Creating a map of language disorders and their relation to cognition

Research proposal for a collaborative scheme between the Grammar & Cognition lab and the Fundación Querer 2018-2019

I. Introduction: Problems in special education that we need to face

Language is a critical factor in a child's cognitive development. It is an inherent element in most social interactions, it structures our thinking, and much of what we learn about the world is learned through language. Language disorders thus must have direct consequences for our cognitive and social development, and our ability to learn. But language disorders can be of numerous kinds, each of which connects with cognition and learning in different ways.

This proposal is for a collaborative scheme between the Grammar & Cognition lab (GraC, www.grammar.cat) and the Querer foundation, in which language profiles are comparatively assessed across different clinical populations and non-linguistic cognitive capacities are assessed alongside, to see how language and cognitive profiles connect and how educational strategies and therapies can be individualized to become more effective.

This scheme seeks to address a number of societal challenges that limit such effectiveness today.

These specifically relate to the need to integrate the two sectors of research and education:

Research in the language sciences and in language disorders is often highly specialized and disunified even in universities themselves and remote from the practice of educators.

This makes it difficult to ground educational principles in such research. Moreover, insight gained from research is slow, but educational needs need to be addressed by educators and parents on a daily basis.

Research is often driven by other factors than the educational needs of children. For example, to this day, children with low-functioning autism, which make up almost half of the autism spectrum, have very little research dedicated to them, although the challenges they pose for educators are much harder than in the case of high-functioning autism, where research activity is vast. There is no such thing as generalized language problems, and hence no generalized language treatment:

1. Language can dysfunction or break down in multiple ways, not only within disorders such as autism spectrum disorders (ASD), but also between disorders such as ASD, Specific Language
2. Impairment (SLI), Landau-Kleffner syndrome and childhood aphasia, severe dyslexia, refractory epilepsy, non-autism-related neurogenetic syndromes such as Cri du chat or Worster-Drought syndromes, or autism-related syndromes such as Heller or Rett syndromes, among others.
3. Differences in the language profiles of these syndromes can help to distinguish between them and illuminate their cognitive bases, yet are scarcely investigated systematically. This makes it difficult to personalize treatment of these problems and educational needs.

Outside of SLI, impairments of language are often regarded as secondary to other cognitive impairments, for example intellectual disability or deficits in social cognition. This is a currently unwarranted assumption where more research is required. This assumption can prevent language from being directly addressed and it can lead to children with language problems not receiving language treatment.

Understanding language problems and differences in them across syndromes requires knowledge of linguistic concepts. But language is a complex domain requiring technical concepts and knowledge of language sciences that is often simply not available to educators in special schools.

In most universities and research centers, recruitment of clinical populations often creates significant challenges, and graduate students have little exposure to such populations. This requires more systematic and long-term cooperation between schools and research groups to be put in place.

Due to resource problems, children in many special schools and even in many centers of attention are often only diagnosed through a clinician's judgment and never involve the appropriate standardized tests (for example, in the case of ASD, standard diagnostic tools such as the ADOS or ADI-R, which together take about 4 hours of assessment by a trained specialist). In rare diseases, such standardized tests are not available at all.

This situation calls for a new approach in which systematic partnerships are forged between research institutions and schools from the beginning, allowing two-way interactions between research and education to be set up sustainably and in the long term. The setting up of El Cole de Celia y Pepe by the Querer Foundation sets up a unique opportunity to make progress on this front.

II: Aims

Our overall aim is to profile language behaviorally across the different populations available in this school and to study connections and disconnections between linguistic and non-linguistic cognitive profiles that can feed into new educational approaches and tests. Specifically, we will:
Go beyond standardized language assessments in assessing language abilities, using a hypothesis-based approach involving up to date concepts, tools and methodologies from the language sciences and psycholinguistics.

Develop a language-based typology of language dysfunction across the disorders.

To systematically assess language along with non-linguistic cognition, to see how the former influences the latter.
To explore the development of new and personalized but generalizable educational perspectives based on the above.

III. Research questions

Our basic research question is whether a typology of different, characteristic language profiles associating with developmental disorders can be set up, in a way that illuminates the cognitive differences between them and facilitates diagnosis and classification. Specific research questions are:

R1: Which levels of organization in the complex architecture of our language capacity are affected in a particular disorder, can these language profiles be diagnostically useful, and can a typology of forms of language dysfunction be aligned with diagnoses?

R2: How do linguistic and non-linguistic cognition connect or disconnect in each disorder?

R3: More specifically, how do motor and cognitive factors interact in generating particular linguistic profiles?

R4: Which standardized clinical language tests show appropriate sensitivity to these language profiles so that they can be recommended in educational practice, and how can they be adapted or replaced in order to improve such sensitivity?

R5: Which treatment trials and educational practices can be motivated based on answers to the research questions above?

IV. Implementation and methodology

4.1: Partners

From its side the GraC lab offers an integrated new research environment in which linguistic theory and clinical research in language disorders has come together. We believe that language disorders will remain intractable if we don't squarely address foundational questions of how language is structured, how it impacts on cognitive development, and how different language disorders can connect to cognition in very different ways. To many people, it seems obvious that language is simply an instrument of communication. But it might be more: an instrument of thought, which mediates our relationship to ourselves and to others. The mission of our lab is to do systematic comparative research on language disorders required to address this question. The mission of El Cole de Celia y Pepe in turn is to provide individualized quality education to children with severe language disorders, and to integrate research into its multi-disciplinary educational team dedicated to educating children with severe language disorders.
Our partnership provides a basis for the needed integration between the sectors of research and education.

4.2: Research team

GraC is directed by Wolfram Hinzen (WH) who leads a team of currently 1 other senior member (Prof. J. Rossello, Universitat de Barcelona), 6 doctoral researchers, 3 postdocs, yearly cohorts of Masters students, with associated doctors and clinicians. WH is an ICREA (Catalan Institute of Advanced Studied and Research) research professor based at the Universitat Pompeu Fabra and the FIDMAG Research Foundation at the Benito Menni Hospital, Sant Boi, Barcelona, where the neuroimaging research is carried out in which GraC is involved (see also below). For the present proposal, 1 further predoctoral and 1 part-time postdoctoral researcher will be integrated into the GraC team who will be specifically devoted to the present cooperation and carry out the research proposed. They will add linguistic expertise to the multidisciplinary team assembled by the school.
Methods and tools

Our general methodology is designed to be flexibly adaptable to different populations with language disorders of the kind that will be seen in the school, as is also in line with our comparative approach. Depending on sample sizes available, studies performed will take the form of case or group studies. To increase samples, additional children will be recruited from five special schools in the Barcelona area with which GraC has collaborative schemes in place. Upon joining this project, the two researchers will start profiling language and

cognition across disorders using both standardized and non-standardized tools. The former include tests such as the Peabody picture vocabulary test, the CELF language assessment, tests of verbal and nonverbal intelligence (e.g. Leiter-R), and the ComFor, which is a visually-based assessment of a child's level of representational cognition currently used in our group in projects on low-functioning ASD. The latter are new to the present research scheme and will include:

- ✓ An adapted version of the Peabody currently in preparation in our research and better suited particularly to low-functioning autism, but potentially to other clinical groups in the school as well;

- ✓ Acoustic and prosodic analysis of speech output as specifically required for answering R3, which only recently has begun within research on ASD (Thorson et al., 2016), but should be expanded to other populations with severe language dysfunction;

- ✓ A classification scheme of nonverbal communication used previously in Slusna (2017), to see how ideas are conveyed by a child when verbal communication is impaired;

Experiments testing skills of semantic generalization in explicit and implicit learning tasks pioneered by DeVilliers (2014) and recently applied by her and colleagues to neurotypical young children visiting the Boston Baby Lab (Shukla, 2016; 2011), to specifically address R2.

To our knowledge, these last experiments have never been executed in children with neuro-developmental disorders, and in particular, with severe language problems, so they require specific comment. In their explicit version, they consist in a 'forced choice' task where the child selects a 'best match' of two pictures, for example a ball and a non-ball, when in a previous learning phrase, different types of balls with different colors were trained to trigger the generalization 'ball'. In a more sophisticated version, where the child can rely less on purely perceptual resources and likely requires language cognitively, the learning phase is set up so as to trigger the generalization of a transitive event, e.g. 'dogs chase boys', though in each trial different dogs chasing different boys are seen, i.e. events are perceptually different. Acting out procedures will also be chosen, i.e. an experimenter performs an action on an agent, e.g. a boy pushes over a tiger, and then repeats the same action with a different boy and/ or tiger, upon which the child will be asked to repeat the action. In one condition, the experiment will give a verbal description of the event (e.g. 'Look, a boy is pushing a tiger'), while in the other he will simply ask the child to 'do the same', so that the child has to tacitly conceptualize the event without the help of an explicit verbalization.

Implicit version of the same paradigm in turn do not require explicit judgments

and will be implemented with an eye-tracker, where anticipatory looking time to the expected location of one of two pictures will be the dependent measure. More details of these procedures are provided in De Villiers (2014). This paradigm allows flexible expansions beyond objects and event-concepts, e.g. the concepts of negation or quantificational concepts, so as to systematically profile a child's thinking and conceptualization of the world under condition when its language capacities are subject to different forms of malfunction.

4.3: Expansion

In the second year of the project, a gradual expansion of this research scheme into a scheme involving a functional neuro-imaging study of brain correlates of different forms of language dysfunction is envisaged. Such a study is currently carried out by GraC on nonverbal children with autism and would be considerably easier in the verbal children in this school. Moreover, the Hermanas Hospitalarias foundation, which hosts this other research, has hospitals in the Madrid area as well, where relevant neuroimaging facilities could likely be made available in cooperation with FIDMAG, where WH is also based. The point of this expansion would be to relate language profiles as well as outcomes of therapeutic interventions to brain images. These would be taken at baseline and when the therapy is finished, so as to be able to potentially predict therapeutic successes based on brain data, and thus to obtain an objective basis for therapeutic decisions. However, this expansion of the present project is not budgeted for here and would require other personnel resources as well.

Time schedule

Month 1-6: Standardized testing and preparation of non-standardized tests.
Month 6-12: Running of non-standardized experiments and tests.
Month 12-18: Evaluation and writing up of results.
Months 18-24: Exploratory research on new educational and therapeutic tools.

BUDGET: 100.000 € / two years

References

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