Trieste Encounters on Cognitive Science, Language Learning

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Book of Abstracts

Contents

13

Can 18-month-olds understand negative sentences?

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Negation is a universal linguistic concept presenting an interesting question in language acquisition research. Researchers have long noted that children start producing the word 'no' in their own speech at about one year of age (e.g., Bloom, 1970; Pea, 1980). Surprisingly, many studies investigating the online processing of negative sentences suggest that children younger than 2 years are not able to understand them (Nordmeyer & Frank, 2014; Feiman, 2015; Feiman, Mody, Carey, Snedeker, 2014; Reuter, Feiman, Snedeker, 2014). This surprising failure might be due to a bona fide lack of understanding of negation in children younger than two, or to the fact that the experimental paradigms used were too demanding (requiring pragmatic inferences, for instance).

Our goal is to investigate French-learning infants' understanding of negation at 18 months, with a simple habituation paradigm, in which toddlers are exposed to simple negative sentences such as "It's not an X" where X is a noun or "It's not Y-ing", where Y is a verb, in a context that pragmatically supports the use of these negative sentences.

The experimental design is based on very recent studies conducted in English and French, showing that 18-month-olds are able to use function words to constrain the possible meaning of novel nouns and verbs (using the Habituation-Switch paradigm; He & Lidz, 2014; de Carvalho, He, Lidz & Christophe, 2015).

In the present study, all infants were habituated with two video stimuli showing a penguin doing two different intransitive actions (e.g., spinning, cartwheeling), one in each video. When hearing sentences such as "Oh Look! It's a bamoule! Do you see the bamoule?" and watching the video of the penguin spinning, infants infer that the novel word "bamoule" refers to the object in the video (the penguin), but when listening to sentences such as "Oh Look! It's pirdaling!" and watching the penguin cartwheeling, they infer that "pirdaling" refers to the action that the penguin is doing (here, cartwheeling).

Then, when infants reach a habituation criterion, they are exposed to a test phase in which the audio tracks of the videos are exchanged, and the original sentences are negated. Thus, they look at the penguin cartwheeling and hear 'It's not a bamoule', and they look at the penguin spinning and hear 'it's not pirdaling'. Given that during the habituation phase the noun 'bamoule' referred to a penguin, if children correctly understand negative sentences, they should be more surprised and look longer toward the videos when they hear the negative noun sentence, 'it's not a bamoule', since the video is still showing a penguin. In contrast, since the verb 'pirdale' refers to cartwheeling, they should not be surprised when hearing the negative verb sentence, 'it's not pirdaling', since indeed the penguin is now spinning, and not cartwheeling. (The syntactic category of the novel words "bamoule" and "pirdale" and their associations with the videos ("spinning" or "cartwheeling") were counterbalanced across participants).

If infants dishabituate more for the negative noun sentences than for the negative verb sentences, this study will show that 18-month-olds are already able to correctly process negative sentences, in a context that supports the use of these negative sentences. If not, this experiment will confirm previous work that negative sentences are hard to process for infants.

We are currently testing infants and I hope to be able to present the results in Trieste.

Co-occurrence statistics as a language-dependant cue for speech segmentation

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Distributional regularities in spoken languages are informative about speech units (words), such that the dependencies are stronger within words than between words; this could therefore be a useful cue for word learning even without rich language-specific knowledge. When tested with artificial speech that contains distributional regularities but no other cues for word boundaries, infants and adults show the ability to extract words from it.
However, artificial languages used in laboratories are usually much more regular than spoken languages, and a more complex strategy might be necessary to segment speech in a natural language than in an artificial stream. Various models of speech segmentation have been proposed in the literature to solve this issue, using different spoken corpora as their input.
Additionally, it is not clear whether the information that can be extracted from distributional regularities is comparable across different languages, such that an uninformed learner could use the same strategy regardless of the input language. To explore this latter question, we model two learning strategies based on transitional probabilities using child-directed speech corpora from nine languages. We show that languages vary as to which statistical segmentation strategies are most successful. The variability of the results can be partially explained by systematic differences between languages, such as rhythmical differences. This in turn indicates that infants may have to primarily rely on non-statistical cues when they begin their process of speech segmentation.

47

Connectionist Semantic Systematicity in Language Production

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A defining characteristic of human language is systematicity: "the ability to produce/understand some sentences is intrinsically connected to the ability to produce/understand certain others" (Fodor & Pylyshyn, 1988). Further, Fodor and Pylyshyn (1988) argue that connectionist models are not able to display systematicity without implementing a classical symbol system.

The connectionist comprehension model developed by Frank, Haselager, and van Rooij (2009), however, challenges this highly debated assertion, by developing a connectionist model of comprehension which is argued to achieve relevant levels of systematicity. Their model constructs a a situation model (see Zwaan and Radvansky (1998)) of the state-ofaffairs described by a sentence that also incorporates world knowledge-driven inferences. When the model processes a sentence like 'a boy plays soccer', for instance, it not only recovers the explicit, literal propositional content, but also constructs a more complete situation model in which a boy is likely playing outside on a field, with a ball, with others, and so forth. Crucially, Frank et al. (2009)'s model generalizes to

both sentences and situations that it has not seen during training, exhibiting different levels of semantic systematicity and is argued to provide an important step in the direction of psychologically plausible models of language comprehension.

In the present paper, we examine whether the approach developed by Frank et al. (2009) is equally well suited to language production, and present a connectionist production model that generates sentences from these situation models.

We employ an extended Simple Recurrent Neural Network architecture (SRN) (Elman, 1990). Our architecture is broadly similar to the one used by Frank et al. (2009), with the main difference being that the inputs and outputs are reversed; it maps situation model representations onto sequences of localist word representations.

In order to assess the performance of the model, we tested it on 5 different conditions representing different levels of generalization or systematicity. In all cases, the queried sentence type has never been seen by the model. We defined a similarity score to evaluate the results. On the training set, the model achieved an average similarity score of 99.43% (and 98.23% perfect matches). On the testing set, the average similarity score across all conditions is of 97.1%, with 88.57% of perfect matches.
Although the performance of the model is very high, the model elicits some mistakes that allow us to get some insight into the internal mechanism of the model. After an analysis of the output, we see that all the sentences produced are syntactically correct and semantically felicitous. The vast majority of the elicited mistakes occur when the model produces a sentence that is semantically highly similar to the one expected. We hypothesize that this happens because the model is able to roughly reconstruct the semantic space, putting together representations that are semantically similar and thus assigning similar linguistic representations to them.

We conclude that our model successfully learns to produce sentences from the situation models. Importantly, we demonstrate that this model is able to describe both unseen situations, demonstrating semantic systematicity similar to Frank et al. (2009), as well as produce alternative encodings (e.g. active/passive) for a given situation, that were not seen during training and thus demonstrating syntactic systematicity.

27

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5

Emotional decisions by pragmatics

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It has for long been taken for granted that, along the course of reading a text, world knowledge is often required in order to establish coherent links between sentences (McKoon & Ratcliff 1992, Iza & Ezquerro 2000). The content grasped from a text turns out to be strongly dependent upon the reader's additional knowledge that allows a coherent interpretation of the text as a whole.
The world knowledge directing the inference may be of distinctive nature. Gygax et al. (2007) showed that mental models related to human action may be of a perceptual nature and may include behavioral as well as emotional elements. Gygax (2010), however, showed the unspecific nature of emotional inferences and the prevalence of behavioral elements in readers' mental models of emotions. Inferences are made in both directions; emotional inferences based on behavior and vice versa.
Harris & de Rosnay (2002) and Pons et al. (2003) proved that different linguistic skills –in particular lexicon, syntax and semantics are closely related to emotion understanding. Iza & Konstenius (2010) showed that additional knowledge about social norms affects the participants' prediction about would be inferred as the behavioral or emotional outcome of a given social situation.
Syntactic and lexical abilities are the best predictors of emotion understanding, but making inferences is the only significant predictor of the most complex components (reflective dimension) of emotion comprehension in normal children. Recently, Farina et al. (2011) showed in a study that the relation between pragmatics and emotional inferences may not be so straight forward. Children with High Functioning Autism (HFA) and Asperger Syndrome (AS) present similar diagnostic profiles, characterized by satisfactory cognitive development, good phonological, syntactic and semantic competences, but poor pragmatic skills and socio-emotional competencies. After training in pragmatics a descriptive analyses showed the whole group to display a deficit in emotion comprehension, but high levels of pragmatic competences. This indicates a further need to study the relationship between emotion and inference in normal subjects too.
We also suggest that while behavioral elements may indeed be of perceptual nature and the inference between emotion and behavior less culturally dependent especially when concerned with basic emotions -the inference concerned with social norms may be more complex and require elaborative inference. We suggest that in further studies a distinction between basic emotions and non basic emotions, social settings and non-social settings should be made. The cognitive models concerned

with social action may be of more complex nature, but with recognizable features on lexical and syntactic levels.

7

Exocentric compounds in Modern Greek: evidence from lexical access

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The present study investigates the lexical access of exocentric compounds in Modern Greek (MG), through a lexical decision task with overt priming. There are three types of compounds in MG depending on the semantic relations holding between their constituents and the position of the head (Ralli, 2013): A) *Dependent compounds* are head-final structures with a dependency relation between their constituents (e.g., *aɣrioɣata* 'wild cat'), b) *Coordinative compounds*, are likely to have a head-head structure as both constituents contribute equally to the whole compound on grammatical and semantic grounds (e.g., *alatopipero* 'salt & pepper'), c) *Exocentric compounds*, which are characterized by the absence of an internal head and attributive semantic relation among constituents (e.g., *kokkinomallis* 'redhead' is not "a kind of head" but "*someone who has red head*"). Previous psycholinguistic evidence (Marelli et al., 2009) reported symmetric priming elicited by the first and the second constituent in Italian exocentric compounds, suggesting no internal hierarchy and a flat representation. For MG, Manouilidou et al. (2012) reported strong priming effects in both first and second constituent of MG coordinative compounds, suggesting that both constituents appear to play a comparable role in accessing meaning and structure of the compound. Aim: This study mainly focuses on exocentric compounds in order to investigate how their core characteristic, that is, the absence of an internal head, affects their lexical access. Method: lexical decision task where the whole compound primed each constituent (e.g., aɣrioɣata > aɣria vs. aɣrioɣata > ɣata). Stimuli: 16 dependent, 16 coordinative, and 20 exocentric compounds. Participants: 30 native speakers of MG. Results showed a main effect of compound type (e.g., dependent, coordinative, exocentric) and a significant compound x constituency interaction. Pairwise tests showed a significant difference between dependent and exocentric compounds. The first showed an equal priming in both constituents while the latter showed an inhibition effect in the 2nd constituent. Discussion: these results provide initial evidence for a lexical access through decomposition for all types of compounds and suggest that the existence of an internal head is a factor which does affect processing.

42

Eye movements and morphological processing in reading aloud derived nouns: A study with primary school children

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Several studies (see Rayner, 2009) focused on the variables that influence eye-movements in reading morphologically complex words. Yan et al. (2014) provided evidence for the role of the morphological structure of words on eye-movements in reading suffixed words. However, Häikiö et al. (2011)

suggested that the use of morphemic structure can be influenced by reading skills, as slow 2nd grade readers are more prone to the processing of morphemic constituents than their fast peers and older children (4th and 6th graders. In a previous study, Traficante et al. (2014) found that, in children, the access to roots that can entertain several morphological relations (e.g., Italian verbs, that have very rich inflectional families) makes the word processing more difficult; on the other hand, the access to roots that have limited morphological families (e.g., Italian nouns) does not affect the processing of the complex form. The aim of this work is to assess the role of word morphology and grammatical class of base-words on eye-movements, in young Italian readers (from 3rd to 5th grades).

Mathods.
Participants. 31 children, attending 3rd to 5th grade, were recruited (mean age = 9 years; 13 M; 19 F) from a primary school in Northern Italy.
Materials and procedure. 42 nouns derived from noun-base (e.g., umorista, humorist), and 29 nouns derived from verb-base (e.g., punizione, punishment) were selected and embedded in sentences. The target word appeared in the middle of the sentence and had a low cloze probability in the used context. Participants' reading skills were assessed with standardized tests. Eye-movements were recorded by SensoMotoric Instruments RED500 system.

Results.
Linear mixed models were used to assess effects of word length, grammatical class of the base word, whole-word and base frequency, and children's reading skills. First-fixation and gaze durations were taken as measures of early and late processing, respectively, and used as dependent variables.
We found a significant interaction between base frequency and base grammatical class, as reported by Traficante et al. (2014). However, this effect only emerged when considering first fixations and not in the analysis of gaze durations. Reading skills did not interact with morphological effects.

Conclusion.
The eye-tracking data provide converging evidence in favor of the base-category modulation reported in Traficante et al. (2014). Crucially, they also indicate, in line with Yan et al.'s (2014) results, that subtle statistical aspects of the roots are captured from early stages of lexical processing, even in young readers.

25

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56

From memory processes to lexical self-organisation: a biologically-motivated integrative view of the morphological lexicon

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According to "Words and Paradigm" approaches to morphological competence (Blevins 2006 among others), mastering the inflectional system of a language amounts to acquiring an increasing number of constraints on how paradigm are filled in by full word forms (see Ackerman et al. 2009; Finkel & Stump 2007; Pirrelli & Battista 2000; Matthews 1991; among others). Linguistic and developmental evidence on word paradigms has met recent developments in Computational Linguistics and Neurolinguistics. Self-organising artificial neural networks (Kohonen 2001; Pirrelli et al. 2015, Marzi & Pirrelli 2015) have offered an algorithmic account of the hypothesis that the mental lexicon is a highly-redundant, dynamic store of full words, which get co-activated and compete for selection during lexical processing. At the same time, recent advances in understanding the neuro-anatomical areas supporting memory (Wilson 2001; D'Esposito 2007; Ma et al. 2014) have showed that working memory consists in the transient activation of long-term memory structures, controlled and maintained by the integration of auditory-motor circuits in the perisylvian network (Catani et al. 2005; Shalom & Poeppel 2008). All these developments converge on the idea that stored lexical representations are in fact the long-term by-product of their processing history. In the talk, we illustrate simulative evidence supporting these insights and explore their theoretical implications for models of the mental lexicon.

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33

From memory processes to lexical self-organisation: a biologically-motivated integrative view of the morphological lexicon

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23

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14

How does the provision of semantic information influence the lexicalization of new spoken words?

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An important aspect of acquiring new words is their integration with existing vocabulary knowledge. The integration of a new word with existing lexical items does not occur immediately after learning, but often requires a period of offline memory consolidation. Whilst the integration of a new spoken word can occur within twenty-four hours of learning its phonological form, previous studies have reported that this lexical integration can be delayed if semantic information is provided during learning. One possibility is that this delay results from reduced phonological processing during learning as a consequence of the need to learn the semantic associations. The current study thus re-examined the influence of semantic exposure on the lexical integration time-course of new spoken words in adults, by equating the task goals for learning new spoken words with and without semantic information. Participants learnt novel words via a phonological training task, in which the words were associated with a picture referent (picture-present condition) or learnt as phonological forms only (form-only condition). Critically, participants were instructed to learn the forms of the novel words, with no goal to learn the word–picture associations. Following training, tests of lexical integration, declarative memory, shadowing, and picture association memory were administered immediately after learning, after 24 hours of consolidation, and after one week of consolidation. Lexical competition effects emerged after one week of consolidation for both the picture-present and form-only words, indicating an equivalent lexical integration time-course. Correlational analyses suggested that larger lexical competition effects at the one week test were tied to stronger declarative memory of the new words at initial learning. Finally, the tests of declarative memory and shadowing showed equivalent performance for picture-present and form-only words, despite participants showing good knowledge of the picture associations immediately after learning. These data suggest that the provision of semantic information does not slow the time-course of lexical integration, provided that phonological information is recruited sufficiently well during training. Further, these data align with recent reports suggesting that the strength and type of initial learning influence the lexical integration process.

52

Information Theory and Language

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38

Language encodes perceptual information: Evidence from distributional semantics

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There is an increasing amount of evidence that language encodes perceptual information. In fact, distributional semantics allow for extracting perceptual relations can be extracted. This talk will give examples of language encoding perceptual information, showing that taking rather simple co-occurrence techniques allow for predicting social networks, valence, iconicity and even longitude and latitude of cities. Moreover, experimental evidence shows that language users rely on these language statistical patterns in their cognitive processes.

46

List translation

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Here we consider the hypothesis that adequate machine translation is possible only in a way when the human thinking gets the standardized form of translational unit which will include contextual and intentional models.
The progress of this idea proceeds throughout the history of Artificial Intelligence. We allow that a human thinking will rather turn into the machine one by reasoning the world according logic or formal argument.
Reflecting on enormous potential of human achievements, we investigate the possibility of reconstruction of the idea by means of the phenomenon of LIST. The first problem in a way of realization of this idea is a thesis of Ch. Peirce advanced in his "Theory of Signs"(Peirce, 1931) that outlines the infinity of meanings and rejects possibility of restoration of idea. However, today it is obvious that people communicate, and use successfully a sign system for understanding and transfer of the ideas. These processes should be explained in more concretized way. For this purpose we allocate LIST as a translational unit based on hypertextual structure. Basically LIST represents a compressed content, easy to understand and transfer the idea.
For the time being we try to present that all aforesaid is a huge layer of knowledge which we would like to systematize by means of only one category of LIST which could (1) present accurately and clearly in the technical plan the idea of possibility of restoration of sense on the basis of significant unit, (2) reflect links between a ratio of language, thinking and reality, (3) become a universal category of language and (4) avoid the abstract, ephemeral and confused realization.
The first question which arises in this regard "WHAT FOR?" It has rather simple answer – for systematization of knowledge and promotion of its accessibility for broad masses. It doesn't refer the category of people, allocated by Aristotle; it's concentrated on machines which are themselves a reflection of a natural genesis in the development of science on the way of systematization.
For all the stages of our research we define the category LIST as ordered set which consists of two and more concrete or intentional elements. Every element of LIST is defined by common predicate

and operations of inclusion/exclusion. Every element is linked with a certain value (s), which should be identified by people or by the machine program.

19

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44

Mapping Visual Symbols onto Spoken Language Forms

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Learning to read is arguably the most important challenge for the child starting school. Mapping new visual symbols onto existing spoken and conceptual forms also presents an interesting challenge for the brain. In this talk, I discuss some of the work that my laboratory has been conducting using artificial language learning approaches to understand how the brain solves this challenge. This work has allowed us to discover how the brain captures different forms of systematicity within the writing system, how the nature of the writing system impacts on emerging representations, and how the acquisition of literacy impacts on spoken language representations. I conclude by relating this work back to discoveries using more naturalistic methods, and argue that these two forms of evidence can be highly complementary in the study of reading acquisition.

30

Mapping Visual Symbols onto Spoken Language Forms

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Learning to read is arguably the most important challenge for the child starting school. Mapping new visual symbols onto existing spoken and conceptual forms also presents an interesting challenge for the brain. In this talk, I discuss some of the work that my laboratory has been conducting using artificial language learning approaches to understand how the brain solves this challenge. This work has allowed us to discover how the brain captures different forms of systematicity within the writing system, how the nature of the writing system impacts on emerging representations, and how the acquisition of literacy impacts on spoken language representations. I conclude by relating this work

back to discoveries using more naturalistic methods, and argue that these two forms of evidence can be highly complementary in the study of reading acquisition.

45

Minimal Complexity Extreme Learning Machines

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Learning sparse representations and minimizing model complexity have gained much interest recently. Parsimonious models are expected to generalize well, are easier to implement, and lead to smaller test times. The recently proposed Minimal Complexity Machine (MCM) showed that for training data $X = \{(x_i, y_i)|x_i \in \mathbb{R}^n, y_i \in \mathbb{R}, i = 1, 2, ...M\}$, minimizing h^2, where
\begin{equation}
h = \frac{\max_{i = 1, 2, ..., M} \|u^T x^i + v\|}{\min_{i = 1, 2, ..., M} \|u^T x^i + v\|}.
\end{equation}
leads to a hyperplane classifier $u^T x + v = 0$ with a small VC dimension. This task was shown to be equivalent to

\begin{equation}
\min_{w, b, h} h + C \cdot \sum_{i = 1}^M q_i
\end{equation}
\begin{equation}
h \geq y_i \cdot [{w^T x^i + b}] + q_i, ~i = 1, 2, ..., M
\end{equation}
\begin{equation}
y_i \cdot [{w^T x^i + b}] + q_i \geq 1, ~i = 1, 2, ..., M
\end{equation}
\begin{equation}
q_i \geq 0, ~i = 1, 2, ..., M.
\end{equation}

Models such as the Extreme Learning Machine (ELM) and Random Vector Functional Link Network (RVFLN) have been adapted to a number of applications and offer several advantages. Typically, the ELM solves
\begin{equation}
\min_{\beta, \xi} \; \frac{1}{2} ||\beta||^2 + \frac{1}{2} C \sum_i^M \xi_i^2
\end{equation}
\begin{equation}
h(x_i) \beta = y_i - \xi_i , \; i=1, 2, ..., M
\end{equation}

The last layer of the ELM network conventionally involves the computation of a pseudo-inverse; the hidden layer output matrix H is computed as a solution to $H\beta = Y$, where $H(w_1, w_2, ..., w_{\hat{n}}, b_1, b_2, ..., b_{\hat{n}}, x_1, x_2, ..., x$ $g(w_i \cdot x_i + b)$, $\beta_i = [\beta_{i1}, \beta_{i2}, ..., \beta_{in}]^T$ is the weight vector connecting the i^{th} hidden node and output nodes, $w = [w_{i1}, w_{i2}, ..., w_{in}]^T$ is the weight vector connecting the i^{th} hidden node and input nodes, and Y is the vector of y_i's.

We propose combining the ELM with the MCM. This allows us to build classifiers or regressors with lower complexity in terms of VC dimension, which induce sparsity in the connections between the neurons of the final layer of the network. This has shown to not only improve generalization, but also create sparser networks which depict models closer to human cognition. Numerical stability issues associated with the calculation of the pseudo-inverse are also avoided.

41

Morpho-lexical and morpho-orthographic components in reading acquisition: Evidence from a masked priming study

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Introduction.
The role of morphology in reading acquisition has been proved in different languages, but it is still unclear which features of linguistic input lead to a morphemically driven processing of complex words. Data on adults suggested that early in processing, morphological segmentation proceeds irrespectively of semantic transparency (morpho-orthographic decomposition: see Davis & Rastle, 2010). Data from young readers are much less clear. Quémart et al. (2011) presented 3rd to 7th graders with a masked primed LDT and found the classic, adult-like pattern of results. On the contrary, testing Hebrew children, Schiff et al. (2012) found that 4th graders did not show any morpho-orthographic effect, which was instead close to significance with 7th graders. In English, morpho-orthographic effects did not emerge in either 3rd or 5th graders, despite clear morpho-lexical effects (Beyersmann et al., 2012). Language differences in orthography-to-phonology mapping rules, and individual differences in language proficiency (Andrews & Lo, 2013; Beyersmann et al., 2015) might explain inconsistency of results. This work studied morpho-orthographic effect in Italian, a shallow orthography language, and took into account the role of reading skills on morphemic processing, considering children attending primary and secondary school.

Method.
Participants. 159 typically developing Italian children attending to 3rd-5th-7th grades (51% M).
Stimuli. 120 prime-target related pairs were selected, 40 for each of the following conditions: a) morphological (e.g., farinoso-FARINA, mealy-meal); b) pseudoderivation (e.g., violenza-VIOLA, violence-violet); c) orthographic control (e.g., costume-COSTO, costume-cost). Each target could be preceded by either a related or an unrelated word (e.g., timoroso-FARINA). Target words were matched for Child word frequency, length in letters and orthographic neighbourhood size.
Procedure. Participants were asked to perform a masked primed lexical decision task, with prime-target SOA of 60 ms. E-Prime 2.0 was used to collect data.

Results and discussion.
Mixed-effects models carried out on RTs showed that, for 3rd and 5th graders, priming only emerged in the truly morphological condition, whereas no sign of facilitation was found in either the pseudoderivation or in the orthographic condition. However, 7th graders showed a pattern of results similar to that found in adults, with a facilitation in the case of pseudoderived and derived primes. Data are consistent with the hypothesis that, in the course of reading acquisition, form-meaning mapping is crucial to detect morphemic units, and that the morpho-orthographic parsing is a late mechanism, which develops only when a high level of reading skill is mastered, also in a transparent orthography.

8

Morphological processing of Hebrew verb classes in native and non-native populations: A masked priming study

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Previous research suggests that access to morphological and morphosyntactic information from visually presented words under masked-priming conditions might not be fully operational in adult second language (L2) learners, relative to native (L1) speakers (e.g., Silva and Clahsen, 2008). We extend this research to a previously unconsidered language type, Semitic, by reporting results from the first masked-priming study comparing L1 and L2 Hebrew. Inflected verb forms in Hebrew comprise a (consonantal) root and a (vocalic) word pattern, the latter taken from seven verbal classes called binyanim. We compared the two most common binyanim, the highly productive 'Piel' and the unproductive 'Paal' in two form types, finite (1sg.past) and non-finite (infinitives) verb forms. We tested whether these forms facilitated the recognition of targets sharing the same root (belonging to binyan 'Hitpael'), which indicates morphological decomposition 'down to the root' in lexical access. From previous research, we expected to find full decomposition for L1 speakers of Hebrew (e.g., Deutsch, Frost & Forster, 1998). If L2 processing, by contrast, relies less on morpho-orthographic decomposition, we should find reduced root-priming effects in L2 Hebrew.
We used the visual masked-priming technique (Forster, Mohan, & Hector, 2003), testing 30 L1 and 46 highly proficient L2 learners of Hebrew. There were two Form Type conditions (1sg.past, infinitive), each with three Prime Types ('Paal', 'Piel' and 'Unrelated'), presented for 50 ms immediately before target words (see Table 1).
The results revealed a significant three-way interaction between Form Type, Prime Type and Participant Group indicating L1/L2 differences in morphological priming. While L1 speakers showed the same priming pattern for both Form Types, with a significant root-priming effect for 'Piel', but not for 'Paal', the L2 group showed a different pattern, with priming only from non-finite forms and no contrast between 'Piel' and 'Paal'.
Our results indicate that L1 access of inflected verbs in Hebrew engages fully decomposed representations, but only for the productive 'Piel' class. Access to 'Paal' verbs, on the other hand, appears to be mediated by stored stems from which the root is less directly available. In contrast, L2 speakers of Hebrew are not sensitive to the subtle 'Paal'/'Piel' morphological contrast and access the root only in non-finite forms. These results suggest that there are differences between L1 and L2 processing of complex words, with non-native speakers showing reduced sensitivity to abstract morphological and morphosyntactic information at the early stages of lexical access.

11

Neonates can extract words from continuous speech relying on distributional cues and on prosodic cues.

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In order to begin to learn their language, infants must extract individual words from continuous speech. Understanding how infants manage to do this and when these skills emerge is fundamental to understanding language acquisition. Since the work of Saffran, Newport and Aslin (1996), extensive research has explored infants' abilities to use the distribution of syllables for speech segmentation, showing that infants can use variations in transitional probabilities between syllables to segment words from speech. However, further research has shown that the success on this task for both adults (Shukla et al. 2007) and infants (Jusczyk et. al 1999; Johnson & Jusczyk, 2001; Shukla et al. 2011) is affected by the presence of prosodic cues, suggesting that prosody is also a cue that guides the segmentation of continuous speech (see also Endress & Hauser, 2010). In two experiments we ask whether from birth, distributional cues alone or prosodic cues alone can cue the segmentation of words from speech.
In Experiment 1 we investigated how neonates use transitional probabilities (TPs) to extract words using functional Near Infrared Spectroscopy (fNIRS). Newborns (N=40) were familiarized to 220 seconds of continuous speech built using 4 3-syllabic words, repeated randomly (TPs of 1/3 between words and 1 within words), and afterwards they heard test blocks of words (sequences delimited

by drops in the TPs) or part-words (sequences containing drops in the TPs). We predicted that if infants were able to segment the stream and extract the words, the words should be familiar, whereas the part-words should be perceived as novel. Previous fNIRS studies show an increase in HbO2 for novel stimuli and a decrease for familiar ones (Nakano et. al, 2009), therefore if infants can extract the words we should observe an increase in HbO2 for part-words compared to words. Cluster-based permutation analyses revealed two clusters with a differential activation. One cluster involved fronto-temporal channels of the right hemisphere ($p<0.01$) and the other fronto-temporal channels of the left hemisphere ($p<0.01$). This suggests that neonates are able to extract the words using TPs between syllables.
In Experiment 2 we asked if neonates could segment speech relying only on prosodic cues. To address this question we used the exact same protocol than in Experiment 1 but we modified the familiarisation phase. We generated a continuous stream by concatenating the 4 3-syllabic words in the exact same order (uniform transitional probabilities of 1). Four prosodic contours of Italian CVCVCV phrases were superimposed, preserving the duration and pitch of each phoneme, and grouping the stream in 4 3-syllabic sequences. During test blocks words (sequences marked by prosodic contours) or part-words (sequences straddling prosodic contours) were presented without prosody and separated by pauses. Removing the prosodic cues at test allowed us to examine if the infants were actually able to use the cues to extract the syllabic sequences. Cluster-based permutation analyses (N=40) revealed one clusters with differential activation on the right hemisphere ($p<0.005$), indicating that neonates can rely on prosodic cues to segment speech. Moreover, at test, the words and part-words were presented without the prosodic contours, suggesting that newborns could recognize the words across the differences in pitch and duration.
Together this experiments show that different mechanism for speech segmentation are available even from birth. The real impact for speech segmentation of each of them and their interaction remains as an open question.

6

Perception patterns of static and dynamic texts: An experimental study of Russian

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The present study is one of the first eye-tracking experiment on Russian language material, checking out if the text style (static or dynamic) is among the readability categories and if it influences the effect of reading perspective. Two text types were used: a static text (descriptive sentences) and a dynamic text (sequence of events following swiftly on one another). In experiment participants (20 native speakers of Russian) read eight texts of the same length written in a different style (4 static texts and 4 dynamic texts), presented randomly and retell them afterwards. The following measurements were considered: first fixation duration, average saccade velocity, regression path duration. Retelling the texts was additionally used to collect data on text comprehension and accessibility. The readability of the texts was also checked on
the special website http://ru.readability.io/, where 5 readability formulas adapted for the Russian language are used (Flesch-Kincaid formula, Automatic Readability Index, SMOG, ColemanLiau Index, Dale–Chall readability formula). This checking and retelling the texts were important in order to interpret and explain the eye tracking data. Findings demonstrated significant differences between perception and comprehension the texts of different types. The results indicate that there is a certain tendency to read a static text longer than dynamic, that was shown while checking first fixation duration. Dynamic texts are easier to retell than static texts (significant differences in the length of the retellings and mentioning the main topics). The results of checking the texts by readability formulas are correlated with eye tracking data and retellings.

Perceptual saliency of affixes

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Recently, Beyersmann, Ziegler & Grainger (2015) tested affix chunking in a letter search experiment. They found an advantage for suffixed nonwords (e.g., *filmure*) over pseudo-suffixed (e.g., *filmire*) but not for prefixed nonwords (i.e., *propoint* is not > than *cropoint*). This asymmetry was interpreted as a reflection of different underlying processes for the recognition of suffixed and prefixed items. A chunking pre-lexical mechanism would operate on suffixed while prefixed would be represented holistically at the word level. As pointed out by Giraudo and Grainger (2003), functional and positional differences could reflect different processes. In the present study we performed two experiments where we tested morphemic saliency (for real stems) and positional effect of affixes. For both experiments, 30 native French speakers performed a letter search task.

In our first experiment, we selected words instead of nonwords because their use allows us to create a pseudoaffixed condition. Hence formal effects can be differentiated from morphological effects. Letter detection performances on real affixed words (e.g., *injuste* 'unfair'; *tueur* 'killer') were tested against pseudo-affixed (*insecte* 'insect'; *fleur* 'flower') and unrelated controls. The critical letter always corresponded to the last letter of the affix or pseudo-affix. While results replicated the asymmetry found by Beyersmann et al. (2015), we found for suffixed words a genuine morphological effect differing from both pseudo-suffixed and the control condition. On the other hand, for prefixed, only formal effects emerged without showing a significant difference between real prefixed and the unrelated control words.

In order to dissociate functional from positional effects of prefixes and suffixes, we carried on a second experiment in which we only manipulated simple words. The target letter was present in a cluster either at the beginning or at the end, for example: 'E' in RE in *chèvre* (goat) vs. in *requin* (shark). Results showed an advantage for the beginning over the ending letters, suggesting that prefix and suffix asymmetry is due to linguistic or functional factors rather than to the left to right reading direction (positional effect).

Taken together, the results show morphemic salience in the suffix condition (possibly due to a functional effect). As for the prefixed words, word salience seems to guide the letter detection. This data has to be interpreted relative to the masked priming data (Giraudo & Grainger, 2003) which also showed an asymmetry but in the opposite direction (morphological facilitation effect only for prefixed words).

50

Prediction in Speech Perception

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Prediction occupies a role in a wide range of cognitive functions. It is known that prediction can be implemented at different levels (i.e. conscious or automatic). When subjects have explicit (i.e. conscious) expectations about incoming stimuli, the presentation of deviants elicits ERP responses with shorter latencies and higher amplitudes.

In the case of speech perception, evidence shows that listeners are able to make predictions about incoming speech stimuli. But so far, the examples found rely on semantic knowledge. We hypothesize that prediction serves a role in speech processing, independently from semantic knowledge.

To test this hypothesis, we performed two electroencephalography experiments with an oddball design. The experiments were virtually identical, with the exception of the instructions given to the subjects. In experiment 1, participants heard repetitions of pseudo-words, and were instructed to count the occurrence of "mistaken" words (i.e. deviants). In experiment 2, no information about the occurrence of the deviants was given. This allowed us to achieve two goals. First, to probe for the presence of ERP responses that act as error signals, triggered when a prediction is not met (i.e. a deviant is presented). Second, to study how these prediction error signals, are modulated by participant's explicit (conscious) expectations about the stimuli.

Our results show that participants can use the first phonemes of a word to make predictions about the rest of the word, even in the absence of semantic information. We identified two canonical ERP signals that haven been linked to prediction. A mismatch negativity response (MMN) was present regardless of the expectations of the participant about the presence of deviant words. Additionally, a P300 response was registered only when the participants had expectations about the presence of deviants.

Our results provide evidence for a role of prediction in speech perception, even in the absence of semantics.

31

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32

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29

Rule Extraction and Generalisation in Language Learning

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Much of language learning consists of discovering regularities across multiple exemplars, which can be used to interpret or produce new linguistic items. Morphology presents an important example of this discovery process. Though we are rarely exposed to prefixes and suffixes in isolation, our repeated exposure to them in different words (e.g. banker, runner, teacher) allows us to develop an understanding of their functionality, in such a way as to use them to create new words (e.g. tweeter; someone who tweets). In this talk, I will describe work that my group has conducted using artificial word learning paradigms, in which we have discovered some key constraints on this discovery process. I then relate the principles that have emerged in these laboratory studies to what is known about children's acquisition of morphological knowledge.

43

Rule Extraction and Generalisation in Language Learning

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Much of language learning consists of discovering regularities across multiple exemplars, which can be used to interpret or produce new linguistic items. Morphology presents an important example of this discovery process. Though we are rarely exposed to prefixes and suffixes in isolation, our repeated exposure to them in different words (e.g. banker, runner, teacher) allows us to develop an understanding of their functionality, in such a way as to use them to create new words (e.g. tweeter; someone who tweets). In this talk, I will describe work that my group has conducted using artificial word learning paradigms, in which we have discovered some key constraints on this discovery process. I then relate the principles that have emerged in these laboratory studies to what is known about children's acquisition of morphological knowledge.

15

Rule learning is affected by the social nature of the stimuli in the Autism Spectrum Disorder

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Rule Learning (RL) is an implicit learning mechanism that allows to extract and generalize abstract rules from a sequence of elements without intention to learn. This capacity to learn complex regularities is thought to be a prerequisite for learning of language rules and for social intuition and adaptation to one's social environment. Despite the relevance of RL for linguistic and social abilities, surprisingly, no studies have investigated this mechanism in the Autism Spectrum Disorder (ASD), a disorder characterized by abnormalities in language, communication and social interaction. Here, we investigated the presence of RL in high functioning autistic individuals, examining their ability to extract and generalize rule-like patterns from sequences of social and non-social stimuli. Using a forced-choice paradigm, two groups of adolescents (mean age = 17), one with diagnosis of ASD (N = 5) and one with typical development (N = 10) were presented with triplets of stimuli organized in ABB or ABA rule-like patterns. ABB is a rule-like pattern easier to learn as it involves a late repetition of the B elements, whereas ABA is a rule-like pattern harder to learn as it involves the nonadjacent repetition of the B elements. Geometric shapes, upright-faces and inverted-faces were used as stimuli. During the test phase, a new ABB or ABA triplet was shown, and reaction times (RT) to recognize the rule were recorded. Preliminary results show that the control group was more accurate and faster in identifying the rule in the presence of geometric shapes than with upright and inverted faces regardless the complexity of the pattern (ABB vs ABA). Conversely, the ASD group was less accurate and slower in recognizing the rule with upright faces. Moreover, the complexity of the rule modulated ASD participants' accuracy with upright and inverted faces. These findings provide evidence that ASD individuals are able to learn and generalize a high-order rule, and that their RL ability is modulated by the social nature of the stimuli.

54

Special Event 2: Tim Shallice

55

Special Event 3: Chris Mathys

39

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49

Stepping out of the Chinese Room: Word meaning with and without consciousness

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What role does consciousness play in word meaning's construction? As previous masked priming experiments have pointed out, subliminal words can affect the processing of other semantically related words (cat-dog). This effect has been taken as evidence that lexical items can be processed up to the semantic level, even when unconsciously perceived. We will refer to this perspective as the semantic-based account of masked priming, as it assumes the activation of conceptual knowledge within the semantic memory.

However, unconscious priming may be alternatively explained through predictive relationships between words' forms established in language use, whose referents are in turn related within the semantic system. Thus, under the wordform-based account, semantic masked priming may not involve any conceptual representation, similarly to Searle's Chinese Room thought experiment. Conversely, the locus of the effect would be the lexical system, whose items are organized according to regularities based on how words are use in natural language.

To distinguish wordform-based and semantic-based accounts of priming, we took advantage from the metaphor linking space to time. Time is mapped onto space both along the sagittal (past is back, future is ahead) and the lateral axis (past is left, future is right). However, only the former mapping is linguistically encoded, in expressions like "leave the past behind" or "the future is in front of you". Consequently, only the sagittal association is likely to be represented in the lexical system, in terms of wordform-wordform association.

We tested the space-time metaphor through a priming experiment with temporal words following spatial words that were shown either consciously or unconsciously. Participants were asked to decide whether temporal words refer to either the past or the future.
Temporal targets were primed by both lateral and sagittal words when primes were consciously perceived. However, only the sagittal words led to priming effect when primes were made subliminal.

According to our data, when people read words consciously, they activate related word-forms and conceptual representations of words referents. Yet, when people process word forms out of awareness, activation only spreads to other word forms. Unconscious semantic processing may thus be limited to wordform-wordform relationships, whereas awareness may be necessary for higher-level semantic information to be activated.

10

Stress development in italian children

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Previous studies have investigated the developing of stress accent in young children learning English, showing that the period between two and three years of age is crucial to learn how to modulate duration, intensity and pitch parameters in order to produce the differences between stressed and unstressed syllables (Pollock et al., 1993, Kehoe et al., 1995; Schwartz et al., 1996). The studies about Italian children are few (see Arciuli, Colombo, 2015) and they focus mainly on periods after an age of three years.
Our aim is to investigate the development of lexical stress in italian children during their second year of life.
We investigated five subjects, all from North Italy (Trieste and Padova), at the age of 21, 24 and 27 month. All the recordings had been collected and transcribed in IPA for previous studies (Zmarich and Bonifacio, 2004; Zmarich and Bonifacio, 2005). In this corpus, we identified target corresponding to spontaneous productions. For both stressed and unstressed syllables of each target word, we calculated, by mean of a script in Praat, vowel duration and peak intensity. We also calculated at the vowel midpoint two measures related to the parameters of spectral emphasis: spectral balance (Bocci, Avesani 2011) and spectral tilt (Fulop, Kari, Ladefoged, 1998). We also calculate F1 and F2 at the vowel midpoint. Some of those measures were already used by other scholars in order to investigate stress (Bertinetto, 1981; Farnetani, Kori, 1982; Bertinetto 1985; Vayra, Fowler, 1987; Albano Leoni, Cutugno, Savy, 1995; Savy, Cutugno, 1997; Vayra, Avesani, Fowler, 1999; D'Imperio, Rosenthall, 2009; Tamburini, 2009).
As a control group, we recorded and analyzed four adult subjects.
Children have shown to produce propely the difference between stressed and unstressed vowels since the 21 month. The most significative parameter differentiating stressed and unstressed vowels was duration, followed by intensity. We also found some differences in measures of F1 (for [a]) and F2 (for [i]). More problematic was the interpretation of results related to spectral emphasis: both adults and children showed differences in measures of spectral balance between stressed and unstressed syllables, however this difference was not found in measures of spectral tilt. A possible explanation of this outcome is that spectral tilt is a normalized (from the point of view of the vowel quality) measure.
In conclusion our research shows that young children handle propely all the parameters used by italian adults in producing stress.

4

The acquisition of word meanings: interactions between parsing and learning

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Having access to the syntactic structure of sentences can help children to discover the meaning of novel words (Gleitman, 1990). We exploited phrasal prosody to construct minimal pairs of sentences in French, to test how children's prosodic-syntactic processing skills impact their learning. A first study used sentences like '*Regarde la petite bamoule*', which can be produced either as [*Regarde la petite bamoule*!] - Look at the little bamoule!, where 'bamoule' is a noun, or as [*Regarde*], [*la petite*] [*bamoule*!] - Look, the little (one) is bamouling, where bamoule is a verb. 18-month-olds correctly parse such sentences and attribute a noun or verb meaning to the critical word depending on its position within the prosodic-syntactic structure. A second study relied on right-dislocated sentences containing a novel verb: [il dase] [le bébé]- 'he is dasing, the baby' (meaning 'the baby is dasing') which is minimally different from the transitive sentence [il dase le bébé] (he's dasing the baby). 28-month-olds interpret novel verbs presented in right-dislocated sentences as transitive, suggesting that they readily interpret each NP in the sentence as an argument of the verb, irrespective of phrasal prosody. Yet, when the syntactic context is enriched with simple intransitive sentences (in both conditions), children become able to correctly interpret right-dislocated sentences. Thus, being exposed to multiple syntactic frames for a single verb allowed children to recover from parsing biases. Taken together, our results show that children exploit the prosodic structure of an utterance to recover its syntactic structure and constrain their learning of novel words.

37

The blind cognitive scientists and an elephant: Language statistics and perceptual simulation in conceptual processing

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Over the last decade the cognitive sciences have strongly advocated an embodied view on cognition. Despite the empirical evidence favoring perceptual simulation in language processing, the conclusions drawn from this evidence often suggest perceptual simulation being the only explanation for conceptual processing. This talk demonstrates that language statistics should not be dismissed in a unified account of cognition. For many findings in the embodied cognition literature attributed to perceptual simulation, language statistics are in fact better predictors, depending on the cognitive task, the nature of the stimulus, individual differences and the time course of processing.

51

The perceptual structure of the phoneme manifold

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Theories of phoneme representation have been based on the notion of 'subphonemic features', i.e. variables such as place of articulation, voicing and nasalization, some binary and some multi-valued, that can be taken to characterize the production, and with some modifications also the perception, of different phonemes. However, perceptual confusion rates between phonemes cannot be simply explained by the number of different values taken by their subphonemic features. Moreover, assuming a discrete nature for these variables is incongruent with the continuous, analog neural processes

that underlie the production and perception of phonemes, and with the remarkable cross-linguistic differences observed, that make the notion of a universal phonemic space rather implausible. As a first step towards a plausible neuronal theory of how phoneme representations may self-organize in each individual upon language learning, we describe methods to derive, from behavioral or neural data, distinct 'weights' for different features. Such weights provide a data-driven metric for the perceptual or motor phoneme manifold. We find that they differ by more than an order of magnitude, and differ across languages, pointing at the need to go beyond the classical digital description of phonemes.

9

The role of frequency effects and cognitive development in language acquisition. A study on countability.

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Literature suggests a bias for countability in language acquisition: children likely assume a new word to refer to a whole-object, not to the substance of the object (Bloom & Kelemen, 1995; Markman, 1990) and prefer the count morpho-syntax over the mass morpho-syntax (Barner & Snedeker, 2005; Gathercole, 1985).

Why is count interpretation favored? Is this bias due to a linguistic difference between mass and count nouns? In our study on Italian, we selected by means of corpus queries: 10 "mass" nouns, i.e. nouns appearing more frequently in a mass context (*sand*); 10 "count" nouns, i.e. nouns appearing more frequently in a count context (*ring*); and 20 "neutral" nouns that appear in both contexts with similar frequency (*pizza*). For each noun, two identical sentences were created: in one the noun appeared in a mass context, in the other one, in a count context. Grammaticality judgments on these 80 sentences were collected on 152 adult native speakers (age range: 19-77) and on 58 preschool children (age range: 62-76 months). Acquisition of experimental nouns were assured.

Adults judgments were collected by means of an online rating questionnaire. Scores ranged from 0 (totally unacceptable) to 4 (totally acceptable). Only count nouns in mass context (mean= 0.37) and mass nouns in count context (mean= 0.48) were rejected; sentences in the other conditions were scored above 2.50, that had been fixed as the acceptability threshold.

Children gave a yes/no answer about the acceptability of the sentences. They partially replicated the pattern of the adults, however they rejected more count nouns in mass context (80.0%) than mass nouns in count context (51.2%, $p < .0001$). Moreover, neutral nouns were mostly rejected in mass context (63.96%).
Additional analyses showed that children's performance with mass ($r= .27$; $p< .05$) -but not count ($r= .12$; $p= .36$)- context positively correlated with their performance in the Logical Operations and Conservation test on abstraction abilities (Vianello & Marin, 1997).

In sum, countability in the language is modulated by frequency effects. However, frequency alone is not explicative for what concerns children's performance on neutral nouns and on mass nouns in count context, which are better explained by hypothesizing that the processing of uncountability relates with extra-linguistic cognitive abilities. Overall, these findings suggest that language acquisition models that rely on statistical learning may also take into consideration the role played in the development by extra-linguistic cognitive abilities which provide salient information encoded into language.

34

Word co-activation and competition and the perception of morphological structure

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The cognitive literature on similarity-based principles of word association has greatly contributed to understanding effects of family size and frequency of neighbouring words on a variety of word processing tasks: non-word repetition (Vitevitch et al. 1997; Vitevitch & Luce 1998), recall from verbal short-term memory (Gathercole et al. 1997), phoneme identification (Pitt & McQueen 1998) and word recognition (Luce 1986; Luce & Pisoni 1998). Beyond specific differences depending on the nature of the input stimuli (e.g. acoustic vs. visual) and the processing requirements of the task (e.g. word recognition vs. word production), an interesting general pattern of reversal emerges: neighbours have facilitative effects on spoken word production and inhibitory effects in spoken word recognition. Furthermore, the frequency distribution of neighbours plays an important role in determining whether competition/co-activation effects are facilitative or inhibitory: high-frequency neighbours tend to exert an inhibitory effect on some processing tasks, while low-frequency neighbours facilitating execution of the same tasks. In the talk, we consider what competition-co-activation effects in lexical processing can tell us about the emergence of structure in morphologically complex words, based on evidence from highly inflected languages (Marzi et al. 2016) and English word compounding (Gagné & Spalding (in press); Ferro et al. 2016).

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57

Word co-activation and competition and the perception of morphological structure

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