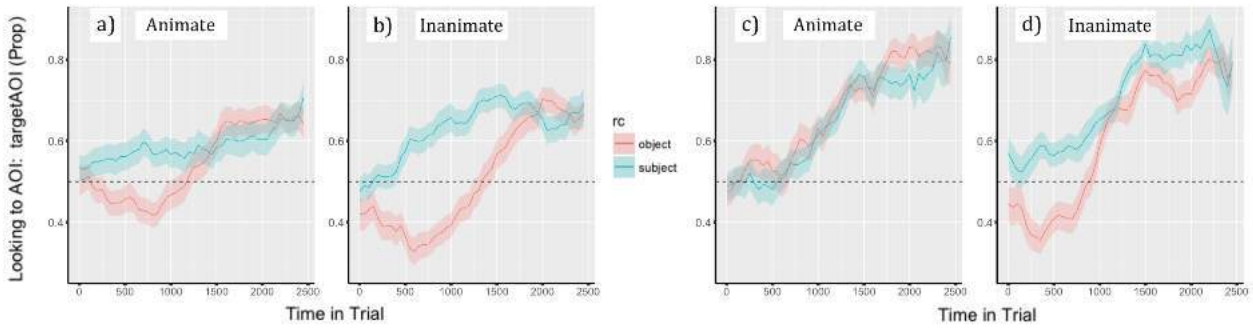

Fig 2: The proportion of looks to the target for children (a, b) and adults (c, d). Time 0 is the onset of the RC, e.g. "that is chasing the cow" (SRC) and "that the cow is chasing" (ORC). Mean RC duration was ~2500 ms.

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Cross-linguistic learning of word classes from distributional information.

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A key question in Language Acquisition is how children learn word classes such as noun and verb. Previous research has shown that distributional information (the fact that nouns tend to be preceded by determiners and followed by verbs, while verbs tend to be preceded by pronouns and followed by determiners and nouns) is a powerful cue to learning these word classes. However, while mechanisms for distributional analysis are thought to be employed by language-learning children, computational versions of these mechanisms do not normally incorporate a developmental component and are not typically evaluated against child data.

Freudenthal et al. (2016) attempted to do this by embedding a variant of Redington et al.'s (1998) mechanism within a computational model of language acquisition (MOSAIC) that represents progressively longer (utterance-final) utterances and hence gradually expands the contexts available for distributional analysis. Using a measure of 'noun-richness' they showed that early child speech contains a far higher ratio of nouns to verbs than adult speech – supporting the notion that children develop a productive noun category before a productive verb category (see Fig. 1).

Simulations with MOSAIC showed that part of this early noun advantage can be explained through MOSAIC's learning biases – nouns tend to occur in utterance-final position and are thus relatively frequent in MOSAIC's early output. MOSAIC's distributional analysis mechanism was also able to build an early noun class that was sufficiently large to boost the model's noun-richness to levels approximating those found in children (see Table 1).

Here, we extend these findings to German and Dutch, two languages that differ from English in terms of their word order as well as their use of Gender and Case. German and Dutch are SOV/V2 languages that have less constrained word order than English. German marks both Gender and Case on determiners, while Dutch only marks Gender. We will show that early child noun-richness scores are very similar across the three languages, suggesting that children in all three languages are equally productive around nouns. Results from MOSAIC's distributional analysis, however, show that German, and to a lesser extent Dutch, models fall short of English models' productivity around nouns, suggesting that their Gender and Case systems hamper the building of a noun category. We examined this by merging the relevant determiners into one lexical item, and re-running the distributional analysis. This brought both the Dutch and German noun class more in line with the English one and suggests that children may be able to ignore the identity of determiners when building an early noun category.

Follow-up analyses also showed that differentiating between determiners allowed the model to distinguish between gender subcategories in German, where Gender is marked on all determiners, but was less successful in Dutch, which marks Gender on the definite, but not the indefinite article.

Taken together, these findings suggest that distributional analysis can account for children's initial noun-richness scores, but that word classes may need to be represented at multiple levels of abstraction to capture both their general properties and their more fine-grained structure.

References:

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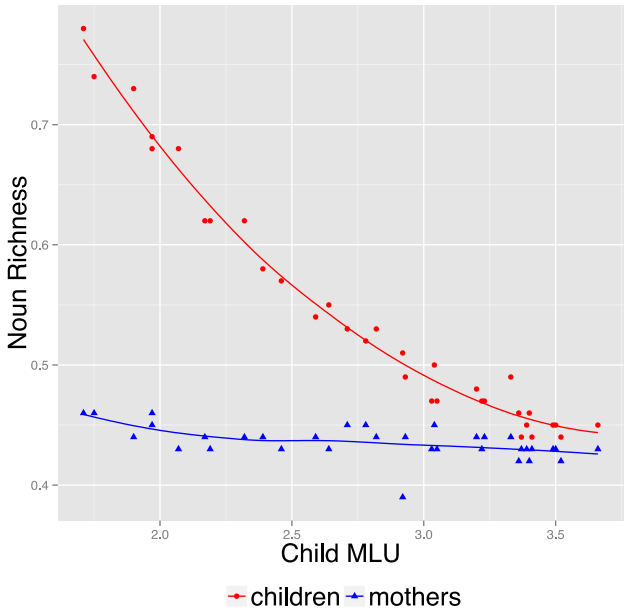

Fig. 1: Average noun-richness scores for children and mothers in the Manchester corpus.

Table 1: Noun and Verb linkage and Accuracy in consecutive runs of MOSAIC trained on English.

Run	Links	Accuracy	Noun richness	Nouns	Verbs	Noun Accuracy	Verb Accuracy
36	1907	0.79	0.85	1244	205	0.83	0.57
38	2674	0.79	0.78	1599	424	0.83	0.65
40	3676	0.83	0.77	2338	611	0.85	0.73
42	4418	0.87	0.78	3015	709	0.89	0.78
44	4755	0.89	0.78	3328	766	0.9	0.83
46	4942	0.9	0.77	3433	831	0.91	0.85
48	5083	0.9	0.77	3511	885	0.91	0.86
50	5142	0.91	0.77	3542	908	0.91	0.87

Session 2: Verbs

Predicting errors in children's production of verb morphology: Evidence from person/number marking in Finnish and Polish

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Introduction: Studies of naturalistic data have suggested that young children acquiring highly- inflected languages do so in a way that is largely error-free. However, low overall error rates in children's production may hide higher error rates in certain parts of the paradigm (Rubino & Pine, 1998; Aguado Orea & Pine, 2015). To investigate this possibility, the current study examines children's production of person/number marking in present tense verbs in two morphologically complex languages, Finnish and Polish, which differ in the complexity of the verb inflection pattern. Input-based accounts, which are based predominantly on English morphological learning (e.g., Matthews & Theakston, 2006), predict that both the input frequency of a particular word form (token frequency) as well as the density of a word's phonological neighbourhood (PND), predict rates of learning. Therefore, we investigate not only whether children make errors in inflection, but also whether input-based accounts are able to predict where in the verb paradigm errors occur.

Method: Seventy-seven native Finnish-speaking children (46 females; mean age: 49.4 months; range: 35-63) and 81 native Polish-speaking children (43 females; mean age: 48.7 months; range: 35-59) participated in the study, which employed an elicited production paradigm. The stimuli consisted of 32 verbs in each language. The verbs were chosen across a range of surface form frequencies and from 8 (Polish) and 11 (Finnish) verb classes varying in PND, with counts taken from CDS corpora and standard grammar dictionaries respectively. Each verb was presented as an action in a video on a laptop computer. Children were shown animations of different characters (1^{st}, 2^{nd}, 3^{rd} person; singular and plural) performing the various actions, and they produced both the pronoun and the inflected present-tense form of the verb (e.g., "Minä uin" *I swim-1sg*; "Sinä imuroit" *You hoover-2sg*).

Results: Analysis with mixed-effects models revealed that, for both languages, despite low overall error rates (7-8%), children made more errors with verb forms with lower token frequencies in the input (Finnish: $\beta=0.38$, SE=0.06, $\chi2(1)=39.14$, $p<0.0001$; Polish: $\beta=0.26$, SE=0.05, $\chi2(1)=29.47$, $p<0.0001$) and with verbs belonging to classes with lower PNDs (Finnish: $\beta=0.17$, SE=0.07, $\chi2(1)=5.78$, $p=0.016$; Polish: $\beta=0.21$, SE=0.07, $\chi2(1)=8.36$, $p=0.004$) (see Figures 1 and 2). In Finnish, but not in Polish, older children also produced fewer errors than did younger children ($\beta=0.08$, SE=0.03, $\chi2(1)=8.71$, $p=0.0032$). The interaction between token frequency and PND was not significant in either language. Analysis of the children's errors indicated that the types of errors made by children were influenced by the type of inflectional paradigm in the language.

Conclusion: These findings suggest that successful models of children's acquisition of verb morphology need to be sensitive to the statistical properties of children's input, i.e., both token frequency (reflecting children's retrieval of individually stored verb forms) and PND (children's use of phonological analogy), and the type of inflectional paradigm children are learning.

Figures

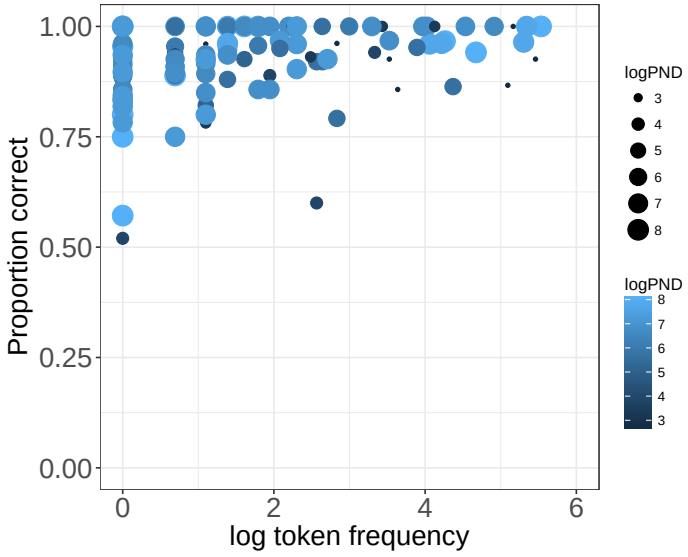

Figure 1. Proportion correct per item in Finnish, with log token frequency on the x-axis and log PND represented by the color and size of the point.

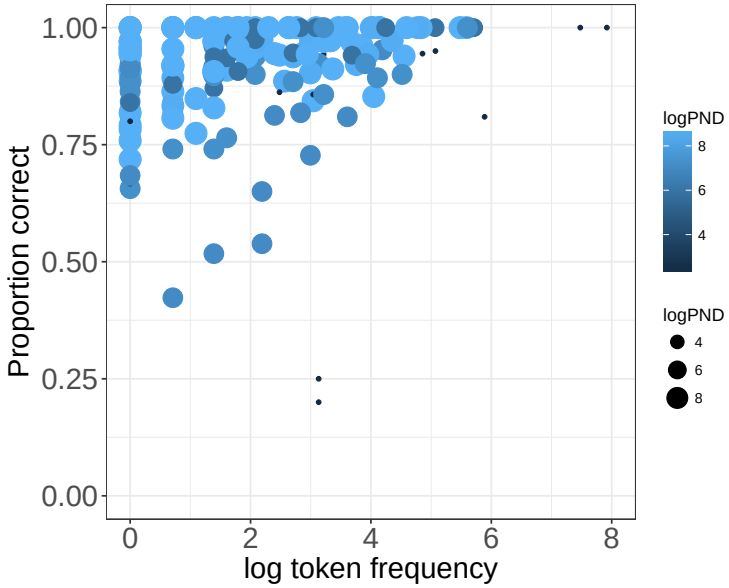

Figure 2. Proportion correct per item in Polish, with log token frequency on the x-axis and log PND represented by the color and size of the point.

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Cross-linguistic acquisition of complex verb inflection in a neural network model

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Knowledge Theme, WP6: Learning how to inflect verbs in different languages
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Usage-based approaches to language learning suggest that the acquisition of inflectional morphology and errors made by young learners are a function of the statistical properties of the input (e.g., Bybee & Moder, 1983). It has been shown that purely exposure-based computational models such as neural networks can approximate human error patterns not only in English verb and noun inflection (e.g., MacWhinney & Leinbach, 1991; Plunkett & Juola, 1999) but also in the more complex system of Serbian noun morphology (Mirković, Seidenberg, & Joanisse, 2011).

In order to test whether the acquisition of verb inflection can be simulated by a single exposure-based mechanism for two morphologically complex and dissimilar languages, we trained neural network models on the task of producing person/number inflected verbs in Finnish (FI) and Polish (PL). We compared the simulations with experimental results of elicited-production studies, where children at the age of about 50 months were shown animations and had to produce the inflected present-tense forms for 32 verbs.

Three-layer network models were presented with phonological representations of verb stems (e.g., FI: /roikːu/; PL: /rɨsuj/) together with a code for one target person/number context on the input layer and were trained to produce the complete inflected form on the output layer (e.g., FI: /roikut/; PL: /rɨsujɛʃ/ for 2nd singular). In each language, 800 present-tense verbs (FI: 1785 forms; PL: 2419 forms) were presented probabilistically during training according to their token frequencies in child-directed speech corpora. While Finnish inflectional suffixes in verb forms are fairly regular, Polish suffixes are highly complex. On the other hand, Finnish features more complex stem alternations than Polish. By limiting the intermediate layer to 200 units, the models were forced nevertheless to generalise rather than rote-learn by relying on morphophonological subreguarities in order to select the appropriately inflected forms based on the input stems.

The models could correctly inflect over 99% of the training tokens after seeing 250,000 (FI) and 500,000 (PL) examples and correctly generalised 90% (FI) and 96% (PL) of unseen Tokens (see Figure 1). Learning in both models was facilitated for highly frequent forms and for verbs with high phonological neighbourhood density (a measure of phonological analogy). Suffix errors often resulted from overgeneralisation (i.e., producing the correct person/number context but from a different inflectional class) and occasionally from substitutions of low-frequency forms with higher-frequency forms (e.g., producing 3rd singular instead of 1st singular). Also see Figure 2.

The simulation results are broadly consistent with our experimental findings. The simulations in conjunction with the experiments suggest that a common learning mechanism underlies the acquisition of inflectional morphology cross-linguistically, and that this mechanism extracts subregularities in the distributional properties of the input. The model performance shows differences in error patterns between inflectional classes and between languages. We will discuss detailed error patterns at different training stages in the light of the characteristic properties of both languages.

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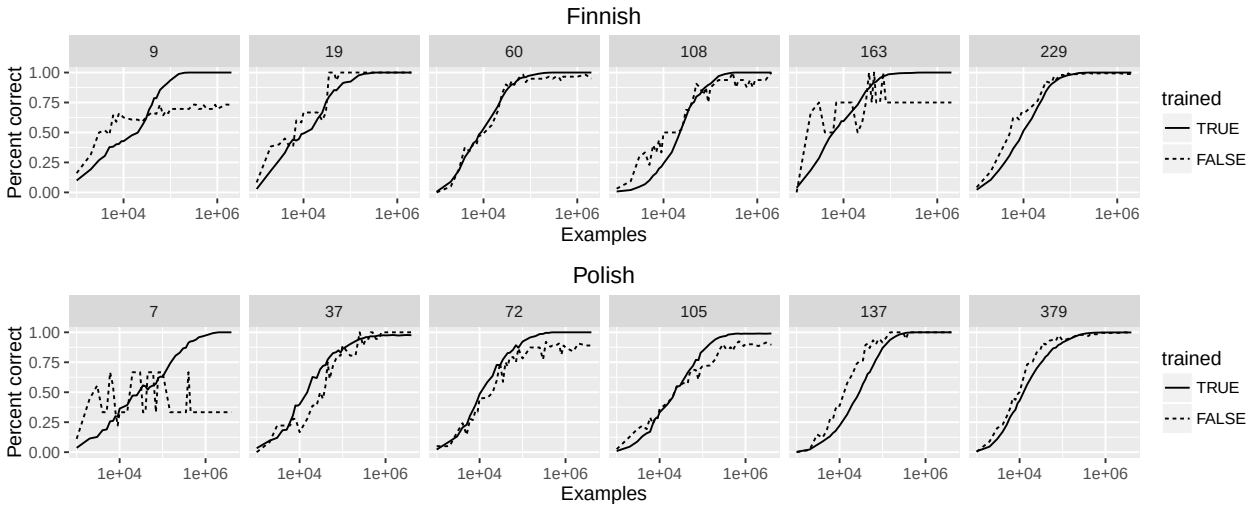

Figure 1: Percent correct of trained vs. untrained tokens over training in the Finnish (top) and Polish model (bottom), listed by inflection classes according to their sizes in the training corpus (neighbourhood density).

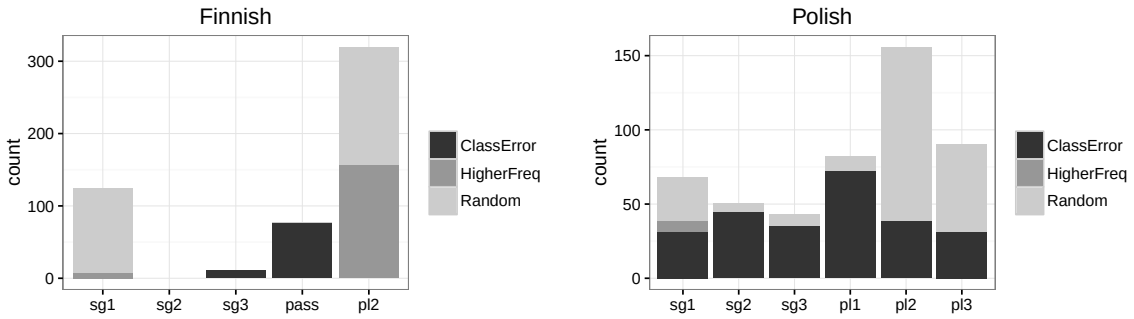

Figure 2: Number of class (overgeneralisation), frequency, and random errors by person/number context in the Finnish (left) and Polish model (right) at a point in training where mean suffix accuracy was around 75% (25,000 examples in PL and 2000 in FI).

Note: In Finnish, the passive is colloquially used in place of 1st plural; 3rd plural is only used in formal language. Finnish mean accuracy was calculated excluding 2nd plural, because this form is acquired a lot later than the others.

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Testing two different models of verb-marking error in children with Developmental Language Disorder and language-matched controls

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Theme: Variation
Keywords: Cross-linguistic data, Developmental Language Disorder (DLD), Optional Infinitive (OI) Stage

The aim of this study was to test two different models of the pattern of verb-marking error in German-speaking children with Developmental Language Disorder (DLD) and language-matched controls. According to the (Extended) Optional Infinitive ((E)OI) Hypothesis (Wexler, 1994; Rice et al., 1995), children's verb-marking errors reflect a stage in which their grammars allow non-finite forms (e.g. 'build') in contexts in which finite forms (e.g. 'builds') are required — a stage which extends higher up the MLU range in children with DLD. According to the Dual-Factor Model (Freudenthal, et al., 2007, 2015), children's verb-marking errors reflect the learning of non-finite forms from compound-finite constructions (which, in German, take the form 'He can a house build-INF'), and to default to high-frequency non-finite forms in simple-finite contexts — with children with DLD being more likely to default than typically developing children.

In order to test these models, a verb-elicitation experiment was designed and conducted with a group of 50 German-speaking children with DLD and a group of 50 language-matched controls. This study involved eliciting a range of verbs that differ in the relative frequency with which they occur in finite and non-finite form in two conditions: a simple-finite condition (e.g. 'Lisa builds a tower. Peter …') and a compound-finite condition (e.g. 'Peter can a house build-INF. Lisa …'). An example context from the elicitation task is given in Figure 1. The participants also completed a battery of linguistic and non-verbal IQ tests to establish that they met the criteria for inclusion in the study.

The critical predictions of the study were that a) children with DLD would make more OI errors than language-matched controls, particularly in simple-finite contexts (EOI Hypothesis) and b) both groups would make more OI errors in compound-finite than in simple-finite contexts (Dual-Factor Model).

In order to test these predictions the rates at which the children produced correct responses (as opposed to OI errors) were entered into a 2x2 Mixed ANOVA, where the between-groups factor was Group (DLD, TD) and the within-groups factor was Condition

(Simple-Finite, Compound-Finite). The results, which are plotted in Figure 2, show a significant main effect of condition, with higher rates of correct responses in simple-finite contexts and no significant main effect of group. However, there was a marginally significant Condition x Group interaction, which reflected the fact that the DLD group performed better than the TD group in the compound-finite condition.

These results count against the EOI Hypothesis, since they fail to show higher rates of OI errors in DLD children than in language-matched controls. On the other hand, they are broadly consistent with the Dual-Factor Model, since they show higher rates of OIs in the compound-finite than the simple-finite Condition. A stronger test of the Dual-Factor Model would be to investigate whether it is possible to predict children's tendency to produce OI errors on a verb-by-verb basis in terms of the relative frequency with which verbs occur in infinitive and finite form in German child-directed speech. Further analysis (using mixed effect models) will address this question.

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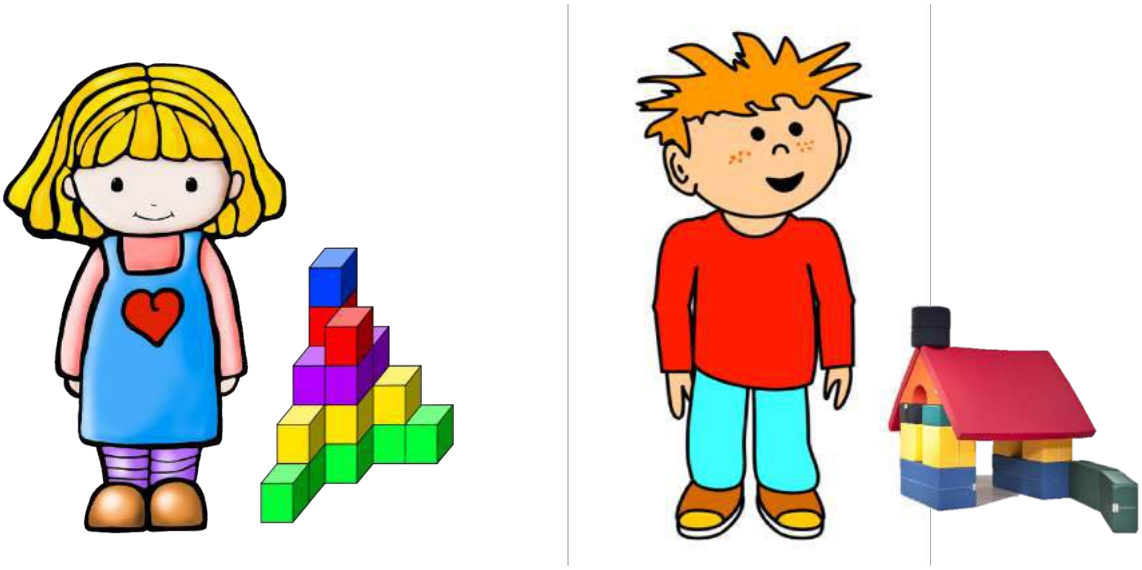

*Figure 1: Example context for **build** taken from the experiment*

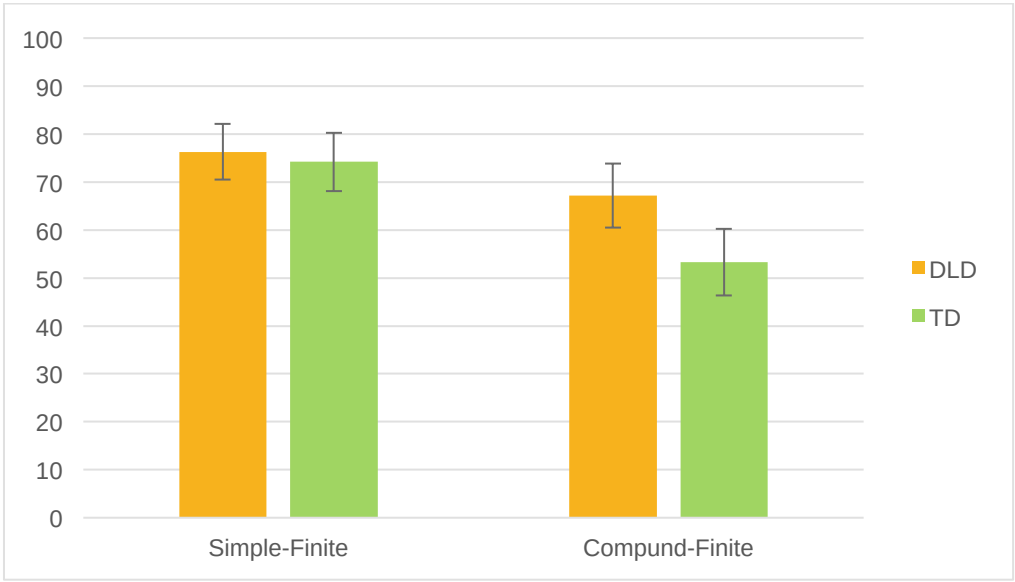

Figure 2: Mean percentage of correct (as opposed to OI) responses (± SEs) as a function of Condition and Group

Session 3: Caregiver Input

Evaluating the effectiveness of a reading for pleasure intervention: A randomised control trial.

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Theme: Environment

Children whose parents read with them regularly in the early years tend to develop a larger vocabulary (Bus, Van Ijzendoorn, & Pellegrini, 1995; Mol, Bus, de Jong, & Smeets, 2008). However, when adults do not feel familiar with books, or do not find books a source of pleasure themselves, shared book reading is less likely to become embedded in family practice (Bus, Leseman, & Keultjes, 2000). We evaluated the impact of a shared reading for pleasure intervention: The Reader's Shared Reading programme. We were interested in testing how families from disadvantaged families responded to a programme which emphasises the enjoyment of reading.

Forty-three primary caregivers and their 3- to 4-year old children were asked to take part in The Reader's Shared Reading programme once a week for 8 weeks. Forty-two further families took part in a comparative control group; they were asked to attend an existing Bookstart 'Story Time' group at their local library group once a week for 8 weeks. The effect of attending the intervention or control reading groups was assessed by comparing (i) children's vocabulary language gains, (ii) attendance at the sessions, and (iii) caregiver's attitudes to reading. In a smaller subset of caregivers, we used semi-structured interviews to ask caregivers about their experience of taking part in The Reader's Shared Reading programme.

Our findings showed that The Reader's Shared Reading programme had no significant effect on children's vocabulary gains. However, families were significantly more likely to attend The Reader's Shared Reading groups than the Bookstart 'Story Time' groups. In addition, the The Reader's Shared Reading groups were rated more favourably than the Bookstart 'Story Time' groups by both caregivers and children. This suggests that The Reader were successful in engaging disadvantaged families to attend their weekly reading groups. There was also evidence that there were numerical increases in how often caregivers in the intervention group read with their children and also the number of hours they themselves spent reading. Caregivers in the intervention group also showed numerical increases in their knowledge of book titles and authors too.

We conclude that the intervention was successful in engaging caregiver and children from disadvantaged backgrounds in shared reading. However, because the intervention was only 8 weeks long, the reading groups may not have been long enough and/or intensive enough for us to detect any positive changes in children's vocabulary. The Reader's Shared Reading model needs to be evaluated in a more intensive and/or longer intervention, with outcome measure follow ups at 6 and 12

months. A dual practitioner-caregiver approach has the potential to significantly impact on children's vocabulary and caregiver's reading attitudes and behaviours.

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Does caregiver input influence children's early acquisition of syntax?

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Theme: Communication

Modal verbs such as 'can', 'must', and 'may' can be used by a speaker to both indicate their level of certainty towards a proposition (e.g. "it *must* be in the blue box") or to express meanings such as obligation or permission (e.g. "you *must* go to bed now") (Papafragou, 2002). It is essential that children learn how to use and comprehend these terms effectively in order to understand others' beliefs and to develop the pragmatic skills necessary to use these terms as politeness strategies in speech (e.g. *would* you like to open the window?). Modal verbs are also a complex aspect of language in regards to form-function mappings since the same modal verb, e.g. 'can', may be associated with more than one meaning (i.e. ability, permission). Acquisition of modal verbs is therefore a difficult task for the language learner and limited research has focused on young children's production of these forms (Fletcher, 1985). Even more limited is research relating to caregiver input and the modal verbs children are exposed to. However, some theories of language learning (e.g. the constructivist usage-based approach) advocate a central role for the analysis of the distributional properties of the input in the learning process, thus a study of the input children hear and its relation to their own developing linguistic representations may help shed light on this crucial aspect of linguistic development. In this study, we examined the properties of modal use in the input to young children using dense samples of two mothers' naturalistic speech addressed to their children between the ages of two to five years. Modals were extracted and analysed according to their frequency and their associated meanings. The results illustrate some consistent patterns of use whereby certain forms typically occur with only one or two meanings, but also a high degree of complexity for other forms, which take a wide range of

different meanings. These differences will be discussed with respect to the theoretical predictions that can be derived concerning the likely pattern of acquisition in children's language, which will subsequently be tested through analysis of the children's longitudinal developmental data.

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How do Pre-School Staff Communicate with Children with English as an Additional Language?

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Keywords: Naturalistic observation, teacher-child interaction, English as an additional language (EAL), pre-school classroom

In a 21st-century super-diverse world, young children are likely to speak different first languages which are not the dominant language of society. For some children, pre-school is the only environment where they experience this dominant language. A pressing issue encountered by pre-school staff is how to communicate with these children and how to help these children acquire the dominant language. The present study aims to investigate how pre-school staff in the UK communicate with pre-schoolers who have English as an additional language (EAL). This study intends to observe whether and how staff tailor their interaction, in terms of utterance length, vocabulary range, syntactic complexity, and the use of gestures and different types of questions, to children of different ages, and with different linguistic backgrounds (native English vs. EAL) and levels of language proficiency. Video and audio recording of a pre-school classroom is on-going. Preliminary analyses on the transcript of the first recording session show that the pre-school staff tended to speak more to the monolingual children and, determined from the type-token ratios (TTR's) of the staff's use of words and lemmas, use more varied vocabulary when speaking to them. The mean length of utterances (MLU) directed at the monolingual children was also higher. In addition, when looking at individual children, the staff's MLU and TTR's both correlate with the children's English proficiency level, assessed by the Clinical Evaluation of Language Fundamentals – Preschool 2 (CELF-P2). The results of this study can give us a glimpse of the general linguistic environment of a pre-school classroom, and the linguistic input that children get from pre-school staff. In

addition, this study will help identify possible strategies that pre-school staff can use to support pre-schoolers' acquisition of society's dominant language.

Session 4: Speech

The role of highly frequent marker words in infants' and adults' language acquisition: A review.

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Theme: Environment

To acquire language, learners must identify words from continuous speech, and discern the grammatical constraints that guide the way those words are used. Studies suggest that both these tasks may benefit from the presence of high-frequency marker words; which may act as anchors around which speech segmentation can occur (Bortfeld et al., 2005), while also providing helpful information to assist with grammatical categorisation (Monaghan & Christiansen, 2010). We tested whether both infant and adult learners could draw on the same high frequency words during speech segmentation and grammatical categorisation.

We familiarised adults with a continuous speech-stream comprising repetitions of 8 bisyllabic *target words*, and compared learning to the same language but with high-frequency monosyllabic *marker words* preceding target words (mimicking, for example, "the" occurring before nouns and "you" occurring before verbs). Critically, marker words distinguished target words into two distributionally-defined categories, which were otherwise unidentifiable. Participants completed a 2AFC test of *segmentation*, and a similarity judgement *categorisation* test. We then tested transfer to a word-action/object learning task, where distributional categories were either consistent or inconsistent with the new action/object distinction. Data from two studies indicated that high frequency words informed adults' early grammatical categorisation at the very early stages of language learning, while they were still segmenting the speech. We then tested the effect of variability on learning using the same training and testing materials as before, but with target words preceded by marker words 100%, 67%, or 33% of the time. The data indicate that variability can help learners draw on the same high-frequency words during speech segmentation and grammatical categorisation.

In a related study with infants, we familiarised 12-month-olds and 8-month-olds with a continuous stream of speech comprising target words or targets plus markers. In a further condition, we examined whether learning was improved when grammatical categories were denoted by phonological cues, in addition to the marker words. We assessed infants' ability to segment the speech by measuring looking times to words versus part words, and we examined categorisation by measuring looking times to word-pairs containing words from the same versus different grammatical categories. Data collection is presently ongoing, but preliminary results will be discussed.

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Gestalt auditory principles support phrase structure parsing

Antony Scott Trotter, Padraic Monaghan & Rebecca L. A. Frost

Lancaster University

To accurately process and respond to speech requires rapidly determining the structural dependencies between words in order to comprehend meaning. While phrase structure may be necessary for producing syntactically complex sentences, it has been argued that sequential processing alone may be sufficient for comprehension, with low-level statistical correspondences providing critical support for dependency detection. In the present study, we investigated the extent to which prosody – the rhythmic and melodic aspects of speech – may support low-level processing of long-distance dependencies in complex syntactic structures. We hypothesized that phrasal units that contain syntactic dependencies would be more similar in terms of pitch, enabling grouping according to the Gestalt similarity principle. Accordingly, phrases that do not share a dependency will contrast in pitch, resulting in perceptually distinct groupings. Further, we hypothesized that pause duration could reflect the Gestalt principle of proximity; pauses occurring between clauses will render those clauses distinct if they are longer in duration than pauses elsewhere in the speech. Similarly, pauses should be of a shorter duration within clauses, supporting the grouping of words contained in each clause.

To explore this possibility, we analysed behavioural data from Montag and MacDonald (2014). In their study, American English speakers (n = 64) spontaneously produced either passive (e.g. [the bear]1 [held]2 [by the girl]3 [is green]4) or hierarchical centre-embedded sentences (HCEs, e.g. [the bear]1 [the girl]2 [held]3 [is green]4), elicited using a picture description task. These sentences were divided into four phrase positions (as indicated by the indices in the examples). According to the proximity and similarity principles, we expected shorter pauses, and more similar pitch to occur between dependent phrases, distinguishing passive and HCE structures. Linear mixed effects modelling (LMEMs) revealed a smaller pitch decrease from the first to second positions in passives (passive; 9.6Hz (t = -6.05) vs. HCE; 12.8Hz (t = -5.93)), a smaller pitch decrease from second to third positions in HCEs (HCE; 6.4Hz (t = -2.626) vs. passive; 17.9Hz (t = -12.623)), and a similar, insignificant decrease between the third and fourth positions (HCE; 5.7Hz (t = -1.977) vs. passive; 5Hz (t = 0.934)), see Figure 1. LMEMs assessing the likelihood of pause occurrence revealed a significant interaction between syntactic form and pause location, indicating that in HCEs, pauses were more likely to occur between the first and second positions ($p < 0.05$), whilst in passives, they were more likely to occur between positions two and three ($p < 0.005$), see Figure 2. Pause duration failed to differ between those occurring within, and at the boundaries of dependent phrases ($t < 2$), see Figure 3. HCEs are challenging to process, but here we see evidence that pitch similarity and temporal proximity provide reliable cues for tracking their dependencies; phrases in positions two and three are temporally proximate, and have high pitch similarity, distinguishing the initial phrase (position one) of the main clause, assisting in the detection of long distance dependencies.

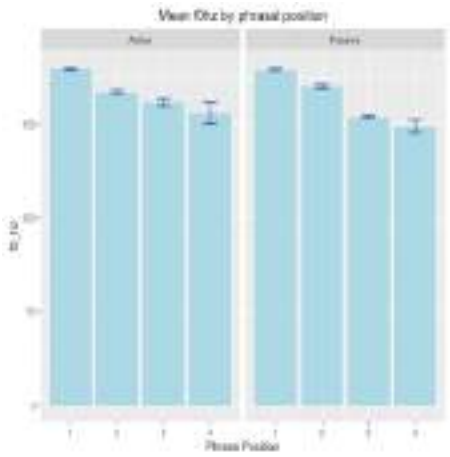

Figure 1: Mean F_0hz for words in each phrase for active vs. passive structures

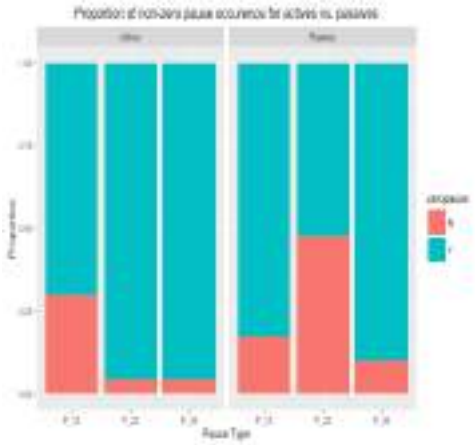

Figure 2: Proportions of pauses with zero vs. non-zero values for active vs. passive structures

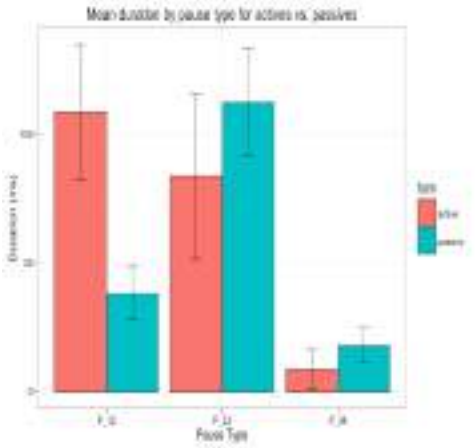

Figure 3: Mean pause duration by pause location for active vs. passive structures

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Investigating Predictors of Individual Differences in Productive Vocabulary and Their Ability to Identify Late Talking Toddlers

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Theme: Knowledge, Language 0 – 5 Project

Understanding individual differences in language acquisition is fundamental to developing our knowledge of language impairments. Currently, late talkers are identified on the basis of productive vocabulary, usually, at 24 months. However, earlier late talking status has been shown to be a poor predictor of later language abilities (Fernald & Marchman, 2012; Dale, Price, Bishop & Plomin, 2003).

In this study, we investigate predictors of individual differences in productive vocabulary at 24 months as measured by the Communicative Development Inventory (CDI). These predictors include earlier measures of receptive and productive vocabulary, non-word repetition, quality of input, gender, family history of speech and language impairments, and speed of processing familiar items. Following this, we investigate the strength of these predictors in identifying late talking status at 24 months as determined by productive vocabulary scores using the CDI.

The first analysis will investigate the association between these measures and productive vocabulary scores. A regression analysis will investigate the ability of these predictors to explain the variance in productive vocabulary at 24 months.

A second analysis will investigate the strength of these predictors in identifying late talking children from typically developing children. The receiver operating characteristic (ROC) analysis will measure the overlap in scores obtained by children identified as late talking compared to children with typically developing language. This analysis will also provide details on scores with optimal sensitivity and specificity for classifying children as Late Talkers.

The preliminary results for the sensitivity and specificity analysis suggest that a number of the predictors successfully identify late talking children, yielding acceptable levels of sensitivity and specificity. In addition there was little overlap between scores achieved by late talkers and typically developing children, as shown by the area under the ROC curves. Successful predictors were the number of words understood at 18 months, the number of words understood and spoken at 18 months, mean length of utterance at 24 months and non-word repetition at 25 months. However, input averaged across 18-21 months, as measured by adult word count using LENA technology, did not distinguish between late talking and typically developing children. Analyses for the predicting individual differences in vocabulary at 24 months is ongoing and will be presented.

Implications for theories of individual differences and criteria for identifying children at risk of late talking will be discussed.

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Session 5: Actions and words

The effect of labels and associated sounds on objet recognition

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There is accumulating evidence showing that infants prefer linguistic (e.g., words) over non-linguistic (e.g., sounds) stimuli, suggesting that from the early stage of language acquisition, words have a privileged status (e.g., Vouloumanos & Werker, 2007; Ferry et al., 2010). Yet, it remains unclear whether verbal (labels) and non-verbal signals (associated sounds) activate conceptual representations in a similar manner. Recently, Lupyan & Thompson-Schill (2012) have shown that adults recognize faster a target image (e.g., cat) when it is primed by a verbal cue, such as a spoken label (the word 'cat'), compared to when it is primed by non-verbal sound (e.g., meowing), indicating that in adults concepts are activated more effectively via verbal compared to non verbal means. The present study aimed to replicate and extend these findings to pre-verbal infants. Nine- and twelve-month-old infants participated in a primed intermodal preferential (IPL) task in which they listened to either a label (e.g., cow) or sound (e.g., mooing) followed by an image containing two objects (e.g., cow – telephone), a target (congruent) and a distracter (incongruent), while their looking times were being recorded. An additional group of adults took part in a behavioural task during which they heard a label or a sound followed by an object on the screen, either matching or not the auditory stimulus. Their task consisted at answering as fast as possible indicating whether the word-image pair matched or not. Preliminary results show that, in line with previous findings, adult participants reacted faster when the object was primed by a label compared to a sound. Upon hearing the auditory stimulus (word vs. sound), the 9-month-old infants looked longer at the target image compared to the distracter in both the label and sound conditions and they were faster in shifting their gaze to the target compared to the distracter in the sound compared to the label condition. On the contrary the 12-month-old infants looked longer at the target image compared to the distracter in the sound condition, but in the label condition they looked longer to the incongruent compared to the congruent object. Twelve-month-old infants were faster in shifting their gaze in the label condition compared to the sound condition, even though we observed no difference between congruent and incongruent images. These findings confirmed that, in adults, conceptual representations are activated more quickly and efficiently by verbal labels as opposed to non-verbal cues, emphasizing the special status of words as referential cues. In infants our data could indicate a developmental trajectory, with 12-month-olds showing a gaze shift pattern more similar to the reaction time in adults compared to the 9-month-olds.

The importance of nonlinguistic variability to early language learning: the case of colour

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Background variability supports learning in multiple domains, for example category learning, generalization and motor development. Recent work suggests that it plays a key role in early language acquisition, however whether variability supports or hinders learning is unclear. For example, speaker variability facilitates early phoneme discrimination (Rost & McMurray, 2009), and visual variability in 3D referents helps toddlers learn nouns (Twomey, Ranson, & Horst, 2014). In contrast, storybook studies suggest that variability in visual context impairs learning (Horst, Parsons, & Bryan, 2011). Thus, the role of nonlinguistic variability in language acquisition is currently unclear.

According to dynamic systems theory (Thelen & Smith, 1996), language – indeed any behaviour – emerges from an interacting system of components, which includes the learner and the learning environment as well as language itself. When these components interact in a predictable way, the result is a predictable behaviour (e.g., crawling). When components of the system change (e.g., muscle strength), new predictable behaviours emerge (e.g., walking). On this account, small amounts of variability should change the way that components of a system interact, speeding up the emergence of new, stable behaviours (Stephen & Dixon, 2009). On this account, nonlinguistic variability during learning should help, not hinder, language acquisition. However, if language is a closed, domain specific system, this environmental variability may hinder learning by distracting the learner from the language input.

To test these contrasting predictions, we taught 2-year-old children three novel nouns in an eyetracked referent selection/retention task, manipulating nonlinguistic variability. First, children were asked to locate the referent of known and novel words (e.g., *Can you find the [X]?*) in an array of one novel and two familiar items. Children were randomly assigned to one of two conditions in which stimuli were identical, but with the critical exception that half the children saw objects on a white background (*constant condition*), and half saw objects on multiple, colored backgrounds (*variable condition*; Fig 1). Next, at test, children were asked to identify the objects encountered during referent selection from an array of novel objects only (Fig. 2). There as no strong evidence for sustained attention to either known or novel targets during referent selection. However, children in the constant condition showed no evidence of retaining novel noun-referent mappings at test. In contrast, children in the variable condition did show evidence of word learning, looking at target objects in response to the label at levels greater than expected by chance on the second block of test trials (Fig. 3). Thus, in the current study nonlinguistic variability facilitated language learning.

The current study makes the novel prediction that other sources of nonlinguistic entropy (e.g., sound, space) may also facilitate language learning; tests of these predictions are currently underway. Overall, however, these data demonstrate that language learning is affected by nonlinguistic entropy, supporting a dynamic systems accounts in which language is fundamentally embedded in and influenced by a complex system of nonlinguistic components.

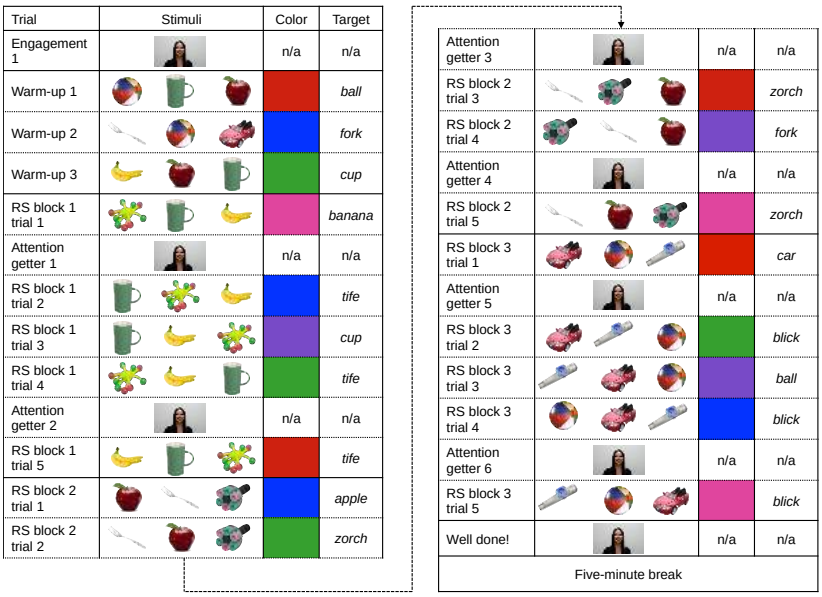

Fig. 1. Example referent selection phase, variable condition. Equivalent trials for the constant condition were identical except that images were presented on a white background.

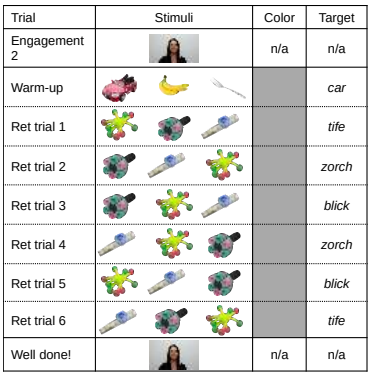

Fig. 2. Example retention phase. Retention trials were identical across conditions.

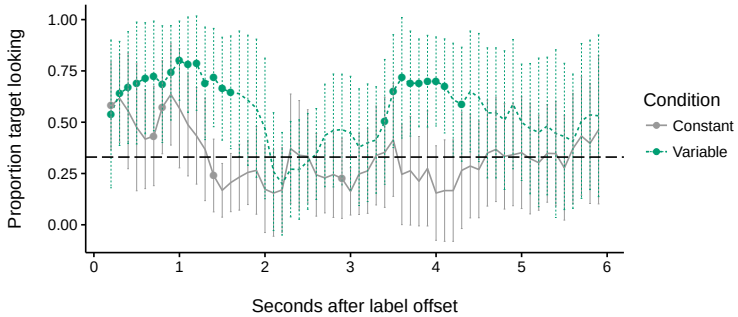

Fig. 3. Proportion target looking during memory reactivation trials. Error bars represent 95% CIs. Where bins are marked with a point, looking is significantly above chance (0.33; $p < .05$, one-sample, two-tailed *t*-tests)

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Seven months' understanding of everyday actions in communicative and non-communicative contexts

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Also submitted as a poster for LCICD 2017

When learning about others' actions, infants interpret actions as goal directed (Hunnius & Bekkering, 2010; Reid et al., 2009). Infants can anticipate familiar head- and mouth-directed actions (e.g. putting a cup to the mouth), but fail to anticipate unfamiliar actions (putting the cup to the ear) even after several observations. However, adults are able to anticipate unexpected action outcomes after a few exposures (Hunnius & Bekkering, 2010).

Infants are also sensitive to ostensive communication (Csibra, 2010). When infants are addressed ostensively, they expect the content of the communication as relevant, meaningful and generalisable (Csibra & Gergely, 2009).

In the study presented here, we investigated whether infants might learn to anticipate unexpected action outcomes when they are addressed ostensively. This replicates Hunnius and Bekkering (2010), with the addition of a communication manipulation: Prior to each action demonstration, the actor addressed the infant either ostensively, or non-ostensively. To control for previous knowledge of the actions, we included an additional condition involving two unfamiliar objects which participants either moved to the mouth or the ear. We also measured their pupil dilation (c.f. Hepach & Westermann, 2016) to investigate whether infants' learning is modulated by differences in arousal after communication or seeing unexpected action outcomes.

We hypothesise that infants learn to anticipate novel action outcomes in ostensive contexts, but not in non-communicative contexts. Ostensive communication might also facilitate the remapping of familiar action outcomes to new goal locations. This study

can potentially show how ostensive communication drives the interpretation of novel information in the context of already known information.

Furthermore, we were interested in the excitatory arousal after seeing the action-outcome pairings and the effect of communication as measured through their pupil dilation (c.f. Hepach, Vaish, & Tomasello, 2012; Hepach & Westermann, 2016). We hypothesised that infants show greater arousal in communicative compared to non-communicative contexts.

Participants

Currently, we have tested 35 seven-month-old infants in a mixed design, pending analysis.

Methods

Infants were presented with three different actors greeting the infant either ostensively, using direct gaze and infant directed speech or an adult-directed control condition without direct gaze. Each actor then presented two objects by picking up the object and putting it either to the mouth or their ear/hair. Each presentation block consisted of nine presentations of the same greeting condition and action. The objects were a spoon, a cup, a hair brush, a mobile phone and two novel, colourful objects. One actor presented two objects congruently, e.g. by picking up the spoon and putting it to their mouth. The next actor would use the objects incongruently, e.g. put the spoon to the ear. The third actor would be using the novel objects. The order of presentation was randomised and the combinations of actors/objects were counterbalanced.

Pupil dilation measurements were taken at the start of the presentation to establish a baseline measure, and then every 6th and 9th trial within a block.

Analysis

We are interested in three measures: (1) Infants' anticipatory looks towards the action outcome throughout trials within one presentation block (2) The time course of anticipatory looks (3) The change in pupil dilation after each presentation block.

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Session 6: Complex Constructions

"Let's lie down because I'm tired of Apple because I'm poorly (be)cause I need to lie down": the influence of pragmatics on children's acquisition of complex causal sentences.

Heather Leman

University of Machester

Theme: Communication

Causal complex adverbial sentences can perform various pragmatic functions (Sweetser, 1990): explain real-world causality (Content – e.g. You're hungry because you didn't eat); justify conclusions (Epistemic – e.g. She didn't eat because there's food left); and justify speech acts (Speech-Act – e.g. Eat your dinner, because you're hungry). Interpreting them requires determining what each clause means and how they relate to each other pragmatically. Insight into how children learning language do this and the factors impacting this understanding can shed light onto how pragmatic awareness and flexibility with form-function mapping develops.

Children produce *because*-utterances from around two-years-old and typically produce these sentences accurately (e.g. Hood & Bloom, 1979). By comparison, children often perform poorly in experimental studies testing comprehension until they are older (e.g. Emerson, 1979, 1980). In looking to understand children's acquisition of *because*-sentences, the role of input is largely overlooked. However, some theoretical approaches (e.g. constructivist, usage-based) consider the distributional properties of the input to be the basis for the development of more abstract form-function linguistic mappings.

To examine the role of input on children's understanding of causal sentences, *because*-utterances were extracted from dense naturalistic corpora of two mothers interacting with their 3-4-year-old children. Mother and child speech was analysed for pragmatic function and Speech-Act type. Results showed that the distribution of different types of causal function differed between mother and child (e.g. mother 28% Content, 13% Epistemic, 59% Speech-Act; child 13%, 8%, 79% respectively). Additionally, while mothers produced different types of causal Speech-Acts, the majority for both children were assertive. These findings show that children hear significant variation in the use of *because,* the majority of uses do not explain real-world causality and children's use is not tightly related to input. This highlights the need for a detailed analysis of form-function mapping to thoroughly investigate the origin of these differences.

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The role of information structure in children's comprehension of complex sentences – testing two hypotheses

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English allows two different clause-orders for complex sentences with adverbial clauses, e.g. (1) *She checked her emails before she went home*. vs. (2) *Before she went home she checked her emails*. Children have difficulty correctly interpreting isolated sentences like these up to the age of 6 or 7 (e.g., Blything, Davies, & Cain, 2015). However, in spoken discourse, sentences occur in context, and contain both new information and given information, which allows the listener to link it to the previous discourse (e.g., *Sue went home. Before she went home, she checked her emails*). We identified two hypotheses in the literature about how information structure affects the processing of complex sentences:

(1) Sentences are easier to process, if given information precedes new information (Haviland & Clark, 1974).

(2) Sentences are easier to process, if the information presupposed in the subordinate clause is given (Gorrell, Crain, & Fodor, 1989).

We tested which of the two hypotheses better predicted English-speaking 4- and 5-year- olds' (N=80) understanding of four different types of adverbial sentences (*after, before, because, if*), using a forced-choice task on a touch-screen laptop: Children had to choose between two picture stories (instruction: "Touch the matching story!"), which differed in the order of in which the two events occurred. We systematically manipulated clause-order (main-subordinate, subordinate-main), and whether a context sentence provided information about the main or the subordinate clause (given main, given sub) (see Table 1). We recorded accuracy as well as response times (RT). We also took standardised measures of working memory, inhibition, receptive vocabulary, and general language ability. We analysed the data using generalised mixed-effects models in R, including random effects for items and subjects.

Our results support hypothesis 1. While five-year-olds performed better than four-year-olds ($z = 4.805$, $p < .0001$), children of both age groups showed the same pattern: They performed better when the initial clause –whether main or subordinate – was given, for example, when the subordinate clause was given, and the complex sentence was in sub- main order) ($z = 4.846$, $p <$

.0001; see Fig.1). We also found that information structure had a differential impact on the "iconicity effect", which is the observation that children find sentences easier to understand if the order of events in the sentence reflects the order of events in the real world (sentence 1 above is iconic, sentence 2 is not) (Blything et al., 2015; Clark, 1971). The iconicity effect was more pronounced when the subordinate clause was given, and less pronounced when the main clause was given. Our findings show that children are sensitive to information structure from an early age, and that even minimal contextual information modulates children's processing preferences.

We will present the complete data set, including the RT data, as well as the effects of different sentence types, age, and individual differences in children's processing, and discuss the theoretical implications of the results.

		CLAUSEGIVEN	
TYPE	CLAUSEORDER	*given-sub*	*given-main*
after	*sub-main*	***Sue paints the old fence. After she paints the old fence, she hoovers the house.***	Sue hoovers the house. After she paints the old fence, she hoovers the house.
before		***Sue paints the old fence. Before she paints the old fence, she hoovers the house.***	Sue hoovers the house. Before she paints the old fence, she hoovers the house.
because		***Tom opens the door. Because he opens the door, he sees the snowman.***	Tom sees the snowman. Because he opens the door, he sees the snowman.
if		***Tom opens the door. If he opens the door, he sees the snowman.***	Tom sees the snowman. If he opens the door, he sees the snowman.
after	*main-sub*	*Sue paints the old fence. She hoovers the house after she paints the old fence.*	**Sue hoovers the house. She hoovers the house after she paints the old fence.**
before		*Sue paints the old fence. She hoovers the house before she paints the old fence.*	**Sue hoovers the house. She hoovers the house before she paints the old fence.**
because		*Tom opens the door. He sees the snowman, because he opens the door.*	**Tom sees the snowman. He sees the snowman, because he opens the door.**
if		*Tom opens the door. He sees the snowman, if he opens the door.*	**Tom sees the snowman. He sees the snowman, if he opens the door.**

Table 1: Stimulus examples for each condition of the experiment: 4 sentence types x 2 clause orders x 2 clause given. Coloured shading matches the shading used in Figure 1 below. Predictions of the two hypotheses are highlighted as follows:
(1) Sentences that are in given-new order are easier to process (**bold**);
(2) Sentences that contain the given information in the subordinate clause are easier to process (*italic*).

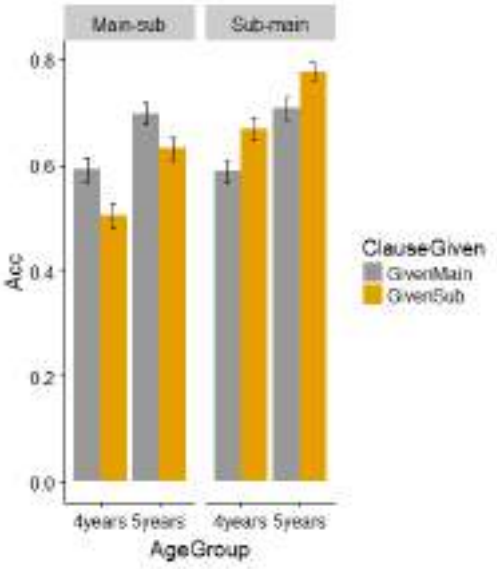

Figure 1: Mean proportion of correct responses. Error bars indicate standard errors.

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Semantic correlates of causative constructions across languages: A potential solution to the retreat from overgeneralization error?

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Few of the productive generalizations that language learners must form are truly exceptionless. Thus children must somehow learn *not* to apply a particular generalization to exception items, while – at the same time – continuing to apply this generalization to items with which it is consistent, including items for which this generalization is novel. The present study investigates one proposal for how this is accomplished in the domain of causation: one of the most fundamental concepts in human cognition, and one that boasts at least one dedicated grammatical structure in probably all human languages (Haspelmath, 1993; Dixon, 2000). For example, English children must learn that while some verbs can appear in the transitive-causative construction (e.g., *The man broke/moved/rolled/spun the vase*), others cannot (e.g., **The clown laughed/cried/fell/disappeared the man*), and instead mark causation using the *periphrastic-causative* construction with *make* (e.g., *The clown made the man laugh/cry/fall/disappear*). This is not merely a quirk of English. Many of the world's languages (Shibatani & Pardeshi, 2002, discuss 38 examples) have two causative structures, which particular verbs prefer to a greater or lesser degree: (1) a *more-transparent* structure with the verb *cause/make/do* or a morpheme that is often a historically grammaticalized form of that verb (e.g., Japanese *-(s)ase*) and and (2) a *less-transparent* structure that marks causation more idiosyncratically (e.g., the English transitive causative).

So how do children learn which verbs are compatible with the more- and less-direct causative structures? One possibility (e.g., Pinker, 1989) is that children use an observed correlation between verbs' semantics and their distribution (Shibatani & Pardeshi, 2002):

- Less-direct causation entails an event in which "both the causing and the caused event enjoy some degree of autonomy…The caused event… may have its own spatial and temporal profiles distinct from those of the causing event", and hence is associated with *more-transparent* causative marking.
- More-direct causation "entails a spatio-temporal overlap of the causer's activity and the caused event, to the extent that the two relevant events are not clearly distinguishable", and hence is associated with *less-transparent* causative marking.

We test this prediction by investigating the extent to which by-verb ratings of this *event-merge* property predict the ability of particular verbs to undergo more- and less-transparent causation in

English, Hindi and Japanese. In each language, adult participants viewed caused events, and rated – on a visual-analogue scale – the extent to which

- B's ACTION/EVENT/CHANGE and A's causing of it are two separate events, that could happen at different times and/or in different points in space. VS
- B's ACTION/EVENT/CHANGE and A's causing of it merge into a single event that happens at a single time and a single point in space

Preliminary results indicate that, as predicted, verbs that denote scenarios in which the causing and caused events are separate (e.g. *laugh*) have a tendency across the three languages to undergo only the more-transparent form of causativization (e.g., *The clown made the man laugh/cry/fall/disappear;* not **The clown laughed/cried/fell/disappeared the man*). If children are able to notice such semantic regularities, this could provide a key to the "paradox" (Pinker, 1989) of restricted generalization.